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TRANSACTIONS

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Contents

Photography has become a universal metaphor for remembering. Rather than making memory more reliable, Professor Graham argues that photography has, in crucial ways, made it difficult to trust what we do recall. By analyzing a poem by Douglas Dunn, *St. Kilda's Parliament,* Graham examines a troubling question: when memory and photography are at odds, as they must often be, which shall we trust?

The effects of the Department of Agriculture's Dairy Termination Program on Wisconsin's dairy industry is examined in this well-researched paper. The data are examined statistically and displayed through a series of maps. The paper concludes with an analysis of the impacts of the program upon the participating farmers and their future agricultural activities.

What is the status of the timber rattlesnake in Wisconsin? Oldfield and Keyler surveyed sites ranging from southern St. Croix County to northern La Crosse County along the Mississippi River Valley. Their conclusion is that the timber rattlesnake may not be as widely distributed or as numerous as previously thought. There may even be a need for both habitat and species protection.

Some of Wisconsin's well-known poets as well as some who are relatively new to our state are represented in the poetry section.

Erosion of the glacially-derived red clay soils in the western Lake Superior Basin is a serious problem. This paper is an examination of the influence of plant root systems on erosion of these soils. The evidence indicates that vegetation comprised of woody, advanced successional species afford the best protection against both surface and deep-seated stream bank erosion.

The Aquatic Macrophyte Community of Black Earth Creek, Wisconsin: 1981–1986 101
John D. Madsen

The biomass and relative species abundance of the submersed aquatic macrophyte communities in Black Earth Creek, Wisconsin, were examined in 1986 and compared to data gathered in 1981 and 1985. The study indicates that although total macrophyte biomass and abundance may fluctuate dramatically due to physical events, the relative frequency and dominance of species remain relatively constant.

Announcement

The Wisconsin Arts Board has awarded the Academy a grant to help publish an anthology of contemporary Wisconsin poetry as a special edition of *Transactions*. There has not been such an anthology for over thirty years, and we think this work will serve as both a showcase and a historical record of the broad geographical, ethnic, and stylistic cross-section of Wisconsin poetry.

Poets who are interested in additional information and directions for submitting poetry should write to the Editor. Since work will be underway before this announcement is published, authors should not delay their inquiries.

From the Editor

We are pleased to be able to publish the 1989 issue of *Transactions* (Vol. 77) in the year of its date. During the past two years we have worked to shift the publication time from February to the fall; it now appears that this distribution schedule can be maintained. Work has already begun on Volume 78 (1990), and Wisconsin writers and people writing about Wisconsin are invited to submit articles or proposals for publication.

The poetry and photography sections contained in the 1988 volume have been well received by members of the Academy. And we are pleased to include another selection of poetry from some of Wisconsin's noted poets in this issue. Though there is no photography section in the current volume, it is hoped that 1990 will see a return of that feature. Anyone wishing to submit a proposal for photography is asked to contact the editor.

Readers of this issue of *Transactions* will see great variety in subjects. Papers range from the concluding one in the series on Black Earth Creek to an analysis of Wisconsin's Changing Dairy Industry to a study of common whites and blacks in Antebellum North Carolina. The opening article, however, is based on a paper presented at the 1988 annual meeting held in Menomonie. The subject of the relationship of photography to memory is common, but David Graham introduces us to "Whittling Time: Photography and the Poetry of Memory." Those who attended the 1989 annual meeting in Green Bay will recognize that this topic was the basis of a symposium presented by three of Wisconsin's leading poets and one of its leading photographers.

In addition to the diversity in the articles presented, I am particularly impressed with the high quality of the work done by people who live in or write about Wisconsin. Making *Transactions* reflect the vigorous intellectual life in the sciences, arts, and letters in our state has been the goal of the Wisconsin Academy for over a hundred years, and it is hoped that the current issue of the journal continues that long tradition.

Comments, submission, or suggestions should be addressed to the Editor.

Carl N. Haywood

Whittling Time: Photography and the Poetry of Memory

David Graham

My subject is, from one perspective, entirely traditional. The link between photography and poetry can be expressed in the most ancient terms: both are children of Zeus and Mnemosyne. The goddess of memory, Mnemosyne, as mother of the Muses, is naturally the source of all the arts and sciences, traditionally defined. Poetry's kinship to memory requires little elaboration; the Greeks delegated authority for poetry to three of Mnemosyne's nine daughters: Calliope, Erato, and Polyhymnia (representing epic, lyric, and sacred poetry, respectively). Photography, which aims to stop time and preserve the present into the future, is, if anything, even more closely allied to memory. The Muse of photography is most likely Clio, the Muse of history, for history is photography's subject and medium.

From another perspective, however, the pairing of poetry and photography raises questions that are not easily dealt with in traditional terms. I want to focus on these issues by way of a close look at a single poem, Scottish poet Douglas Dunn's remarkable dramatic monologue, "St. Kilda's Parliament: 1879–1979." But first, I want briefly to provide the poem and photography itself some historical context.

Photographer Paul Strand claimed in a 1917 essay that photography "is the first and only important contribution thus far, of science to the arts" (219). A hyperbolic assertion, perhaps, but it points in a useful direction. For science, in its oldest meaning, is simply knowledge; and the modern era is characterized by countless developments in science and technology which, in supplying new ways of viewing the world, have thus influenced the arts directly or indirectly. Though not always mentioned with science and technology, the invention of photography has arguably had as much influence on our ways of knowing the world as any other: it has led to developments as varied as cinema, television, electron microscopy, surveillance cameras, and modern techniques of propaganda, advertising, and book printing and illustration.

Indeed, some writers have gone further than Paul Strand, declaring that photography has effected an alteration in human consciousness comparable to the theories of Darwin and Freud. As just one instance of such large claims, consider Walter Benjamin's famous essay of 1936, "The Work of Art in the Age of Mechanical Reproduction," in which he specifically details the way that photography, like Freud's theories, fundamentally modified the way we perceive our reality; and in which he also firmly places photography at the center of the political upheavals in modern life predicted by Marx. Whether such radical claims for photography may hold up remains an open question and falls outside the scope of this essay. But, as I will argue later on, photography has important links to at least one crucial development of modern thought, quantum physics.

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Since photography made it possible, as never before, for nearly everyone to record the features of loved ones, places visited, and public or private events, it has become a universal metaphor for remembering itself. It is this idea and its ramifications that I want to examine more closely. For if the ways in which photography has altered our views of reality are not yet fully charted, we may begin to understand them, at least, by looking closely at a single theme.

Photography's importance to the poetry of memory is obvious. What is less obvious, at least to the general public, is the possibility that in crucial ways photography has made it difficult to trust what we do recall. We all want to believe that the camera never lies, but, as we all probably sense instinctively, it does lie, and with a maddening, pervasive persistence. Not only does the camera portray reality as what it is not—a series of static, two-dimensional slices of time—but even more critically, the photograph cannot, by definition, capture what we tend to value most: the imaginative or interpretive meaning of a scene, its full context. John Berger is correct in pointing out that "unlike memory, photographs do not in themselves preserve meaning. They offer appearances—with all the credibility and gravity we normally lend to appearances—prised away from their meaning. Meaning is the result of understanding functions" (51).

Meaning can in fact be fraudulently imposed on a scene. This happens not just when there is propagandistic intent, but whenever a photograph is taken, because any photographer must frame the shot, decide on angles and exposures, and ultimately select the "best" picture for display. Similarly, as many photographic historians and critics have demonstrated, the visual information provided in photographs is sometimes inherently ambiguous; we need the captions in order to understand numerous photos. Janet Malcolm writes,

> One of the chief paradoxes of photography is that though it seems to be uniquely empowered to function as a medium of realism, it does so only rarely and under special circumstances, often behaving as if reality were something to be avoided at all costs. If "the camera can't lie," neither is it inclined to tell the truth, since it can reflect only the usually ambiguous, and sometimes outright deceitful, surface of reality. (77)

The photograph's ability to distort reality is, or ought to be, a truism. Yet photography does indeed capture something; as Susan Sontag notes, we assume that each photo, even if visually enigmatic, nonetheless is "a piece of the world" (93). As such, it still possesses an uncanny persuasive power, even when we know better than to trust it fully. Here is what is perhaps photography's richest paradox, between what Roland Barthes in his book *Camera Lucida* calls each photograph's "certificate of presence" (87) and its inevitable warpings of reality.

With these tensions and paradoxes in mind, I want now to look in detail at Douglas Dunn's poem, which appeared in 1981 as the title poem of his book *St. Kilda's Parliament*. In it he conducts a focused meditation, with far-reaching implications, on a single photograph. This image may have been invented by the poet, or it might be a fictive composite of many similar photographs. It is nevertheless treated as real in the poem's fiction. (Worth keeping in mind here is the likelihood that without the rich record of historical documentary photographs, Dunn, born in 1942, could not have written this poem.)

Since it is fairly long and not well known, I give the poem here in its entirety:

St. Kilda's Parliament: 1879–1979

The photographer revisits his picture

On either side of a rock-paved lane,
Two files of men are standing barefooted,
Bearded, waistcoated, each with a tam-o'-shanter
On his head, and most with a set half-smile
That comes from their companionship with rock,
With soft mists, with rain, with roaring gales,
And from a diet of solan goose and eggs,
A diet of dulse and sloke and sea-tangle,
And ignorance of what a pig, a bee, a rat,
Or rabbit look like, although they remember
The three apples brought here by a traveller
Five years ago, and have discussed them since.
And there are several dogs doing nothing
Who seem contemptuous of my camera,
And a woman who might not believe it
If she were told of the populous mainland.
A man sits on a bank by the door of his house,
Staring out to sea and at a small craft
Bobbing there, the little boat that brought me here,
Whose carpentry was slowly shaped by waves,
By a history of these northern waters.
Wise men or simpletons—it is hard to tell—
But in that way they almost look alike
You also see how each is individual,
Proud of his shyness and of his small life
On this outcast of the Hebrides
With his eyes full of weather and seabirds,
Fish, and whatever morsel he grows here.
Clear, too, is manhood, and how each man looks
Secure in the love of a woman who
Also knows the wisdom of the sun rising,
Of weather in the eyes like landmarks.
Fifty years before depopulation—
Before the boats came at their own request
To ease them from their dying babies—
It was easy, even then, to imagine
St. Kilda return to its naked self,
Its archaeology of hazelraw
And footprints stratified beneath the lichen.
See, how simple it all is, these toes
Playfullly clutching the edge of a boulder.
It is a remote democracy, where men,
In manacles of place, outstare a sea
That rattles back its manacles of salt,
The moody jailer of the wild Atlantic.
  Traveller, tourist with your mind set on
Romantic Staffas and materials for
Winter conversations, if you should go there,
Landing at sunrise on its difficult shores,
On St. Kilda you will surely hear Gaelic
Spoken softly like a poetry of ghosts
By those who never were contorted by
Hierarchies of cuisine and literacy.
You need only look at the faces of these men
Standing there like everybody's ancestors,
This flick of time I shuttered on a face.
Look at their sly, assuring mockery.
They are aware of what we are up to
With our internal explorations, our
Designs of affluence and education.
They know us so well, and are not jealous,
Whose be-all and end-all was an eternal
Casual husbandry upon a toehold
Of Europe, which, when failing, was not their fault.
You can see how they have already prophesied
A day when survivors look across the stern
Of a departing vessel for the last time
At their gannet-shrouded cliffs, and the farewells
Of the St. Kilda mouse and St. Kilda wren
As they fall into the texts of specialists,
Ornithological visitors at the prow
Of a sullenly managed boat from the future.
They pose for ever outside their parliament,
Looking at me, as if they have grown from
Affection scattered across my own eyes.
And it is because of this that I, who took
This photograph in a year of many events—
The Zulu massacres, Tchaikovsky's opera—
Return to tell you this, and that after
My many photographs of distressed cities,
My portraits of successive elegants,
Of the emaciated dead, the lost empires,
Exploded fleets, and of the writhing flesh
Of dead civilians and commercial copulations,
That after so much of that larger franchise
It is to this island that I return.
Here I whittle time, like a dry stick,
From sunrise to sunset, among the groans
And sighings of a tongue I cannot speak,
Outside a parliament, looking at them,
As they, too, must always look at me
Looking through my apparatus at them
Looking. Benevolent, or malign? But who,
At this late stage, could tell, or think it worth it?
For I was there, and am, and I forget. (13–15)

Dunn's beautifully comprehensive poem manages to touch on most of the issues I have mentioned while focusing on the idea of using photography as an aid to memory. Precisely this problem has interested many poets: when memory and photography are at odds, as they must often be, which shall we trust? Dunn's subtitle, "the photographer revisits his picture," reminds us from the start of the difficulty in evaluating the past through both memory and photographic record. Presumably a visit will never be the same as a revisiting. In this case he puts the closely allied questions of memory's reliability and photography's truthfulness at the heart of things in several related ways. First, the photographed scene took place in a village that no longer exists: as the poem relates, the island of St. Kilda (actually a group of four small islands), located at the outermost of the Outer Hebrides, was depopulated fifty years after the photo was taken. Victorian Britons had been charmed to discover an example of a relatively primitive, "untainted" culture so close to home. The islanders had lived for centuries in comfortable isolation from technological developments on the mainland. Naturally, with the influx of tourists to their island, their way of life began to be disrupted with epidemic diseases as well as the breakdown of their traditional economy. In 1879, the year of the photograph, this process would have been well underway, though the end may not yet have been in sight. To twentieth-century ears, of course, that end has a sadly familiar ring: by 1930, the few who had not already emigrated had to be evacuated by the British government from a home that was no longer hospitable. The island is now a nature preserve and, with restoration efforts, is once again a destination for tourists (Tindall 169–71).

Whether or not Dunn is referring to an actual photograph, he is describing a common social use of photography. As James Guimond notes, from the inception of photography, "whenever people believe[d] that something [was] going to be destroyed, they rush[ed] to photograph it" (788). Photographers have always been "obsessed with the desire to capture what are called 'vanishing ways of life.' " Guimond continues, "photographers . . . have shared the . . . determination to record the images of aboriginal cultures which were on the brink of disappearing or being assimilated" (788). The nostalgic and sentimental impulse that, in America, produced stories, art, and photographic documentation of our "vanishing frontier," sent British Victorian photographers across the world in search of quaint, primitive, and exotic cultures. Finding such a people so close to home was especially exhilarating. The inescapable irony here, and one of which Dunn's narrator seems keenly aware, is that the curiosity for information about such endangered cultures helped contribute to their extinction.

Thus, the photographer in 1979 views a reality that is permanently ended. In addition, the photographer, unless he is well over a century old, must be speaking to us from the grave and so is himself doubly removed from the described scene. Therefore, he may also be intended as a sort of historical Everyman, looking back on the first century and a half of photography's existence. In any event, he makes it plain in his monologue that he feels at home neither in St. Kilda, "among the groans / and sighings of a tongue [he] cannot speak," nor in the "larger franchise" of modern life. I will have more to say about this uneasiness shortly.

Furthermore, we readers are distanced from the scene by its very unfamiliarity. As Dunn notes, these remote islanders photographed in 1879 live without knowledge of

> . . . what a pig, a bee, a rat,
> Or rabbit look like, although they remember
> The three apples brought here by a traveller
> Five years ago, and have discussed them since.

Such details clearly are what attracted tourists in the first place. These islanders were inevitably seen in patronizing terms by the inhabitants of industrialized Britain, praised and condescended to simultaneously, as representatives of the persistent myth of pastoral simplicity and innocence.

Obviously the barriers to comprehension here are formidable and many-layered. These islanders are inescapably *other* (different, strange) in habit, outlook, experience, and, of course, in time. The melancholy of such separation (even from someone, like the photographer, who has been there) is frequent in poems about photographs. Here, Dunn's narrator sees such separation, understandably, as being slightly threatening to him. Most of the men in the photo, he notes, display "a set half-smile / That comes from their companionship with rock, / With soft mists, with rain, with roaring gales . . . ." Even dogs "seem contemptuous of [his] camera," he feels, commenting of the islanders generally:

Wise men or simpletons—it is hard to tell—
But in that way they almost look alike
You also see how each is individual,
Proud of his shyness and of his small life
On this outcast of the Hebrides . . . .

This photographer is intelligent enough to know that however "alike" such people may look to the outsider's eye and the camera's lens, they maintain an ineffable individuality, one that he can only express, perhaps, by oxymoronic phrases like "proud of his shyness." This recognition shows up in many small details throughout the poem, in the poet's fussy or self-deprecating tone, in his cautious qualifiers, but most of all in his savoring of the visible details of the scene, tacitly recognizing that such appearances are the lion's share of what he really knows. In a sense, he can be sure only of what is outwardly apparent, such as the "toes / Playfully clutching the edge of a boulder."

We see more than a trace of envy, too, in the speaker's noting that each St. Kilda man looks "secure in the love of a woman who / Also knows the wisdom of the sun rising, / Of weather in the eyes like landmarks." These dead men and women, in other words, are secure in more than one sense: safe in each other's love, they are also secured against doubt by their customs and remoteness, and, finally, protected utterly from intrusion by their eternal dwelling in that vanished year. Here we are not far in spirit, of course, from the happy lovers on Keats's Grecian Urn, who, imprisoned in their artistic image, are thus preserved from the depredations of time and remain eternally young and lovely. As much as he leans on such romantic notions, however, Dunn never lets us forget that these St. Kildans were actual people in a real place.

The poem grows more explicit about the photographer's melancholy envy as it continues, granting these doubly exiled islanders an ironic triumph over both the reader and the photographer himself. In turning to address the modern tourist, the "Traveller," the narrator speaks across the double gulfs of time and poetic fiction, and explicitly implicates the contemporary reader in his themes:

. . . if you should go there,
Landing at sunrise on its difficult shores,
On St. Kilda you will surely hear Gaelic
Spoken softly like a poetry of ghosts
By those who never were contorted by
Hierarchies of cuisine and literacy.
You need only look at the faces of these men
Standing there like everybody's ancestors,
This flick of time I shuttered on a face.
Look at their sly, assuring mockery.
They are aware of what we are up to
With our internal explorations, our
Designs of affluence and education.
They know us so well, and are not jealous,
Whose be-all and end-all was an eternal
Casual husbandry upon a toehold
Of Europe, which, when failing, was not their fault.

The sly mockery here is, of course, not so much read in the photo as read into it by the speaker, who believes that in many ways the more technologically advanced society which absorbed these people is inferior to their culture. No doubt he achieved this perception only as time passed. He may now regret his part, as a nineteenth-century tourist, in the corruption of the St. Kildans' traditional ways, even though as a photographer he is also party to its preservation in images. The St.

Kildans had, or so he now believes, no need for "internal explorations" (such as this poem, for instance), and were not warped by the presumably spurious "hierarchies" of civilized life, including "literacy" itself as well as "designs of affluence and education."

Up to this point Dunn's view of these islanders might seem sentimental, as if he saw them as somehow noble in their simple-minded farming of their "toehold" of an island. It is a familiar symbolic structure: ever since Virgil, poets have been lauding an Arcadian ideal, the rural life far from the corruptions of city and court. Yet if the language spoken by the St. Kildans, "a poetry of ghosts," is the idiom of lost innocence, it is of a special kind. There is indeed an implicit judgment in their "casual husbandry," an indictment of the mainland culture and its simplistic belief in progress. These islanders, after all, have survived since prehistoric times with an unchanging, self-sufficient economy, however primitive it might appear to outside eyes. However, the narrator is careful to declare that though the islanders may "know us so well," that is, well enough to mock our obsessive trust in progress, still they "are not jealous" and evidently do not regret the imminent passing away of their own way of life. The islanders are not seen as simple pastoral types; they embrace modern life pragmatically or fatalistically enough, for their own unstated reasons.

The poem's photographer imagines that these people, fifty years in advance, have "already prophesied" their departure from St. Kilda, and still "pose for ever outside their parliament, / Looking at me, as if they have grown from / Affection scattered across my own eyes." Although they were indeed real enough, their representation in the photograph derives precisely from the "affection scattered" across the photographer's eyes because the photographer has arranged the moment, posed them, and, most of all, preserved his photo for a century. Why did he do so? Why is he compelled (even from the grave) to revisit his own photograph? No doubt he needs to verify, with the photograph's aid, his feelings for these people and their vanished way of life. All ways of life are vanishing, from such a perspective, and the photographer is one whose profession involves an attempt to halt such flux. This effort is doomed, of course, and the photographer must know it as well as anyone does. He sees these islanders as not being jealous of him, we may presume, precisely because he is jealous of them.

The poignancy of such a moment—looking back at the photographed past, knowing absolutely its eventual dissolution and yet remembering, with the photo's aid, its vivid presence—is central to this poem and to others like it. In fact, as Roland Barthes has written, this paradox lies at the heart of historical photography's ability to move us. Commenting on an 1865 photo of a soon-to-be-executed criminal, Barthes notes:

> . . . *he is going to die*. I read at the same time: *This will be* and *this has been*; I observe with horror an anterior future of which death is the stake. . . . I shudder . . . *over a catastrophe which has already occurred*. Whether or not the subject is already dead, every photograph is this catastrophe. (96)

Similarly in Dunn's poem: "looking at them," the photographer notes that "they, too, must always look at me / Looking through my apparatus at them / Looking." Richard Powers, in *Three Farmers On Their Way To A Dance*, his complex historical novel revolving about a similar re-viewing of an old photograph, has suggestive things to say about such self-conscious moments:

> We scour *over* a photo, asking not "What world is preserved here?" but "How do I differ from the fellow who preserved this, the fellows here preserved?" Understanding another is indistinguishable from revising our own self-image. The two processes swallow one another. Photos interest us mostly because they look back. (332)

This unsettling feeling of being watched, even judged, that often comes to us while looking at old photographs, derives from the "catastrophe" Barthes describes, that shudder of recognition coexisting with the inevitable feeling of separation. It is normal to feel pity for the inhabitants of the past in old photographs because we presumably know more than they do; we may even know the details of their own future catastrophes. Yet, as Barthes knew and Dunn implies, what really animates our pity is the sense that these disappeared people also knew much that we never will. Likewise, the one invisible but suggestive presence in any old photograph, of course, is the photographer himself, who is just as much a disappeared person as the nominal subjects. Looking at a photograph we have taken spurs us to ask questions of ourselves the answers to which are largely lost.

Dunn's narrator concludes by asking, of the St. Kildans' looking through time at him, "Benevolent, or malign?" And he answers himself unsparingly: "But who, / At this late stage, could tell, or think it worth it? / For I was there, and am, and I forget." What does it all matter, then, if forgetting is inevitable, as it surely is?

The answer, to the extent that a paradoxical compromise can be one, must lie in the interplay of viewer and viewed. For the poem recognizes that there is really no such thing as disinterested observation. Having been to St. Kilda before its culture vanished, having been indulged by the islanders, the photographer is forever marked by the exchange. He feels impelled by "affection" to return not just to St. Kilda, but to "a year of many events— / The Zulu massacres, Tchaikovsky's opera . . . "—in other words, a year like any other, equally rich with human suffering and high achievement. His return both reflects and implicitly rejects "that larger franchise" of worldly pain, loss, dissolution, and tawdry display that this photographer confesses he spent many subsequent years recording, and from which these St. Kildans are forever protected:

. . . photographs of distressed cities,
My portraits of successive elegants,
Of the emaciated dead, the lost empires,
Exploded fleets, and of the writhing flesh
Of dead civilians and commercial copulations . . . .

Listed thus, these familiar elements of the modern age, so often the impetus for sensational photographs, seem flat and pathetic. Dead and gone, the people of St. Kilda cannot writhe or suffer exploitation. The photographer, in returning to tell them this, is obviously telling himself and us, and seeking (without real hope) the impossible stasis of a prelapsarian world. He finds that world not in memory, precisely, but in the shaping of memory represented by photography, which both preserves and distances the past and its inhabitants. His solace depends upon convincing himself not just that St. Kilda did indeed exist as he remembers it, but also that its natives were in fact *knowing* in a way forever denied to him. He senses their knowledge as a tight-lipped judgment of him, which he can feel but never fully understand. And thus, paradoxically, the photographer and his subjects are united while being forever separated.

This paradox, lying at the heart of the photographic act, is relevant to modern notions of the ambiguity and relativity of all knowledge. Einstein's central idea, like Freud's, has spread beyond its original context, becoming part of the intellectual inheritance of modernity. As Jacob Bronowski summarized it, "relativity is the understanding of the world not as events but as relations" (38), a remark that could fairly stand as a description of one of Dunn's themes here. The photographer revisiting his picture is not revisiting a thing or a place, but is involved in preceiving the relation between his various selves over time. Similarly, Werner Heisenberg's Principle of Uncertainty has infiltrated areas beyond quantum physics; many modern poets have been impressed by the fact that nothing can be measured without being in some way altered. If such a notion seems little more than common sense today, it is a mark of how deeply we have been influenced by such scientific ideas.

Photography, then, is like a scientific experiment: in recording reality, it also invariably changes it, however subtly. The subjects of any photograph always look back.

So if the photographer is to the people of St. Kilda like a "[visitor] at the prow / Of a sullenly managed boat from the future," they are to him the never escapable fact of his own and the world's past. The interplay of viewer and viewed is of the essence. Again, Richard Powers provides in his novel an eloquent gloss on this aspect of the poem:

> To look at a thing is already to change it. Conversely, acting must begin with the most reverent looking. The sitter's eyes look beyond the photographer's shoulders, beyond the frame, and change, forever, any future looker who catches that gaze. The viewer, the new subject of that gaze, begins the long obligations of rewriting biography to conform to the inverted lens. Every jump cut or soft focus becomes a call to edit. Every cropping, pan, downstopping receives ratification, becomes one's own. (334–5)

Thus have novelists and poets internalized, even if in oversimplified form, both relativity theory and Heisenberg's Principle of Uncertainty.

Photography, the art that is both of time and beyond it, is uniquely able to render such tensions. It is of time in that each photograph records a particular, actual instant; it is timeless in the same way any work of art is. As Dunn's speaker says earlier in the poem, "Here I whittle time, like a dry stick, / From sunrise to sunset, among the groans / And sighings of a tongue I cannot speak . . . ." Any photographer does this, of course, marking out the implications of the still scene which we know is never really stilled. So, as Dunn's speaker reminds us, a photo is not a record of time itself, or even of time's passing, but simply of discrete instants, paralyzed and solitary, like notches on a stick. Eventually, following the metaphor's implications, we must suppose that the stick will be whittled away; of course, there is one inevitable end to all memory, the grave.

Even before death, though, our efforts to remember and preserve the past are compromised. Indeed, the whole poem, in its anxious dependence on and swerving away from the consolations of Keats's "Ode on a Grecian Urn," suggests reflection on the limits of its own descriptive power. How well, after all, does Dunn's narrator succeed in rendering for us the material world of St. Kilda? His description at first seems tangible enough, studded with details of barefooted peasants, boats bobbing in the swells, dogs lounging about, and all the "manacles of place." And he is shrewd enough to lace his description with appealingly localized diction: "a diet of dulse and sloke and sea tangle," and an "archaeology of hazelraw"—precisely the kind of exoticism that draws in an armchair traveller.

A closer look at the poem, however, soon reveals that it is not very descriptive at all. The details noted above occur in its first half only and do not really add up to a very full picture. We have only to think of the pages that Conrad or D.H. Lawrence might have devoted to the photographed scene to realize how spotty and selective Dunn's description is. Furthermore, as the second half of the poem gives itself over entirely to reflection rather than description, Dunn continues to refer rather unconvincingly to what "you can see" in the photograph. Readers are informed, as I have noted, that they can see how the St. Kildans "have already prophesied" their departure; and that they are "aware of what we are up to" in our very different society. It is no mere literalism to point out that these are exactly the sorts of things that the readers cannot see; they are interpretive remarks not backed up by any tangible evidence from the scene. In fact, such judgments obviously cannot exist in any mute image.

Given the poem's frequent emphasis on what cannot be known (all part of the "poetry of ghosts"), it seems reasonable to suggest that Dunn's deepest concern here is to devise a language that is adequate not to the people of St. Kilda but to his own sighing, observing, and scattering of affection. To paraphrase Heisenberg, Dunn is not simply describing a memory but self-consciously examining his process of remembering. The pathos of this poem and similar ones is that it inexorably becomes aware of its own inadequacy at capturing outward events and their attendant meanings.

The more we study our time-bound world, then, the stranger and more remote it seems. And naturally, the more we rely on photos as aids to memory, the more our powers of memory are bound to deteriorate, and the more, in turn, we will seek out photography: a vicious circle. Just as the spread of printed books dealt a never-rescinded blow to the oral tradition of memorization and recital, the proliferation of photography into all areas of life has probably rendered it increasingly more difficult for us to recall and interpret what has happened. "Not only is the photograph never, in essence, a memory," according to Roland Barthes, "but it actually blocks memory, quickly becomes a counter-memory" (91). To put it in less exaggerated terms, memory is a complex activity, rich with context and ripe with imagination, while a photograph's meanings are inevitably limited, cut off from context.

There is one final, related problem as well, which has occurred to nearly every commentator on the history of photography. As Dunn's fictive photographer is shrewd enough to notice, this age of the news photograph and documentary tends to conflate the values of all events, finding "Zulu massacres" precisely as interesting and photographically valuable as "commercial copulations." As Sontag puts it: "Images transfix. Images anesthetize" (20). The result is another of the peculiar dualities of photography. Images anesthetize in that the very things we find touching in photographs, like the one of St. Kilda's Parliament, tend to lose, through over-exposure, their ability to move us. Images of almost everything that was once remote, sensational, or fascinating are so widely accessible that each one carries less and less of a kick. Yet at the same time, paradoxically, images transfix in that, with time, all photographs come to look like works of art, regardless of their subjects. Photography, for all its fabled truthfulness, can easily glorify abstract form, thus beautifying the ugly or the evil. In Max Kozloff's stern summary of the history of photography,

> the genres of information were all leveled, made interchangeable with each other and of equal value. International conferences, swimming meets, strikes, and doggie pranks came to have the same, unstressed, driveling importance. (23–4)

It is a sad enough circumstance: the glut of historical photographs causes them to lose their original significance, whether we look to them for truth or for beauty. In Dunn's poem, the casual juxtaposition of "the emaciated dead" and "successive elegants," and of the "writhing flesh / Of dead civilians and commercial copulations" seem obvious instances of the leveling of value that Kozloff complains about. Less apparent, perhaps, is the way in which Dunn's photographer has inevitably, though unwittingly, aestheticized the grim reality of these St. Kildans' lives. Whatever hardships they have endured; whatever angers they feel; whatever pain or despair is to come—all tend to dissolve into the picturesque. Craggy, wind-marked faces are inescapably photogenic, and it is hard to avoid a sentimentalizing effect, however much the narrator wants to show contempt for tourists in search of "materials for / Winter conversations."

Ultimately, then, the "sly, assuring mockery" of the villagers in Dunn's poem is assuring us of one uncomfortable fact about our technological progress: that the more we have striven to grasp and record experience with our fine instruments of perception, the more impediments we have inadvertently placed between ourselves and reality—not just the reality of the past, but the present and the future as well. The "tongue [the photographer] cannot speak" is not just the Gaelic of the inhabitants of St. Kilda, but, more fundamentally, our failure to order and explain the mysteries of time and memory. It is an ancient theme after all, the chief novelty being our continuing naive belief in photography's accuracy.

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Wisconsin's Changing Dairy Industry and the Dairy Termination Program

John A. Cross

Abstract. *Wisconsin's leadership role in the United States dairy industry has increased over the past half century, although the number of dairy herds has declined by three-quarters. The U.S. Department of Agriculture's Dairy Termination Program eliminated over sixteen hundred of Wisconsin's dairy operations, with the leading milk producing areas losing proportionately the fewest operators. An additional twenty-four hundred dairy farms were lost during the two years since the first buyout herds were eliminated. Marginal areas within northern Wisconsin proportionately lost far more production than the state's leading milk producing areas. Most buyout participants remain in farming, relying upon hay and beef sales.*

The dairy industry of Wisconsin has been marked by a steady decline in the number of herds, an increase in herd size on the remaining farms, and a rising productivity per cow over the past several decades. In an effort to reduce milk surpluses Congress in late December 1985 enacted the Food Security Act of 1985 (Public Law 99-198). One provision of this legislation established the U.S. Department of Agriculture's Dairy Termination Program (DTP), whereby the dairy herds of participating farmers would be slaughtered or sold for export. This paper examines statistically the impact of the Dairy Termination Program, commonly called the whole-herd buyout program, on the changing spatial pattern of the dairy industry in Wisconsin, "America's Dairy Heartland." The impacts of the program upon the participating farmers and their future agricultural activities are also explored.

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Data Collection Methodology

Several strategies were utilized to collect data for this paper. Raw statistics were obtained from the Wisconsin State Agricultural Stabilization and Conservation Service Office concerning each accepted buyout bid and summary statistics reporting bids accepted, bids submitted, bid values, herd sizes, and 1985 milk marketing of accepted herds. A questionnaire was sent during June 1987 to each county-level office of the U.S. Department of Agriculture's Agricultural Stabilization and Conservation Service (ASCS) within Wisconsin. Because these officials had the responsibility of administering the DTP at the local level, it was anticipated that they could provide information concerning dairying trends within their counties, activities of DTP farmers, and characteristics of DTP farmers. Completed questionnaires were received for sixty-three of Wisconsin's seventy dairying counties (there are no commercial herds in Menominee and Vilas counties), representing a response rate of 90%. A four-page questionnaire was mailed in July 1987 to nearly four hundred farmers whose buyout bids were "potentially accepted." Completed survey forms were received from 305 farmers scattered throughout the state, representing a response rate of 80%. This survey queried farmers concerning their motivations for participating in the program, their past and present agricultural activities, their overall socio-economic characteristics, and their future intentions.

Changes in the Dairy Industry Since 1930

Wisconsin's national leadership in dairy production has increased over the past half century,[1] even though the nation's leading milk-producing county is found outside the state. In 1930 Wisconsin contained 8.9% of all U.S. milk cows. By 1985 this figure had risen to 17%. In 1930 Wisconsin's milk production was 11.2% of the nation's total, increasing to 17.5% by 1985 (Wisc. Agr. Stat. Ser. 1986). In 1930, three of the top five—and five of the top ten—milk-producing counties were found in Wisconsin. Although as recently as 1969 Wisconsin held two of the top five and five of the top ten positions (U.S. Bureau of the Census 1932 and 1972), by 1985 Wisconsin's only milk-producing county in the top ten was Marathon County, ranked eighth. Nevertheless, in 1985, ten of the top twenty milk-producing counties remained in Wisconsin (Wisc. Agr. Stat. Ser. 1986), the same share as in 1930. Nationally, the biggest shifts in milk production have been the declining prominence of New York counties (in 1930 St. Lawrence County, New York ranked number one nationally, with that state having six of the twenty largest producers) and the rising role of California (with eight of the top twenty counties and the nation's leading producer—San Bernandino County—by the mid-1980s). Wisconsin's milk production in 1985 was one and a half times that of California—the nation's second largest producer (Wisc. Agr. Stat. Ser. 1986). At that time 80% of Wisconsin's milk was used to manufacture dairy products, with Wisconsin producing 35.4% of the cheese and 23.7% of the butter produced in the United States. Thus in raw milk, cheese, butter, as well as condensed milk, Wisconsin's premier position is unchallenged.

At the beginning of 1986 Wisconsin's dairy herd included 1,876,000 dairy cows, the largest number since 1968 and less than 500,000 below the all-time high reached in the mid-1940s (Wisc. Agr. Stat. Ser. 1986). Although the number of Wisconsin dairy cows declined until 1978, it subsequently increased, rising 3.4% in the five years leading up to the buyout program. Largely because of greater milk production per cow (by genetic improvement of herds by use of artificial insemination, presently used to produce three-quarters of all Wisconsin calves), milk production in Wisconsin rose by 12.6% in the same half decade. By 1985 Wisconsin cows produced 25.1 billion pounds of fluid milk or an average of 13,383 pounds annually per cow (Wisc. Agr. Stat. Ser. 1986). Although the number of dairy cows within the state had only increased by 2% since 1930, the number of dairy farms[2] had plummeted 73.6% by the 1982 Census of Agriculture, a drop from 166,996 to 44,093 (U.S. Bureau of the Census 1932 and 1984). The number of commercial herds, represented by those undergoing the Brucellosis Ring test, dropped an additional 5.9% between March 1982 and March 1986, at which time Wisconsin had 40,950 dairy herds (Wisc. Stat. Rep. Ser. 1982; Wisc. Agr. Stat. Ser. 1986).

Considerable spatial variations were discerned in the impacts of these changes in Wisconsin's dairy industry. Declines in the number of dairy herds over the past half century (Fig. 1) as well as between 1981 and 1986 (Fig. 2) have been the greatest in the counties of northern Wisconsin, those counties encompassing and surrounding the Milwaukee metropolitan area, and several counties within the center of the state along the Wisconsin River. Indeed, two counties of northern Wisconsin no longer have any dairy herds. Overall the smallest declines in the number of herds have been in the south-

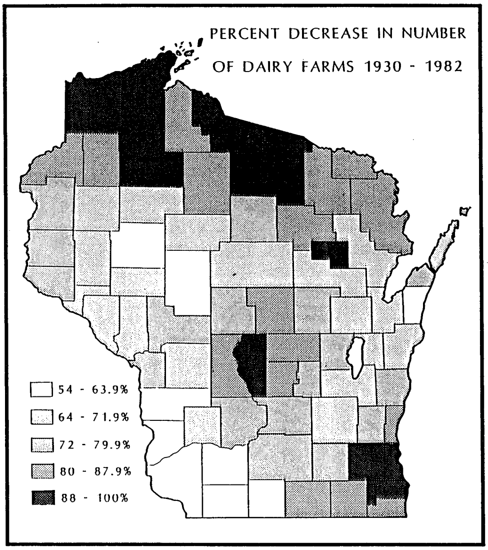
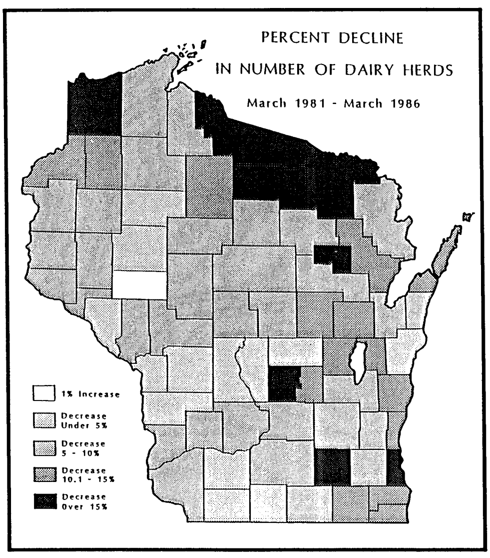


Figure 1

western counties. Although the number of dairy cows within the state as a whole rose slightly since 1930, six counties within northern Wisconsin recorded losses exceeding 50%, as did four counties in southeastern Wisconsin (Figs. 3 and 4). Conversely, large increases were noted in several counties of southwestern Wisconsin as well as in a band of counties extending across central Wisconsin from Kewaunee County on Lake Michigan, through Marathon County in the center of the state, to Buffalo and Pepin Counties along the Mississippi River. The most intensive dairying region of Wisconsin in the 1980s, if measured by the number of cows per square mile, is Calumet County, situated along the eastern shore of Lake Winnebago.

Participation in the Whole Herd Buyout Program

The U.S. Department of Agriculture's Dairy Termination Program thus came at a time when many changes were already reshaping Wisconsin's dairy industry (Table 1). Ninety-six hundred Wisconsin dairy farmers, representing 23.4% of Wisconsin's dairy herds, submitted bids to participate in this whole herd buyout program (Wisc. State ASCS 1986; Hill 1986; Wisconsin Agriculturalist 1986). Nearly seventeen hundred of these bids were provisionally accepted in March 1986. Thus, this buyout program eliminated 4.1% of Wisconsin's dairy herds between April 1986 and August 1987. The buyout herds totalled 62,633 cows. Although the dairy herds could either be sold for export or slaughter, 98% of the Wisconsin DTP dairy cows were terminated



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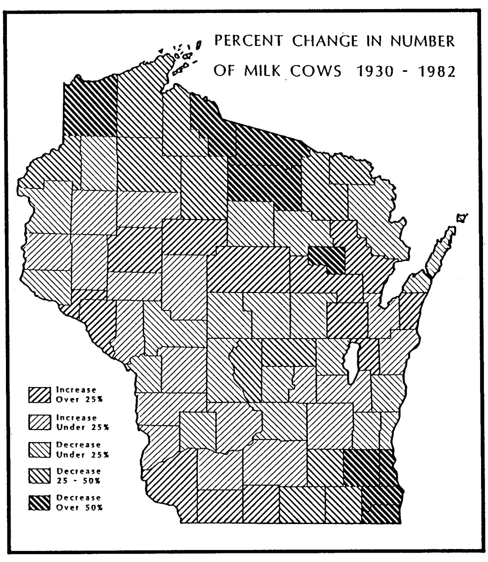

Figure 3

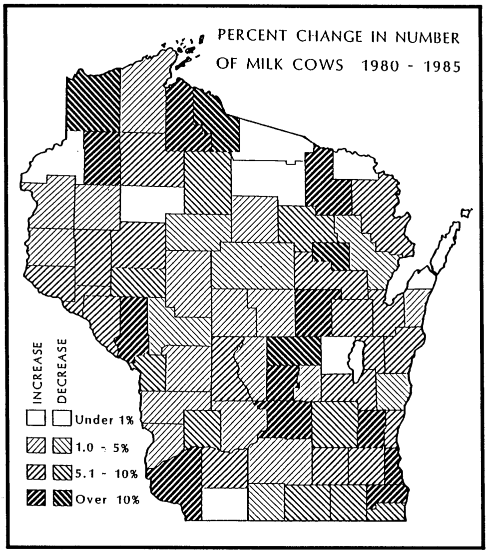

Figure 4

by slaughter. These terminated herds had accounted for 3.1% of the state's milk production in 1985 and contained 3.3% of Wisconsin's dairy cow population.

A smaller proportion of Wisconsin dairy farmers were accepted into the dairy termination program than within any other state except Nevada and Pennsylvania, even though Wisconsin led the nation in the number of total bids submitted—24.4% of all bids submitted nationally. Although nationally 35.4% of all bids submitted were accepted, Wisconsin's acceptance rate (17.4%) was by far the nation's lowest. Acceptance rates within all four states adjoining Wisconsin exceeded 40%, and Minnesota had the nation's largest number of herds accepted for termination—2,150 (Illinois State ASCS 1986; Iowa State ASCS 1986; Michigan State ASCS 1986;

Table 1. Recent decline in number of Wisconsin dairy herds and participation in USDA Dairy Termination Program by county.

County	*Number of Herds March 1986*	*Percent Decline in Herds 1981–86*	*Percent of Herds With Bids Submitted*	*Percent of Herds With Bids Accepted*	*Actual % Decline in Herds 1986–88*
Adams	100	3.8%	25.0%	10.0%	21.0%
Ashland	135	6.3%	31.1%	9.6%	15.6%
Barron	1,198	8.0%	22.4%	5.4%	11.4%
Bayfield	176	6.4%	22.2%	7.4%	22.7%
Brown	786	9.7%	31.0%	4.6%	12.1%
Buffalo	665	2.9%	24.1%	4.4%	12.0%
Burnett	196	10.1%	33.7%	10.2%	21.4%
Calumet	623	10.6%	24.1%	4.2%	9.3%
Chippewa	1,233	4.4%	20.6%	4.0%	7.6%
Clark	1,724	5.2%	19.5%	1.9%	7.1%
Columbia	526	7.6%	25.7%	3.8%	7.8%
Crawford	555	7.7%	28.8%	1.8%	7.9%
Dane	1,111	7.0%	25.8%	4.7%	10.0%
Dodge	1,248	7.6%	17.5%	3.3%	8.6%
Door	394	11.7%	27.7%	4.8%	11.7%
Douglas	55	17.9%	23.6%	7.3%	12.7%
Dunn	955	7.4%	26.5%	6.6%	11.7%
Eau Claire	585	(1.4%)	18.1%	5.5%	9.1%
Florence	27	20.6%	37.0%	11.1%	(3.7%)
Fond du Lac	1,052	6.2%	16.7%	3.1%	8.1%
Forest	41	18.0%	7.3%	2.4%	12.2%
Grant	1,302	5.6%	23.2%	3.1%	5.9%
Green	970	2.3%	19.3%	2.1%	6.3%
Green Lake	314	10.8%	24.2%	4.8%	7.0%
Iowa	830	2.5%	25.9%	2.8%	8.8%
Iron	17	19.0%	41.2%	23.5%	35.3%
Jackson	460	5.2%	23.5%	5.4%	8.9%
Jefferson	570	15.3%	18.2%	3.7%	11.0%

Table 1. Recent decline in number of Wisconsin dairy herds and participation in USDA Dairy Termination Program by county. (Continued)

County	Number of Herds March 1986	Percent Decline in Herds 1981–86	Percent of Herds With Bids Submitted	Percent of Herds With Bids Accepted	Actual % Decline in Herds 1986–88
Juneau	372	2.1%	25.0%	4.6%	9.7%
Kenosha	118	14.5%	27.1%	6.8%	8.5%
Kewaunee	656	9.0%	24.4%	2.3%	6.3%
LaCrosse	420	1.6%	19.3%	6.7%	11.0%
Lafayette	774	3.7%	30.1%	2.3%	3.6%
Langlade	281	9.6%	32.4%	5.7%	14.9%
Lincoln	280	9.4%	27.9%	4.3%	12.1%
Manitowoc	935	4.6%	19.8%	4.1%	10.2%
Marathon	1,971	7.9%	25.6%	1.9%	10.5%
Marinette	340	8.1%	27.1%	7.6%	12.9%
Marquette	158	16.4%	25.3%	5.1%	9.5%
Menominee	0	100.0%	No Commercial Herds in County		
Milwaukee	4	20.0%	0.0%	0.0%	(50.0%)
Monroe	1,006	.6%	20.5%	2.6%	4.0%
Oconto	683	11.4%	21.3%	6.1%	11.4%
Oneida	5	37.5%	40.0%	40.0%	20.0%
Outagamie	881	12.6%	30.2%	4.0%	10.6%
Ozaukee	190	12.4%	18.9%	8.4%	15.8%
Pepin	259	8.2%	26.7%	3.9%	9.7%
Pierce	603	5.0%	27.4%	5.8%	9.5%
Polk	833	8.9%	32.3%	8.3%	17.0%
Portage	495	6.8%	21.6%	4.8%	8.6%
Price	283	10.7%	26.1%	6.7%	19.8%
Racine	133	13.6%	23.3%	6.8%	13.5%
Richland	680	8.5%	23.5%	2.9%	5.3%
Rock	474	9.7%	23.2%	6.3%	11.4%
Rusk	549	1.6%	21.7%	2.9%	17.9%
St. Croix	772	5.2%	25.8%	4.8%	11.0%
Sauk	808	5.9%	24.7%	4.3%	10.4%
Sawyer	89	8.2%	33.7%	7.9%	10.1%
Shawano	1,156	7.0%	19.2%	2.2%	9.7%
Sheboygan	586	11.9%	23.7%	7.5%	11.4%
Taylor	811	7.2%	24.9%	2.2%	11.8%
Trempealeau	832	7.0%	26.9%	4.2%	9.4%
Vernon	1,291	4.9%	18.8%	1.7%	6.4%
Vilas	0		No Commercial Herds in County		
Walworth	337	11.8%	21.7%	9.8%	14.2%
Washburn	160	14.9%	24.4%	11.9%	24.2%
Washington	469	9.3%	19.0%	4.3%	11.3%
Waukesha	197	8.8%	22.8%	7.6%	14.7%
Waupaca	757	10.5%	22.2%	2.9%	7.7%
Waushara	297	3.6%	21.5%	8.1%	18.2%
Winnebago	491	12.9%	22.8%	4.1%	9.2%
Wood	666	5.4%	20.7%	1.1%	8.6%
WISCONSIN	40,950	7.1%	23.4%	4.1%	9.8%

Data Sources:
Wisconsin State Agricultural Stabilization and Conservation Services Office. (1986). Madison: USDA. Unpublished statistics.
(number of bids accepted, and milk cows (excluding heifers and calves) accepted for termination)
Wisconsin Agricultural Statistics Service, 1986.
(number of herds tested for Brucellosis in March 1986 test period—used to calculate percentages.)
Wisconsin Agricultural Statistics Service, 1988.
(number of herds tested for Brucellosis in test period ending March 1988.)
Hill, 1986 and *Wisconsin Agriculturalist,* 1986.
(number of bids submitted and bids accepted.)

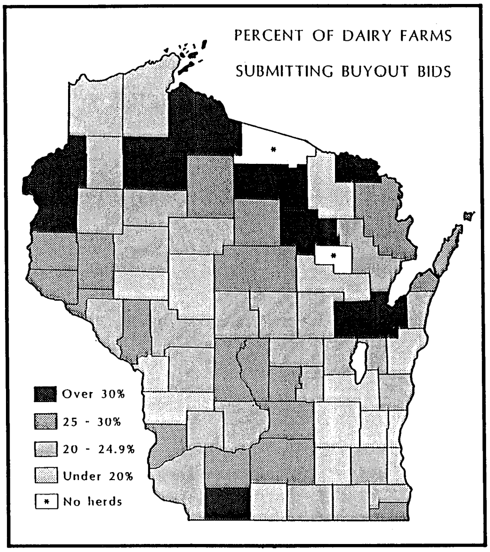

Figure 5

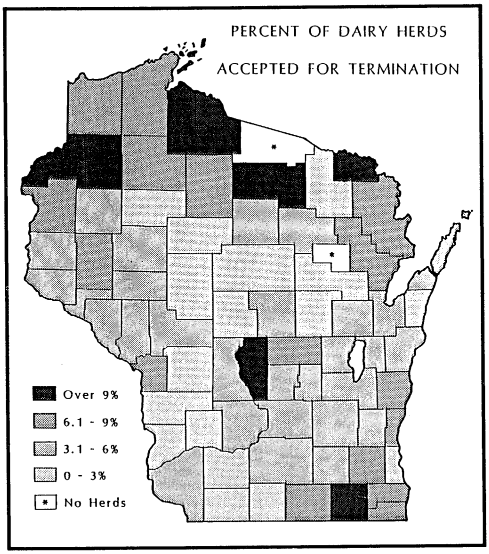

Figure 6

Minnesota State ASCS 1986; and Halladay 1986).

The proportion of dairy farmers within each Wisconsin county submitting buyout bids was the greatest within the counties of northern Wisconsin where 40% or more of the dairy farmers submitted bids in three counties (Fig. 5). With the exception of Milwaukee county (where no bids were received from that county's four dairy farmers) and Vilas and Menominee counties (where there are no commercial herds), Fond du Lac county dairymen were proportionately least likely to submit buyout bids, with only 16% submitting offers.

Although fewer than 2% of the dairy herds in the leading milk producing counties of central Wisconsin were accepted for termination, participation rates exceeded 10% in several counties of northern Wisconsin where dairying was already declining (Figs. 6 and 7). Indeed, the Dairy Termination Program reduced the number of herds in Iron and Oneida counties by 23.5 and 40.0%, respectively. Tables 2 and 3 and a comparison of Figures 1 through 4 with Figures 6 and 7 illustrate that participation in the buyout program was proportionately greatest in those counties already experiencing declines in dairying. Participation was proportionately the least within those counties experiencing the largest expansions in the number of dairy cows and having the greatest intensity of dairying (Table 4). A stepwise regression, with the proportion of dairy herds accepted for elimination as the dependent variable, found that the percent decline in number of dairy farms (1930–1982) and decline in commercial herds

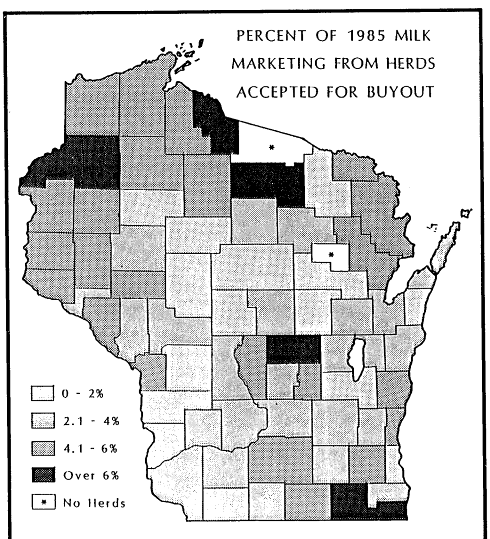

Figure 7

Table 2. Long-term decline in number of dairy farms (1930–1982) and USDA Dairy Termination Program bid acceptances by county.

Percent Decline In Number of Dairy Farms:	*Percent of Farms with Buyout Bids Accepted*		
	Under 3 Percent	*3–6 Percent*	*Over 6 Percent*
Under 70 Percent	12	9	0
70–80 Percent	3	16	5
Over 80 Percent	2	4	19

Chi-Square = 42.19, Significance = .0000

Table 3. Recent decline in number of dairy herds (March 1981–March 1986) and USDA Dairy Termination Program bid acceptances by county.

Percent Decline In Number of Dairy Herds:	*Percent of Farms with Buyout Bids Accepted*		
	Under 3 Percent	*3–6 Percent*	*Over 6 Percent*
Under 6 Percent	8	10	3
6–10 Percent	6	12	8
Over 10 Percent	3	7	13

Chi-Square = 9.73, Significance = .0453

Table 4. Intensity of dairy farming (milk cows per square mile) and participation in USDA Dairy Termination Program by county.

Number of Milk Cows Per Square Mile:	*Percent of Farms with Buyout Bids Accepted*		
	Under 3 Percent	*3–6 Percent*	*Over 6 Percent*
Under 25	3	6	16
25–50	6	10	7
Over 50	8	13	1

Chi-Square = 18.63, Significance = .0009

between March 1981 and March 1986 explained 56.3% of the variation of the dependent variable (Multiple R = 0.75).

The average value of the accepted buyout bids was generally highest within the counties of west-central and southwestern Wisconsin. On the other hand, the average bid in several counties of northern Wisconsin and within two counties near Milwaukee were over $2.00 less than the statewide average accepted bid of $16.85 per hundredweight (Fig. 8). Statistically, the greater the percentage of the county's dairy farmers who submitted accepted bids, the lower the average bid (Table 5).

The mean buyout herd size was generally highest within those counties having the most intensive dairy industry (Fig. 9). On the other hand, when the average number of head within the terminated herds is compared with the average herd size within the county, a different picture emerges. Throughout central Wisconsin the typical herd accepted for termination was smaller than the mean herd size within those counties, while within several counties of northern and southeastern Wisconsin the buyout herds closely approximated or exceeded the average herd size within the various counties.

Participant Characteristics

Participants in the buyout program represented a broad spectrum of Wisconsin dairy

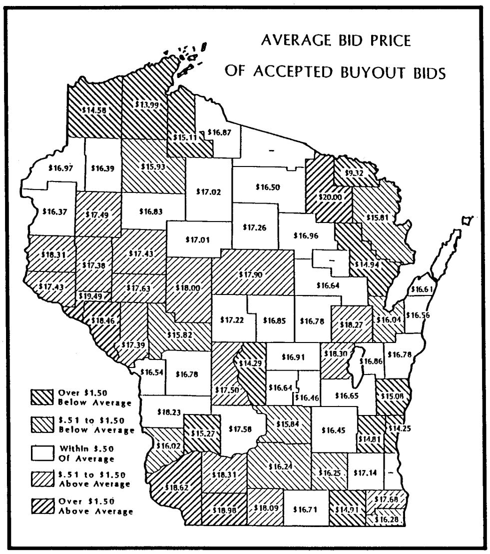

Figure 8

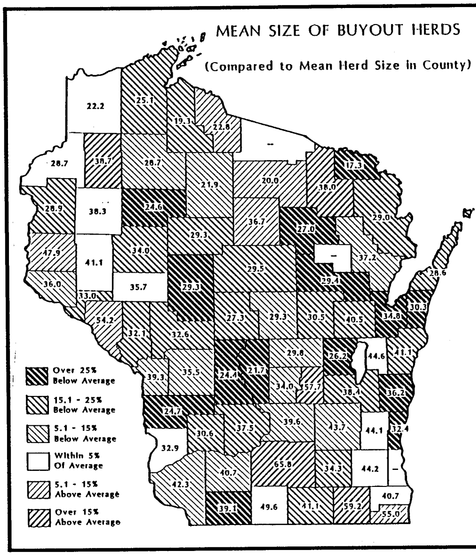

Figure 9

farmers. Several comments from county-level ASCS officials clearly make this point: "It was a typical cross-section of . . . farmers that submitted bids and were accepted. There was really no significant trend to any particular group of farmers"; "We [in a southwest Wisconsin county] did not notice any substantial differences—buyout producers ranged in age from 25 to 70—from 20 cows to 85 cows—from new farmer to experienced—it cut across all types"; and "those with accepted bids were either good operations or poor operations—as a group tended to be middle of the road. . . ." Although DTP participants were considered by ASCS officials (Table 6) as typical of the average Wisconsin dairy farmer with respect to their educational attainments, their farm acreage, and their herd grade, they differed, at least regionally, from continuing dairy operators in several key aspects, particularly age and experience.

The typical Wisconsin dairyman (all but 4% were male) participating within the U.S. Department of Agriculture's Dairy Termination Program was nearing retirement age and had operated his farm for at least twenty-five years. Indeed, 41.8% of the participants were at least sixty years of age, with only 13.4% under forty years old. These figures contrast sharply with the ages of Wisconsin dairy farm operators reported in the 1982 Census of Agriculture. For example, although the census indicated that individuals aged sixty-five years and older comprised 7.9% of the state's dairy farmers, this age group

Table 5. Average buyout bid price per county and participation in USDA Dairy Termination Program.

Average Price Of Accepted Buyout Bids:	*Percent of Farms with Buyout Bids Accepted*		
	Under 3 Percent	*3–6 Percent*	*Over 6 Percent*
Under $16.00	1	3	11
$16.00–$17.00	6	12	9
Over $17.00	9	14	4

Chi-Square = 14.88 , Significance = .0049

Table 6. Characteristics of typical DTP participants: Observations of county-level ASCS officials in Wisconsin.

"In comparison with the typical dairy farmer in your county, the . . .	*Below Average*	*Average*	*Above Average*
Farm Income of those dairy operators submitting buyout bids was generally:"	45.9%	46.2%	4.9%
Farm Acreage of those dairy operators submitting buyout bids was generally:"	21.3%	70.5%	8.2%
Dairy Herd Size of those dairy operators submitting buyout bids was generally:"	29.5%	62.3%	8.2%
Number of Years of Farm Experience of those dairy operators submitting buyout bids was generally:"	1.6%	52.5%	45.9%
Education of those dairy operators submitting buyout bids was generally:"	8.2%	86.9%	4.9%
Age of those dairy operators submitting buyout bids was generally:"	3.2%	55.6%	41.3%
Off-Farm Income of those dairy operators submitting buyout bids was generally:"	27.4%	62.9%	9.7%
Proportion of Farm Income Coming from Non-Dairy Agricultural Production (before termination) for those dairy operators submitting buyout bids was generally:"	27.4%	69.4%	3.2%
Proportion of those dairy operators submitting buyout bids which had *Grade A Herds* was generally:"	25.4%	54.0%	20.6%

comprised 20.1% of the Dairy Termination Program participants. Thirty-two percent of the state's dairy operators were at least fifty-five years old, but 56.9% of the DTP participants were this age. Conversely, the Census reported that 22.3% of Wisconsin's dairy farmers were under thirty-five (U.S. Bureau of the Census 1984), yet only 4.6% of the DTP participants were this young.

Eight percent of the Wisconsin DTP participants had entered dairying within the previous five years; however, the preponderance were leaving the dairy business after a lifetime of involvement. Only within the northernmost counties of Wisconsin, where dairying was already a marginal agricultural activity, and within the north-central portion of the state, including the major dairy counties of Marathon and Barron, did significant numbers of dairymen with less than fifteen years of experience enter the DTP. Indeed, within the northernmost counties 45.8% had less than fifteen years of experience, while 18.7% of those participants within the southern third of the state had that little longevity.

Economically, DTP participants were quite varied. Indeed, total 1985 milk marketing of these farmers ranged from a low of 225 hundredweight for one Price County farm to 118,808 hundredweight on a Dane County dairy, with their termination payments, correspondingly, ranging from $2,678 to $2,132,606. Nevertheless, average DTP herd size of thirty-seven cows plus twenty-seven heifers and calves was smaller than the average-sized Wisconsin herd. Although one ASCS official wrote that "surprisingly, many poorer producers didn't submit bids," the average buyout cow was 850 pounds under the state average in her milk production. Indeed, one DTP farmer wrote that he was participating because his cows were all old. Conversely, another ASCS respondent indicated that, at least within his central Wisconsin county, "for the most part they were more progressive farmers." For many participants, as discussed in the following section, their higher-than-average debt loads brought them into the program.

The overwhelming majority of DTP participants had herds of Holsteins (91.4%), with only 2% having Guernseys and 1% having Jerseys. The few remaining dairymen had herds comprised of several varieties. Thus, Holsteins are over-represented within the buyout program. Statewide, Holsteins account for 79% of Wisconsin's dairy herd, Jerseys for 13%, and Guernseys for 5% (Vogeler 1986). Fifty-five percent of the buyout herds were rated Grade A, similar to the 59.6% figure for all Wisconsin herds at the beginning of 1986 (Wisc. Agr. Stat. Ser. 1986).

Motivations for Entering Buyout Program

Buyout participants were asked both "What was the main reason you decided to submit your dairy buyout bid?" and to indicate the importance of several factors, including "desire to retire" and "farm debts" (Table 7). Responses to the first question indicated that although most participants had several motivations, age, poor health, and retirement were among the most frequently cited. Nineteen percent of the respondents explicitly mentioned that they submitted bids so they could retire, with an additional 23.6% indicating that their age or poor health were motivations. Although frequently related to age, the lack of help with the dairy operation was another frequently cited factor (by 9.8%), especially among those farmers whose children were no longer at home helping with the farm chores—a factor of critical importance to the typical labor-intensive family operation. These responses, together with the DTP participant's ranking of the importance of their "desire to retire" in the submission of their bids, indicates that 59.9% of the participants saw the program as a way to leave dairying for retirement, age, or health reasons. If those who cited a lack of help are included, this retirement figure rises to 63.3%. However, retirement from dairying should not imply that all these individuals have totally retired from farming. An additional 6.2% of the respondents indicated that a desire for more free time and less work—but not retirement—motivated their participation in the buyout program. Such motivations for DTP participation parallel the responses of farmers in Walworth, Rock, and Jefferson counties who were surveyed concerning their decisions to leave dairying before 1985. Indeed, Richler writes, "reasons included age of farmer, desire for a different life style, lack/cost of farm labor, and high capital investment and excessive debt vis a vis economic return" (Richler 1985).

Economic problems facing America's farmers, including over-production and low prices, have received considerable attention by journalists within the past few years. Indeed, the DTP was legislated in an effort to reduce milk surpluses. However, economic considerations were cited by only 39.5% of the survey respondents as a motivation for their participation. Nevertheless, 7.7% of the DTP participants entered the program to "get out of debt" and an additional 1.8% claimed their participation would enable them to avoid bankruptcy and a farm auction. The size of DTP payment that the farmers received was statistically related to their voiced concerns about their personal economic problems, with the dairymen who received the largest payments being most likely to express economic concerns.

The typical Wisconsin dairy buyout program participant had relied upon the sales of milk or dairy products to generate the pre-

Table 7. Motivations of DTP participants for terminating their herds.

"Please indicate the importance these factors in your decision to terminate your dairy herd:"	*Very Important*	*Somewhat Important*	*Slightly Important*	*Not Important*
Milk Price Levels	41.3%	25.8%	9.7%	23.2%
Size of Your Dairy Herd	7.4%	20.2%	17.2%	55.2%
Desire to Retire	31.2%	19.5%	11.1%	38.3%
Farm Debts	18.2%	9.4%	10.8%	61.6%
Distance from Dairy Plant	.3%	.7%	1.7%	97.3%
Other Job Opportunities	5.7%	8.1%	6.4%	79.8%

ponderance of his farm sales. Indeed, 50.1% indicated that milk sales accounted for at least four-fifths of their farm sales before they terminated dairy operations, while only 5.3% reported that milk and dairy products provided for less than two-fifths of their farm income. Fewer than one in ten reported off-farm income exceeding their income from farming before they sold their dairy herd, and over half the participants indicated that neither they nor their spouse had any off-farm employment.

Impacts Upon Wisconsin's Dairy Industry

Sixty-three thousand cows (plus 27,600 heifers and 18,500 calves) were accepted for slaughter or export under the buyout plan at a cost of $125.5 million (Wisc. State ASCS 1986). Nevertheless, during the eighteen months during which these DTP herds were eliminated, the number of milk cows in Wisconsin dropped by 93,000. By June 1988 Wisconsin's dairy herd had dropped to 1,760,000, the smallest number since 1920 (Wisc. Agr. Stat. Ser. 1988). However, because the average milk production per cow has been steadily rising (up by 9.1% in the past five years), total milk production is still higher than what it was at the beginning of the decade (Wisc. Agr. Stat. Ser. 1988). Viewed from this context, the Dairy Termination Program has only resulted in momentarily slowing the long-term trend of increased production that produced the milk surpluses the program sought to reduce.

The impact that the elimination of 4.1% of Wisconsin's dairy farmers through the buyout plan will have upon the long-term decline in the number of operators is more subject to speculation (see Table 1). By March 1988, the number of dairy operators in Wisconsin had fallen to 36,924 (Wisc. Agr. Stat. Ser. 1988). Thus in the two years since the first herd was slaughtered under the Dairy Termination Program, the number of Wisconsin dairy herds has dropped by 4,026—a whopping 9.8%. During the first year of the buyout program, when 71% of the 1,681 accepted herds were scheduled for termination, the number of Wisconsin dairy herds actually fell by 2,724, a drop of 6.7% (Wisc. Agr. Stat. Ser. 1987). Within the previous five years, between March 1981 and March 1986, the number of dairy farms within Wisconsin had decreased by only 7.1%.

Nearly 8,000 of the Wisconsin dairy farmers who submitted buyout bids had their bids rejected, being in excess of the $22.50 per hundredweight cut-off. Thus, had all the submitted bids been accepted, 22.9% of the state's dairy operations would have been eliminated—far more than the actual 4.1%. County-level ASCS officials estimated that one-quarter of these individuals would leave dairying by 1992, the year that participating farmers may begin to re-enter the dairy business. However, the loss of nearly twenty-four hundred Wisconsin dairy operators who were not DTP participants within the past two years indicates that these officials' estimates may be too conservative.

The total declines in the number of dairy herds between March 1986 and March 1988 (including the DTP herds) are indicated in Figure 10. Comparison of this map with those of previous declines and DTP participation indicates that the problems facing dairy operators in the northernmost portions of Wisconsin appear to be expanding farther south. For example, historically the highest rates of decline (in northern Wisconsin) were in those counties along Lake Superior and the Michigan border (plus Oneida county). The decline in this last two-year period has extended farther south to include Polk, Rusk, Langlade, and Marinette counties, which all had substantial numbers of herds. Polk county lost 17% of its herds. Rusk county lost 18%. Even the state's leading dairying county, Marathon, reported a decline exceeding the state average. Although Milwaukee county actually showed an increase (the county had only six dairy operations in early 1988), declines in the collar counties all greatly exceeded the state average. Of particular interest is the continued prosperity of dairying in the state's southwestern corner. This area experienced the smallest decline in number of dairy operators between 1930–1982, below average declines between 1981 and 1986, below average DTP participation, and decreases in the number of herds between 1986 and 1988 that were half of the state average. Grant and Vernon counties are now the state's third and fourth leading counties in number of herds.

Farming Activities in 1987

Most of the buyout farms remained in some type of agricultural production in 1987. Livestock production was still occurring on 73% of the operating DTP farms (Table 8). Beef production was most common, being reported by 95% of DTP operators raising livestock, many who indicated they were now concentrating their efforts upon "dairy beef" or "Holstein steers." Beef production was uniformly attractive to these former dairymen across the state. Hogs were being raised by one-fifth of those farms with livestock. Hog production, although reported by former dairymen throughout Wisconsin, was most attractive to farmers within the southwestern portion of the state. Nearly one-third of all DTP farms in production within southwestern Wisconsin were raising hogs in 1987. Although other farmers reported raising chickens, sheep, goats, horses, and donkeys, not one of these animals was found on as many as 5% of the DTP farms.

Statewide, 96% of those DTP participants whose farms were in production reported that crops were grown in 1987. Only in Wisconsin's northernmost counties did any sizeable number of these farmers report that crops were not being produced. The most commonly grown crops were hay (on 86.7% of all operating DTP farms), corn (on 78.4%), and oats (on 43.8%).

Hay (including alfalfa and clover) was uniformly popular as a crop among former dairy operators across Wisconsin, although the distribution of corn and oats was spatially less uniform. Corn was produced on at least 80% of all operating DTP farms except for the northernmost area, where only one-third of

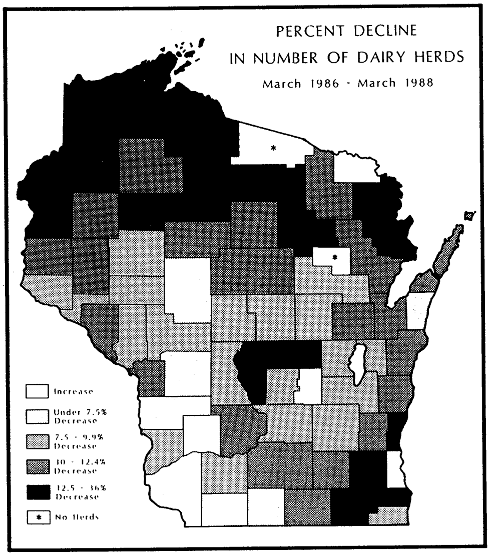

Figure 10

the farms were growing the crop. Oats, likewise, were under-represented in the northern counties, although they were least popular within southeastern Wisconsin.

Less commonly grown crops included soybeans (on 11.5% of all operating DTP farms), tobacco (on 4%), vegetables (4.9%—including sweet corn, peas, and snap beans), and barley (4%), plus several other crops—none of which were reported by more than 2% of the DTP participants. Although soybeans were grown by a few farms in all areas of the state, only within southwestern Wisconsin did as many as a third of the farmers cultivate this crop. Tobacco was only grown by DTP farms in the south-central and southwestern portions of Wisconsin. Vegetables were predominately grown by DTP participants in south-central Wisconsin.

Most DTP farmers reported production of several crops and livestock. Hay and beef, however, were expected to provide the greatest source of farm income (Table 9). Indeed, when asked "what single crop or livestock do you expect to provide the most income to your farm this year [1987]?" statewide 35.7% indicated hay and 33% reported beef. Hay was either the first or second most frequently cited income source in every region of Wisconsin, while beef was similarly reported in

Table 8. Agricultural activities of DTP farms remaining in production—1987.

	*Region of Wisconsin**							
Type of Production	*Far North (N = 45)*	*North Central (N = 36)*	*Central (N = 32)*	*East Central (N = 27)*	*South-West (N = 31)*	*South Central (N = 35)*	*South-East (N = 20)*	*Wisconsin Total (N = 226)*
Livestock	75.6%	69.4%	75.0%	70.4%	80.6%	68.6%	65.0%	72.9%
Beef	73.3%	66.7%	68.7%	70.4%	77.4%	65.7%	65.0%	69.9%
Hogs	8.9%	11.1%	12.5%	7.4%	29.0%	17.1%	15.0%	14.2%
Crops	84.4%	100.0%	100.0%	100.0%	93.5%	100.0%	95.0%	95.6%
Hay	80.0%	100.0%	84.4%	96.3%	93.5%	82.9%	65.0%	86.7%
Corn	33.3%	83.3%	100.0%	81.5%	90.3%	94.3%	85.0%	78.4%
Oats	31.1%	55.6%	15.6%	70.4%	51.6%	48.6%	40.0%	43.8%
Soybeans	4.4%	5.6%	15.6%	11.1%	6.5%	14.3%	35.0%	11.5%
Tobacco	0	0	0	0	12.9%	14.3%	0	4.0%
Vegetables	0	5.5%	6.2%	0	0	17.1%	5.0%	4.9%

*Regions, unless otherwise specified, correspond to Wisconsin Agricultural Statistics Service reporting districts. The Far North region includes the N.E. District and the northern counties of the N.W. and N.C. Districts. The North Central Region includes the southern counties of the N.W. and N.C. Districts, including Marathon and Barron counties. The South-West region includes both the S.W. and W.C. Districts.

Table 9. Chief agricultural products of DTP farms remaining in production—1987.

	*Percent of Farmers Reporting Item as Greatest Source of Farm Income by Region of Wisconsin**							
Crop or Livestock	*Far North*	*North Central*	*Central*	*East Central*	*South-West*	*South Central*	*South-East*	*Wisconsin Total*
Hay	50.0%	44.4%	29.6%	46.1%	20.0%	20.7%	33.3%	35.5%
Beef	35.0%	29.6%	37.0%	26.9%	46.7%	24.1%	27.8%	33.0%
Corn	0	14.8%	18.5%	14.8%	20.0%	27.6%	33.3%	16.8%
Other	15.0%	11.1%	14.8%	11.5%	13.3%	27.6%	5.6%	14.7%

*Regions same as defined in Table 8.

all areas except the south-central and southeastern parts of the state where corn was equal to hay in importance.

On-Farm and Off-Farm Employment in 1987

The summer of 1987 found the former dairy farmers looking towards other economic pursuits. One-third (32.7%) of the DTP participants reported that either they or their spouse had obtained off-farm employment since entering the program, while one-fifth had retired. Jobs that these farm operators reported having in mid-1987 ranged from providers of farm services to factory workers, from unskilled laborers to plumbers and electricians, and from sales to the professions. Although great employment diversity was reported, several of the most frequently reported off-farm jobs included driving trucks (7% of those not retired), driving school busses (2.6%), logging (2.6%), and sales (of all varieties, 6.1%). Nevertheless, of those who had not retired, farming was still considered by half of the DTP participants as their occupation in 1987.

Farming remains the primary occupation for most DTP participants. Although many commented about how much they missed their cows, the long hours without any vacation were not missed. Although 59.9% indicated that a motivation for leaving dairying was to retire, 96% of those who owned farmlands before they entered the DTP still owned their lands, even though 22.9% of these persons responded that they wished to sell their farms. Of those farmers who had not sold their farms, 22% rented their lands to other farmers, but only 5.5% of the farms had been totally taken out of production (with three-quarters of these located within the northern third of Wisconsin). Thus, 74% of the Wisconsin dairy farmers who entered the DTP still had at least part of their lands in production in 1987.

Statewide, 18.3% of the DTP participants entered at least part of their farmland into the Conservation Reserve Program, whereby lands vulnerable to soil erosion are removed from production. This program included one-third of the buyout farmers within the southwestern and south-central portions of Wisconsin. Undoubtedly, more farmers would have entered this program had their lands been eligible, as several farmers responded that their requests for inclusion into the program were rejected because their lands were too level.

A Return to Dairying?

The vast majority of buyout participants were satisfied with their decision to enter the program. In response to the question "Do you still think you made the correct decision by participating in the dairy herd buyout program?" 79.7% answered affirmatively, 7.3% responded negatively, while 13% were uncertain. The farmers who had the most productive cows were significantly more satisfied with their participation than those with below-average milk yields.

When surveyed after being in the buyout program for one year, fewer than one in ten of the DTP participants indicated that they planned to re-enter dairy operations after the required five-year moratorium elapses. A much smaller survey, conducted by the *Wisconsin Agriculturalist* shortly after the winning bids were announced, found that only one out of fewer than one hundred respondents hoped to return to dairying (Morrow 1986). In response to a direct inquiry on my survey, 7.3% indicated that they intended to return to dairying, 23.8% responded that they were uncertain, while 68.9% stated they had no intention. Such responses were not surprising considering the large proportion of the buyout participants who used the DTP as an avenue for retirement. Indeed, only 20.3% of Wisconsin farmers within the buyout program expected to still be dairying within five years if their herd had not been accepted for termination. An additional 26.3% replied that they were uncertain as to whether they would be operating by 1992. Even among those dairy operators under fifty years of age, 39.8% expected to have left dairying by 1992, and an additional 26.5% were uncertain as to whether they would still be in business. Thirteen percent of those buyout farmers who were not retiring expected to re-enter dairying, although 44.3% felt they had permanently left the business. Thus, only one of twenty Wisconsin buyout participants had any intention of returning to dairying.

The Dairy Termination Program, in conclusion, has sped up the consolidation of Wisconsin's dairy industry into fewer hands. However, this shrinkage would have occurred even without the program; most participants would have quit dairying anyway because of age or economic pressures. The ongoing process of farm consolidation statewide and retrenchment from the agricultural frontiers of northern Wisconsin and the central Wisconsin River Valley and from the expanding urban areas in southeastern Wisconsin has only been hastened. Participation rates were less than 2% in the leading milk producing counties of north-central Wisconsin, while rates exceeded 10% (to as high as 40%) within Wisconsin's northernmost counties where historically dairying was already in a precipitous decline.

Even without the cows, most DTP participants in Wisconsin remain involved in agricultural pursuits. Considering that a smaller proportion of DTP bids from Wisconsin farmers were accepted than within any other state and that Wisconsin's herd was proportionately reduced less than within any state except Nevada and Pennsylvania, Wisconsin remains the nation's dairyland. If anything, its role has been strengthened. Likewise, the same arguments may be made within Wisconsin. Marginal areas within the northernmost counties proportionately lost far more production than the state's leading milk producing areas. Considering the proportion of DTP participants who continue to produce hay (and that one-third still consider it their leading source of farm sales) and those who have concentrated upon cultivating feed grains, farmers remaining in dairying should find little—save low milk prices—to keep them from expanding their herd sizes. In the past, such overproduction has done little to diminish overall production; it has just driven the less productive producer out of business and concentrated production into fewer hands. In retrospect, it is doubtful whether the Dairy Termination Program will have any lasting effect upon overall milk production, but it may have accelerated the process of farm consolidation and the increased size of the remaining operations. The USDA Dairy Termination Program has merely advanced trends that have been redefining Wisconsin's dairy industry for over a half century, spatially restricting the dairy belt within the state.

Notes

[1]Comparable data on the number of Wisconsin farms reporting milk cows is unavailable for censuses before 1930.

[2]The 1930 and 1982 U.S. Census of Agriculture data on the number of farms reporting milk cows was utilized. The Wisconsin Agricultural Statistics Service reports precise data on the number of dairy herds that have had the Brucellosis Ring test, required for all commercial herds. The Wisconsin statistics may not precisely correspond to the U.S. Census data (which is also adjusted to compensate for nonresponse and sample errors). The 1982 Census was the most recent prior to the beginning of the DTP, while the Brucellosis Ring Test data for the period ending March 1986 immediately preceded the beginning of the buyout program.

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Survey of Timber Rattlesnake (*Crotalus horridus*) Distribution Along the Mississippi River In Western Wisconsin

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Abstract. A study of sites ranging from southern St. Croix County to northern La Crosse County along the Mississippi River Valley was made to determine the current geographical distribution of the timber rattlesnake (Crotalus horridus) *in western Wisconsin. A total of forty-two surveys were made at sixteen different sites from April 11, 1988, through October 15, 1988. A total of twenty-five specimens were observed with the earliest observation being made on May 1 and the latest on September 11. Limited biological data were obtained on eighteen snakes. The most northern and southern specimens came from northwestern Pierce County and southern Trempealeau County, respectively. A single specimen found 16.9 km from the Mississippi River in Buffalo County represented the furthest inland observation. Of the forty-two survey trips,* C. horridus *were only observed on sixteen occasions. Large numbers of snakes were not found at any one site. Thus, the timber rattlesnake may not be as widely distributed or present in as large of numbers as have been reported historically. These preliminary data suggest the need for further investigation of* C. horridus *distribution and population in western Wisconsin and may even warrant the need for both habitat and species protection.*

Wisconsin and Minnesota are the most northwestern geographical range of the timber rattlesnake *(Crotalus horridus)*. Early reports of this species in Wisconsin date back to 1680 when L. Hennepin, on a voyage up the Mississippi River, observed "Serpens Sonnettes" or what is now known as the timber rattlesnake. Later in 1700, Le Seur reported that it was dangerous to enter caverns near Lake Pepin because of rattlesnakes (Schorger 1968). Historical references yield reports of ninety-nine specimens being found in a single day at a single site, confirming the existence of large populations in the past (Schorger 1968). It is the concentration of this species in a given area for denning and/or other reasons that has made the species vulnerable to predation by man. *Crotalus horridus* represents the largest species of rattlesnake occurring in the northern United States (Klauber 1982), and its notoriety rivals that of another wilderness species, the timber wolf *(Canus lupus)*. Prior to 1975, large numbers of timber rattlesnakes were taken in Wisconsin when the state's

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bounty system was still in force. Although historically the timber rattlesnake was afforded a much wider range, as literature and museum records attest to, more recent records on distribution (Cochran 1986) and population status for this species have been sparse. Therefore, the current study was undertaken to determine the present-day distribution of *C. horridus* along the Mississippi River valley in western Wisconsin.

Methods and Materials

Timber rattlesnake museum records and published literature were used initially to establish known historical distribution for the seven western Wisconsin counties under study (St. Croix, Pierce, Pepin, Buffalo, Dunn, Trempealeau, and La Crosse). USGS quadrangle (7.5 minute series) topographical maps were evaluated for potential timber rattlesnake survey sites. USGS Wisconsin county quadrangle maps were used to plot survey sites and results. Early in the study, prior to snake emergence in the spring, and on days of inclement weather, time was spent driving country roads to search for potential denning areas. Also, several landowners were interviewed concerning known local snake populations.

It became evident during the study that conducting site surveys to establish the presence of the timber rattlesnake could be a time-consuming activity. This made it necessary to concentrate efforts in the four central counties of the survey area.

Sites were surveyed on foot. Careful searches for rattlesnakes were conducted in accessible habitat. When a snake was found if possible, it was captured with a Furmont snake hook, and biological data were recorded. A Miller and Weber cloacal thermometer was used to measure body temperature. Sex of the snake was determined using Furmont snake sexing probes (Fuhrman Diversified, Inc., La Porte, Texas). Live measurements from snout to base of rattle and from snout to vent were taken with a conventional tape measure. The rattles were counted beginning with the button as 0 and all free segments thereafter numbered consecutively. The animal was placed in a cloth bag and weighed with a Sargent-Welch spring scale (Sargent-Welch, Skokie, Illinois) with either a 0–2000 gm range or a 0–200 gm range scale previously tared for bag weight. After release at the capture site, photographs were taken. A Taylor digital thermometer (Markson, Phoenix, Arizona) and a Miller and Weber surface thermometer (Miller and Weber, Inc., Queens, New York) were used to record air and substrate temperatures.

Several sites were repeatedly surveyed in an attempt to establish the presence of *C. horridus* at a particular site and to obtain population data from sites where snakes were known to occur. All snakes were handled for study in accordance with the 1987 *Guidelines for Use of Live Amphibians and Reptiles in Field Research*.

Results

Habitat. A total of sixteen different geographical sites were surveyed on forty-two different occasions. The sites had many similarities; all had areas of rock, bluff prairies, Oaks (*Quercus* spp.), and other mixed vegetation and were at elevations between 198 m and 350 m above sea level (Table 1).

Distribution and Numbers. The northernmost site at which a specimen of *C. horridus* was observed was PIE-6 (Clifton, Civil town, Pierce County) and the southernmost site of observation was TRE-1 (Trempealeau, Civil town, Trempealeau County). These were also the northern and southern extremes of sites surveyed (Table 1, Fig. 1). A single site approximately 16.9 km inland from the Mississippi River BUF-3 (Alma, Civil town, Buffalo County) yielded a single specimen. A total of twenty-five specimens of *C. horridus* were found during the course of the study. However, these were only observed at nine of the sixteen different sites surveyed. One female specimen was observed on three different occasions. The largest number of snakes found at a given site over the period

Table 1. Geographical Location and Habitat of Timber Rattlesnake Sites Surveyed in Western Wisconsin

Site	*County*	*Civil Towns*	*Habitat*
PIE 1*	Pierce	Isabelle	Limestone outcrop without loose boulders; intermittent bluff prairie, Oak, Cottonwood, Cedar, Bittersweet, elevation 274–320 m.
PIE 2		Isabelle	Large limestone bluff, some loose rock, many Cedars, Oak, Grape Vine, Bluff Prairie, elevation 274–320 m.
PIE 3*		Diamond Bluff	Scattered limestone boulders, heavy vine vegetation, intermittent Bluff Prairie, Oak, Birch, elevation 213–274 m.
PIE 4*		Trenton	Large limestone bluff, Sumac, Oak, Birch, intermittent Bluff Prairie, elevation 244–305 m.
PIE 5		Heartland	Limestone outcrop, heavy Oak, some grass areas, elevation 274–320 m.
PIE 6*		Clifton	Woodland of Oak, Elm, Maple below small limestone outcrops, river flood plain area, elevation 213–244 m.
PEP 1*	Pepin	Stockholm	Large limestone bluff in tiers, steep, intermittent bluff prairie with Cedar, Oak, elevation 229–305 m.
PEP 2		Stockholm	Sandstone formations, Cedar, Birch, bluff prairie, elevation 244–305 m.
PEP 3		Pepin	Large bluff prairie, some scattered limestone shelves, Sumac, Oak, elevation 305–335 m.
PEP 4		Stockholm	Limestone rocks, railroad ties, fallen trees, Oak, Elm, Maple, grape vine, elevation 198–213 m.
BUF 1*	Buffalo	Nelson	Large sandstone formations with loose slabs mixed with grass, Cedar, Hackberry, Oak, elevation 274–335 m.
BUF 2		Alma	Scattered limestone around old quarry, Birch, Grape vine, Cedar and Oak, elevation 274–335 m.
BUF 3*		Alma	Limestone boulders scattered, bluff prairie, Birch, Cedar, Oak, elevation 274–335 m.
BUF 4		Milton	River flood plane forest, grass, Oak, Maple, Birch, elevation 213–244 m.
BUF 5*		Milton	Community below limestone bluffs, elevation 213–244 m.
TRE 1*	Trempealeau	Trempealeau	Large limestone, sandstone rock, some loose rock, Cedar, Birch, Oak, elevation 305–350 m.

*Timber Rattlesnake confirmed at these sites

of the study was twelve, and the most snakes found at a single site at a given time was five (Table 2).

Chronology of Surveys and Climatology. The first spring survey was made on April 11, with the first specimens not being observed until May 1. In the fall, surveys were made until October 15, but the last specimen was seen on September 11 (Table 2). All surveys were made between 1100 and 2000 hours. The average air and substrate temperatures were 28.3°C and 30.1°C, respectively. Weather conditions varied considerably from sunny to cloudy, calm to windy, and hot (29.8°C) to cool (16.8°C) with specimens having been observed under all the different conditions (Table 2).

Biology. Of the twenty-five specimens of *C. horridus* observed, limited and incomplete biological data were obtained due to limited numbers of field personnel and equipment, snakes unable to be captured, and precarious circumstances on several occasions (Table 3). The mean body temperature for nine specimens was 29.6°C. Total body lengths ranged from 35.5 cm to 123.2 cm, and body masses ranged from 30 g to 1110 g. Two snakes had complete rattles of eight seg-

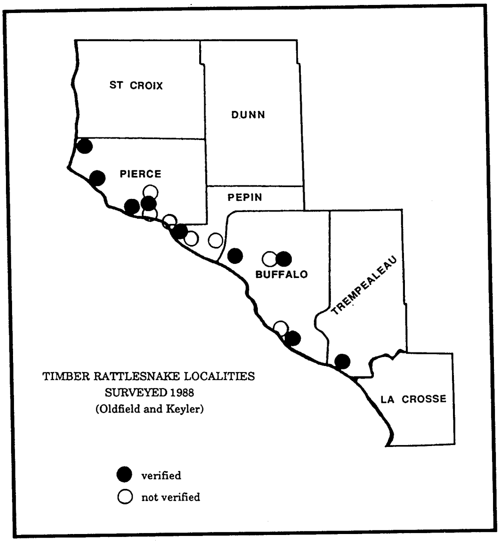

Figure 1

ments; these were the largest rattles observed. Of the nine specimens in which sex was determined, five were female and four were male and were from seven different sites. Two females were determined to be gravid by palpation. An interesting observation was noted on two specimens as they possessed post-ocular stripes and prominent mid-dorsal stripes. These markings were apparent on a female and a male from different sites.

Discussion

Timber rattlesnakes have been extirpated in many areas of Wisconsin; thus, they remain in the most rugged and nearly inaccessible micro-wilderness areas of the state. Because of this fact, their secretive nature, and their absence for six to seven months of the year due to hibernation, they are a difficult animal to study. Furthermore, legends and stories have contributed a variety of unfounded reasons for man's irrational fear of the animal.

The objectives of this field survey of *C. horridus* were to ascertain present-day distribution in seven counties for historical comparisons, to assess habitat requirements in western Wisconsin, and to make recommendations regarding conservation of the species. A substantial amount of information was gathered to fulfill these objectives considering the extent of the geographical area under study and constraints of time and budget. Although incomplete, some biological data were accumulated during the study.

Crotalus horridus is a species of the steeply dissected, forested hills along the Mississippi River and its tributaries in western Wisconsin. The snake reaches the extreme northwestern limit of its U.S. range here and in

Table 2. Chronology, Climatology, and Number of Timber Rattlesnakes by Study Site

Date	*Time*	*Site*	*Weather*	*Air Temp (0°C)*	*Substrate*	*No. Rattlesnakes*
May 1	1200–1300	PIE-1	clear, sunny, windy	24.3	30.0	2
May 13	1330–1430	PEP-1	clear, sunny, windy	28.3	18.3	2
May 18	1100–1230	PIE-1	overcast, breeze	23.4	30.0	3
May 18	1300–1400	PEP-1	clear, slight breeze	25.0		1
May 21	1330–1430	PIE-3	clear, calm, humid	29.6	38.0	1
May 21	1545–1710	PIE-1	high overcast, calm	27.4	32.0	5
May 23	1200–1330	PEP-1	clear, sunny, calm	26.8		1
May 23	1600–1800	PIE-4	clear, sunny calm	29.8	38.0	2
May 28	1200–1300	BUF-1	partly cloudy, rain	24.0	30.0	1
May 28	1930–2000	PIE-1	clear, almost dark	27.5	32.0	1
May 30	1115–1300	BUF-3	hazy, breeze	26.5	31.0	1
June 4	NA	BUF-5	NA	NA	NA	1 (dead)
July 30	1515–1600	PIE-6	clear, sunny, humid	28.8	32.0	1
Sept. 3	1700	TRE-1	cool, rain, calm	16.8	21.0	1
Sept. 11	1000–1145	PIE-1	clear, calm	28.1	30.2	1
Sept. 11	1210–1300	PEP-1	clear, breeze	28.0	28.4	1
Mean + SD				26.3±3.3 n = 15	30.1±5.5 n = 13	

NA = not applicable

Table 3. Various Biological Information for 18 Timber Rattlesnakes by Study Site in Western Wisconsin

Site	Date	Sex	SBR (cm)	SVL (cm)	BT (°C)	BM (g)	No. Rattle Seg
PIE-1	May 23	F	106.7	99.0	30.4	92	8
PIE-1	May 1		91.4			50	8
PIE-1	May 18		61.0				
PIE-1	May 18		53.3	49.5		100	
PIE-1	May 18		76.3				
PIE-1	May 21	F (gravid)	111.8	104.0	30.6	940	
PIE-1	May 21		55.9	50.8	30.5	110	button +1
PIE-4	May 23	M	95.0	87.6	30.4	530	
PIE-4	May 23		92.0				
PIE-6	July 30	F (gravid)	101.6		33.6	834	
PEP-1	May 13		78.7				5
PEP-1	May 13		73.7				
PEP-1	May 18	F	96.5	90.2		510	6
PEP-1	May 23		35.5		30		button only
PEP-1	Sept. 11	M	101.6	93.3	29.1	835	2 (broken)
BUF-1	May 28	M	123.2	114.0	30.2	1110	4 (broken)
BUF-5	June 4	F (dead)	71.0	66.0		395	6
TRE-1	Sept. 3	M	55.9	50.9	21.6	95	button +1
Range			35.5-123.2		21.6-33.6	30-1110	
Mean + SD					29.6±3.5		

SBR = Snout to base of rattle, SVL = Snout-vent Length, BT = Body Temperature, BM = Body Mass

adjacent southeastern Minnesota (Conant 1975). Timber rattlesnakes den in areas of bluffs and steep rock outcrops on south and southwest facing hillsides. They are found near these rock outcrops during the spring and again in the fall. In these northern latitudes this species of rattlesnake requires rock outcrops or bluffs of limestone, sandstone, or dolomite with ample sun exposure. Plants associated with these outcrops and bluff prairies are cedar, oak species, birch, cottonwood, hackberry, sumac species, poison ivy, wild grape, bittersweet, columbine, harebell, puccoon, violet species, wood sorrel, and various grass species. *Crotalus horridus* moves in nearby mixed deciduous forests and agricultural lands during the summer (Vogt 1981). The summer foraging areas need to be in close proximity to the denning areas as this species seldom travels more than 2.4 km from its den (Martin 1966). Adequate ground cover, suitable drinking water, and a stable food supply are provided by mixed deciduous forests of oak species, maple species, basswood, elm, and hickory. While searching for rodents, the timber rattlesnake will also utilize forest edge next to agricultural fields and woodlots.

The range of *C. horridus* has been shrinking and fragmenting across the northeastern United States ever since European settlers began colonizing. Since the turn of the century, wanton destruction of rattlesnakes has occurred in Wisconsin. Our study was prompted by the apparent, but undocumented decline of *C. horridus* in Wisconsin. Historical distribution prior to 1880 is shown in Figure 3 as adapted from Schorger. Figure 1, which was generated by our study, compares favorably with Figure 2, which was adapted from Vogt. Results of our study show that the northern and southern points of distribution along the Mississippi River closely coincide with those reported by Schorger and Vogt. However, inland distribution continues to be of concern. Recent sightings and reports by landowners (personal communication) did not afford any confirmation of present-day inland distribution.

The extreme northern record for *C. horridus* in Wisconsin, as reported by Breckenridge (1944) prior to 1939, came from the

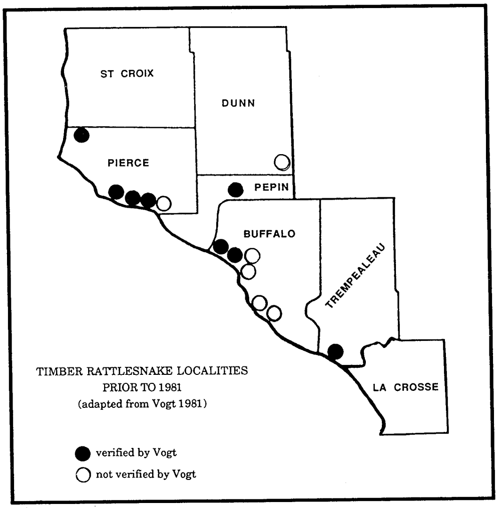

Figure 2

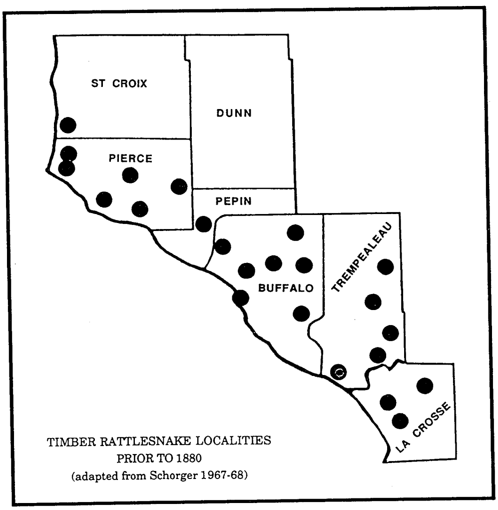

Figure 3

civil town of Troy in St. Croix County. Our study confirmed a population in the extreme northwestern corner of Pierce County (PIE-1) about 8 km south of the Troy record.

Schorger reported sixteen references to localities in six civil towns in Pierce County. Vogt indicated four localities within the county personally verified by him. Our study established localities in five civil towns.

All of Schorger's data from Dunn County refers to massasauga rattlesnakes (*Sistrurus catenatus*), and the single locality in the county submitted by Vogt (1981) was unverified. Time constraints precluded any field work in Dunn County by our study.

Only one *C. horridus* locality was reported in Pepin County by Schorger. This was near the town of Frankfort. Vogt (1981) reported one locality northeast of Frankfort. In our study, a population was found near the Mississippi River in the civil town of Stockholm. We surveyed three additional sites in this county and could not establish the presence of the rattlesnake.

References to seven localities in six different civil towns for Buffalo County exist, and six of these localities are inland. Vogt (1981) map-plotted six sites of which only two were verified by him. We were able to demonstrate the presence of *C. horridus* at three localities in three different civil towns. One inland site was verified by our field work.

We surveyed one site in Trempealeau County, and this was Brady's Bluff in Perrot State Park. The existence of *C. horridus* was verified. Several other sightings were reported by park officials and visitors during 1988 within the park (personal communication, Perrot State Park officials). The park was the only map locality given by Vogt. In addition to the park, Schorger listed four inland sites.

While three *C. horridus* localities have been historically reported in La Crosse County, we were unable to do field surveys in La Crosse County for present-day verification. Martin (personal communication) indicated that he had two reports of sightings of rattlesnakes in La Crosse County in recent years; however, specifics as to species or exact localities were not available.

Evaluation of population densities was not within the scope of our study; however, results suggest that large populations of timber rattlesnakes as reported historically no longer exist. Schorger presented a number of citations in which thirty or more snakes were killed at one time at various locations; and reported that ninety-nine rattlesnakes were killed in 1862 at Gilmanton (Buffalo County) on a rattlesnake hunt (Schorger 1968). We spent 136 actual field hours and located twenty-five timber rattlesnakes from late April through October 1988. This calculates out to be 5.5 field hours per timber rattlesnake encounter. Forty-two site visits produced snakes only sixteen times, or on 38% of the site visits. The largest number of snakes found at a single site visit was five, supporting the theory that large populations no longer exist.

The biological data gathered by our study (Table 3) from eighteen timber rattlesnakes, although incomplete in some aspects, does give useful information. The sex ratio of 4:5 (four males and five females) is approximately 1:1, and suggests no dominant sex ratio. The average body temperature of eight snakes was 29.6°C; this closely approximates the preferred body temperature of other North American pit vipers as reported by Lillywhite (Seiger et al. 1987). A single specimen had a body temperature of 21.6°C, but this animal was found coiled underneath a rock on a cool, rainy day and does not reflect a preferred temperature. An established preferred body temperature for timber rattlesnakes could not be located in the literature.

Recently there has been considerable scientific controversy concerning the validity of the subspecies *C. horridus atricaudatus* (Brown et al. 1986 and Pisani et al. 1977). During the course of the present study two specimens were found with distinct post-ocular stripes, and several displayed obvious mid-dorsal stripes. Both of these characteristics are criteria used to partially describe the southern subspecies. A marked variation in pattern and coloration was observed among the animals studied.

Conservation of the timber rattlesnake has two important facets: habitat preservation and snake protection. Economic incentive threatens habitat alteration of bluff prairies and steep rock outcrops by man and may be an immediate threat to the snake. Land development and residential building sites at the base of rattlesnake hills or on top near dens generally has a deleterious impact on snake populations due primarily to increased encounters with man. Periodically timber rattlesnakes show up in the yards of residents near bluffs in Pierce County (personal communication, Bob Burnett, two reports during the summer of 1988 near Hager City). A golfer searching for golfballs in the rough at Clifton Hollow Golf Course suffered a rattlesnake bite on June 24, 1988 (personal communication, D. Foley, attending physician). Roadkills claim an unknown number of rattlesnakes each year on highways and roads located near *C. horridus* habitat. Land developers continue to subdivide and sell building sites along the bluffs in southern Pierce and northern Pepin Counties. Thus, habitat encroachment by man continues at a substantial pace.

Man's persistent predation of the timber rattlesnake has reduced populations to the point of requiring total legal protection in several northeastern states (Martin 1982). The vulnerability of this species at ancestral den sites makes it an easy target for snake hunters. A bounty system deploys more snake hunters and also increases the chance of snakebite. Nontarget and protected snake species may also be destroyed by indiscriminant bounty hunters. Minnesota had an active rattlesnake bounty until August, 1989. A snake hunter from Buffalo County indicated that snakes could be taken from Wisconsin into Minnesota for payment of bounties (personal communication). Our study data strongly upholds a non-bounty policy in Wisconsin and in fact gives support to total protection of this species. In many states (Connecticut, Massachusetts, Vermont, Rhode Island, New York, New Jersey, Texas, Missouri, and Kentucky) the timber rattlesnake is a protected species (Allen 1988).

The results of our preliminary survey suggest the need for future studies of *C. horridus* in Wisconsin with information needed on remaining inland populations. Surveys should be conducted along the Mississippi River from La Crosse to the Illinois border. Devising a method for evaluating population densities would be extremely valuable for management of the species. Considerable time and effort are required to do rattlesnake fieldwork. Our study consumed 136.25 field hours, 79 travel hours, 20 field days and 3,950 miles. Adequate allotments for time and effort will help to ensure the collection of an adequate volume of data.

The timber rattlesnake is a non-aggressive, secretive animal of steep bluffs and adjacent forests. It undoubtedly plays an important role in biological balance as a rodent predator. The snake has few natural enemies, a low reproductive rate, and a long lifespan (Martin 1966). The timber rattlesnake is a symbol of the wilderness, as is the timber wolf, and should be provided the opportunity for continued survival in the natural world.

Acknowledgments

We would like to give special thanks to Gary Casper of the Milwaukee Public Museum for providing museum records, published information, and interview material from naturalists and snake hunters of western Wisconsin. He also offered technical assistance and encouragement with the project.

Several individuals generously volunteered their time to assist with field surveys. We wish to thank Jim Gerholdt, Del Jones, Tom Keyler, Don Leaf, John Moriarty, and Casey Oldfield. Bob Burnett with extensive field experience hunting timber rattlesnakes in Pierce, Pepin, and Buffalo counties provided us with useful information concerning localities and general hunting advice. He also assisted with field surveys. Dave Lindenrude and Cindy Swanberg of the Wisconsin Department of Natural Resources provided useful locality data. The authors wish to thank W. H. Martin of Harpers Ferry, West Virginia, for distribution information of *C. horridus* in Western Wisconsin. We also are most appreciative for the efforts of Diane Loudon in the preparation of this manuscript.

Finally, we wish to extend special thanks to our wives and families for their support and cooperation throughout the rattlesnake season.

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From Wisconsin Poets

In this, the second issue in which we have featured poetry, all the poets represented are once again from our state. We are particularly pleased that our call for poetry resulted in submissions by poets as well known and admired as Ron Ellis, Mary Shumway, Susan Firer, David Steingass, Ronald Wallace, and Kelly Cherry. We are also pleased to present the work of David Graham and Karen Loeb who are relatively new voices to readers of Wisconsin poetry. We hope the appearance of poetry of such quality and distinction will please our readers and continue to establish *Transactions* as a showcase for poetry in Wisconsin.

About the Poets

David Graham *is Assistant Professor of English at Ripon College. He is the author of two collections of poetry,* Magic Shows *and* Common Waters. *In addition, his poems and essays have appeared in such places as* Poetry Review, The Georgia Review, Poetry, and College English. *"The Naked and the Nude," presented here, is part of a recently completed manuscript of poems concerning photography entitled* Mirror With a Memory.

Ron Wallace *directs the creative writing program at UW-Madison. He has published numerous books, and his anthology,* Vital Signs: Contemporary American Poetry From the University Presses, *will be published in August by University of Wisconsin Press. His work has also appeared in* The New Yorker, The Atlantic, The Nation, Poetry, *and elsewhere.*

Mary Shumway *teaches at UW-Stevens Point. Her poems have appeared in a variety of journals including* Denver Quarterly, Northeast, Prairie Schooner, *and* Wisconsin Academy Review. *Her next manuscript is to be published by Juniper Press.*

Kelly Cherry *is the author of seven books, most recently* Natural Theology. *She has been awarded numerous fellowships and two PEN Syndicated Fiction Awards. The Fellowship of Southern Writers has just named her the recipient of the first Poetry Award, which is given in recognition of a distinguished body of work. She teaches at UW-Madison.*

David Steingass *lives in Madison where he conducts public school writing workshops. His books* Body Compass *and* American Handbook *were published by The University of Pittsburgh Press, while his poems are found in numerous journals. His chapbook,* Homesick for Fox-Blood, *is scheduled to be published in 1990. He is the first recipient of the Paulette Chandler Award from the Council of Wisconsin Writers, 1988.*

Ron Ellis *teaches writing at UW-Whitewater and edits the poetry journal* Windfall. *He is not only well known for his poetry, but his special interest in performance has gained national recognition. His audio cassette album,* Open My Eyes, *has been favorably reviewed in* The Village Voice *and has been aired on National Public Radio as well as WNCY in New York.*

Susan Firer, *whose work is published in a number of poetry journals, is the author of* My Life with the Tsar and Other Poems. *She says that the two strongest influences on her daily work are her family and Lake Michigan. Susan teaches creative writing at UW-Milwaukee.*

Karen Loeb *recently moved to Wisconsin from Florida. She has published fiction, poetry, and non-fiction in numerous journals. Her recent stories are found in* The South Dakota Review, Korone, Footwork, *and in* New Visions: Fiction by Florida Writers. *Two of her stories have received PEN Syndicated Fiction Awards and appeared in participating newspapers.*

The Naked and the Nude
—three photos by Imogen Cunningham

1. Side, 1930s

A side of what? It could be flesh, could be
some twisted glove or over-ripe pepper.
If flesh, male or female? Does it matter?
Only bent leg, rippled skin, and curving edge
of spine survive the cropping. Neither naked
nor nude, these whorls and eddies of torso,
textured like rock, water, sand in shadow,
even a hint of scar part of the design.
(In my book a banana plant bristles
on the opposite page, though without label
it could be rumpled foil, or farmland
from an airplane.)

Looking closer, I see
how nothing but living skin shines this way,
curled for the naked eye to judge, easy to love
as a meal. Anonymous and true,
flesh consumed with or without label.

2. Two Sisters, 1928

No doubt it was fashion to crop their faces,
as if to show photography can mimic
the headless heroines of ancient Greece.
Yet if they are no more than light and form,
why the title? For as they are sisters
they are stories, and as they are stories
they blur and fade, they will not sit still.
Are they twins? Do they enjoy being nude
together before this accurate eye?
Can form be beautiful without content?
And if their goose bumps, their moles, and the hair
between their legs are not beautiful,
then the eye is false witness to the heart.

Half a century later, these women
may still live. Imagine eighty-five year old twins
sharing an apartment in Florida,
sleeping in the same bed, taking baths,
always nude, always together,
their changed bodies still mirror images.

Even if she only exists before
I was born, a nude woman interests me,
but any sister would know we are best
unobserved, loveliest seen through the eyes
of self-fulfilling love. This photograph
has love in it, more than most, but no one
could wholly love these women and still see.

3. Triangles, 1928

Clouds, leafy shade, the long roll of water
between wind and stone, mirage of desire:
mother-triangles in the rectangle
of art. Light and dark, light and dark again,
until the thing comes right, becomes word
without turning to statement, becomes nude
open to light, casting shadows herself
on herself, softness created by light
more than by smooth belly, nipple, and thigh,
and all folded into triangles, yes,
like a mother folded around her daughter
yet to be born, yet to be conceived.

David Graham

Winter Strings Concert

Dwarfed by cellos,
violins and violas stuck under chins,
arms and legs akimbo, they grin
out at the audience. *Please,*
says the teacher, as one Japanese
boy leaves weeping, jabbed by a bow,
this can be dangerous.
My daughter, shy in her finery
mouths *Father, go home,*
as I lip read.
And they're off! Cellos grumbling,
violins squeezing the lemony air,
from Humoresque to Hot Cross Buns,
from Jelly Roll Blues to Jingle Bells,
from the Halls of Montezuma to
the Shores of Tripoli
they trill inexplicably, solemnly
gazing into space as if
they were anyplace else but here,
hamstrung in sound,
each instrument wandering off
on its own lonely inventions.
Until, measure by measure
the years collapse,
and crescendoed with tears, I'm back
in my own gradeschool gymnasium,
the future a symphony
warming before me, furiously
sawing my way out of childhood,
playing the dangerous music of nostalgia
to the roar of improbable applause.

Ronald Wallace

In the Sculpture Garden

Ernest Trouva's "Poet"
in his cloak and rakish hat
sits flat beneath his flat black tree,
mere silhouette, mere shadow
among the dying elms and maples.
Edging the wrought-iron woods,
"Three Women Poets,"
arm in arm, and stiff as nuns,
walk in place.

A hundred years ago
they'd not have worn
this black absence of our imagination
as they met and talked
Rimbaud and Baudelaire
in those flamboyant hours
when everything was possible.
Where is the gaudy eloquence?
Where the bluff and strut?

This is no time for poets.
On the near horizon
oil drums loom red and magenta—
toppled, tubular stacks.

What Easter Island of the mind,
what Stonehenge of the soul
will some unimaginable future
make of this
which baffles even us?

Meanwhile, Garnett Puet's bees,
mistaking a wax-filled plywood box
for a hollow tree,
are busy sculpting
a woman out of honeycomb.
Bees in eyes and nipples.
Pubic hair of bees.
We watch like drones.
We glance furtively back.

Ronald Wallace

Mr. Evans' Oracle: Sally Rand Vacations in the Dells

They cut and harvested more than usual that winter
but the icehouse was almost empty. Kids
no longer played among the blocks nested
in straw to escape the stubborn sun. Lids

of tarp, lowered as the ice was sold or melted,
couldn't mold, even dried by midday in that sun-
dogged and long July. The men grumbled,
thumbs in their overalls, long after they'd won

their bets—or lost—on rain that never came.
Thomas shuffled toward the door. "It's low,
perilous low," he mumbled. They all knew what
he meant, and Thomas would be first to go

when the rest was sold, probably in August.
Hans remembered, and to cheer him said,
"You better find a bench downtown today,
Mr. Evans. A certain dancer's here to spread

her feathers." "Or shed 'em," Lambert added
with lust he summoned only for the rain
and the river's rise and the early cold to make
ice enough to last through fall, and plain

hearty meals regular as pay allows
until the winter harvesting again. He grinned,
a little thin though, and Evans' face frowned
into a pending storm announcing Lambert sinned

to pass such news. It was nothing to him. Nevertheless,
without a backward glance he turned toward town
and found a bench unoccupied by sun, one
at least he wouldn't stick to, and settled down

to watch the traffic at the ice cream stand
across the street. The icehouse kids, adrift
among the tourists, pigtailed to the counter
where flavors melted to a ribboned gift

of possibilities. Two scoops for a nickel,
and nickels rarer than this summer's rain,
choice amounted to responsibility—
dark, heavy as a man's long pain

of idleness. And then a shadow passed.
Thomas stirred and frowned into the sky.
Above the glass and unrelenting blue,
plumes of mare's tails splayed—too high

for shadow. But low across the hills, atilt
as Bessie's cones, scoop on scoop, clouds
piled. The children's voices dropped, their eyes
and mouths round with awe. He saw crowds

cleave and gather as Sally stole the show
amid grins and consternation paired
imperfectly. The icehouse kids even feathered out
around, deft as her fabled fans, and stared.

They never saw the clouds. Sally played
their spellbound impudence, her walk a game
that out-maneuvered fans with grace of one
who knows her house, her claim of space, her fame.

Well, dour old Thomas, caught between
those feathers high and low, rose and pranced
adrift uncertain air that freshened with the lift
of bright and tendered promises, and danced.

Mary Shumway

The Final Visit With Her Brother

She remembers the drafty rooms,
      the front lawn where mud blooms,

how he lay there, legs like sticks
      of kindling, drinking six-

pack beer or "tonic water."
      My eye. Later,

how he insisted on standing and taking her
      in his arms, after making clear

how deeply he felt she'd let him down,
      and said he loved her anyway, but soon

she pulled away, feeling caught
      in the embrace she had fought

so hard to free herself from,
      and he lay back down on the bed and said, "Come

again, you hear?"—softly mocking
      the Southern sense of what is kindly, what is shocking—

and turned the TV on again,
      the black-and-white portable, when

she left, as if denying—
      oh, everything.

Kelly Cherry

Portrait in Blue and Red

Her nerves were shot.
Dr. Fear had paid her a housecall.

After he left, she stood alone in the hall
As if expecting the front door to burst open,

Someone to come in like Jack Nicholson
With a knife in his hand.

In the mirror above the blue china bowl on the marble stand
She saw a small girl jumping rope.

(The apples in the bowl were ripe,
Radiating redness.) When she was five,

She'd loved being alive,
Wearing her hair in pigtails, jumping rope,

But already, she could see, she'd been desperate, and losing hope.

Kelly Cherry

The Margin For Loss

To live through winter
we need to see our best direction
lost in snow. Then ambition finds

each of us alone. We recognize
what once we turned our backs on
we'd leave home for. We feel wind

shape our thoughts, and find owls
crouched inside dark pines. Their eyes,
a constellation's cold fire,

lead us away. We name zero
the margin of error, total
the margin for loss.

David Steingass

Front Door Open

sunlight untouched by glass
          air   we'll take raw

step out
          talk about
picking up the yard

redwings
          crows
                    cranes

until a silence
a spreading   attention
the shadow
          swoop
                    red-tailed hawk

a sudden remembering

                    until the first
                      redwing call

Ron Ellis

Easter Sunday Afternoon

Aunt Virginia sleeps two sheets to the wind
upstairs in the martini spinning bed.
She has once again drunk the children's
Easter bubbles and removed
her wig with her bonnet.
Easter lamb fragrance,
white coconut covered lamb cake.
One snowy spring years ago
the Dusenberg of death drove Edward,
her only husband, away on a snow
blowing Sunday. Only his glasses
and Sunday Journal left behind
on their marital bed. Once widely traveled
heavily jeweled, when young chauffeured
Virginia became a proofreader on the
Milwaukee Journal. "Never trust
the advice columnist," she warned
me when I was ten. "I've shared
the lavatory with her, never washes
her hands when she's finished."
Many bridge games and a half dozen
well fed and collared dachshunds later
Virge rests upstairs. God bless all
childless Aunts who give themselves
to unappreciative nieces and nephews,
take them to plays, buy them books,
or like Virge bought me when I was ten:
a leopard skin coat and garnets.
God bless all, but especially
Aunt Virge whose keys are once
again locked in her baby blue T-Bird.
We're going through the trunk for them
this Easter. Wish us and her luck.

Susan Firer

Stirring

''Always stir
from left to right,''
my mother said
moving the wooden spoon
through the chocolate pudding.

After all
Grandma stirred
from left to right.

Something to do
with gravitational pull
maybe the moon
and the tides.
Who knows
what unseen forces
have caused people to stir
from left to right.

''It's why the clock goes
from left to right,''
she said
tapping the spoon on the pot
like a metronome.

I never wondered
why the clock
didn't go the other way
never thought it was
related to stirring.

My father too
knew about this stirring.
I found him at the stove.
He held the spoon
differently than my mother
but he stirred
from left to right.

If you're stirring something,
can't remember the direction,
think of the clock
and the way it knows to go.

Karen Loeb

The Role of Plant Root Distribution and Strength in Moderating Erosion of Red Clay in the Lake Superior Watershed

Donald W. Davidson, Lawrence A. Kapustka, and Rudy G. Koch

Abstract. *Erosion of the glacially derived red clay soils in the western Lake Superior Basin is a serious problem and has been known to be a problem since the settlement of western Lake Superior lands. We investigated the influence of plant root systems on erosion of the red clay soils. Measurements of the rates of surface erosion and of deep-seated slope failure (slumping) were made between August, 1975, and June, 1978. Slope failure as monitored along transects was greatest in areas with sparse trees or herbaceous cover. The most stable area had a dense tree cover along with a dense understory of* Corylus cornuta *and* Cornus stolonifera. *The estimated soil loss (mton · ha^{-1}) during the period 15 May through 15 October 1977 was stable grassed area, 0.2; grassed areas experiencing slumping, 7.8; stable wood areas, <0.1; wooded areas with slumping, 0.4. During the same period detailed measurements of vertical root distributions, root tensile strength, and vegetation cover along and adjacent to stream banks were obtained. Roots were excavated from 36 quadrat sites adjacent to 8 of 12 transects established to quantify slumping of soils. The excavation of 0.2 m^2 quadrats was accomplished at 10 cm intervals to a depth of 50 cm. All roots obtained from the excavation were sorted according to 12 diameter classes to determine total root mass and calculate total root length. Essentially all roots occurred in the upper 50 cm of clay soil, and 50% of the root mass occurred in the 0–10 cm zone. The tensile strength of roots less than 2 mm diameter of selected species was determined for 5 cm segments of roots. The tensile strength of small fresh roots (less than 1 mm diameter) was 1.5–8.5 times greater in woody species than in herbaceous species. Among woody species, later successional species characteristically had stronger roots than early successional species. Collectively these data indicate that vegetation comprised of woody, advanced successional species afford the best protection against both surface and deep-seated stream bank erosion.*

Vegetation effectively reduces both surface erosion and subsurface slumping by intercepting and reducing the velocity of precipitation and retaining soil particles and reinforcing soil structure (Penman 1963). Among the most significant features in this regard are (*a*) an increase in the shear strength of soils as a result of reinforcement by roots and (*b*) soil arching, the transfer of stress across a potential failure surface in the soil (Gray 1976).

Significant correlations between tree cover and slope stability have been developed in several field studies (Gray 1973, 1974; Marsh and Koerner 1972; Bishop and Stevens 1964;

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Anderson 1972). Swanston (1970) found an apparent soil cohesion and shear strength caused by roots that is not reflected by the physical properties of Karta soils in southeastern Alaska. His study of root deterioration following clear cutting indicated that the contribution by tree roots to soil shear strength diminished within three to five years. This decline coincided with the observed time lag for landslide acceleration following timber harvest. DeGraff (1979) further distinguished the relative advantages of various vegetation types with respect to erosion. His work identified increased landslide activity when tree and brush cover was converted to grassland cover. The apparent causes were a concomitant increase in soil moisture and a reduction in the consolidating root network.

The erosion of red clay, a source of natural pollution of the south shore of Lake Superior, has been a problem since the last glacier receded (Mengel 1970). This erosion has had an impact on the ecology of the Lake Superior waters. The physical parameters of the red clay loading of Lake Superior have been studied in detail by Oman and Sydor (1978), Diehl et al. (1977), Sydor et al. (1978), Stortz and Sydor (1980), and Sydor et al. (1978). These workers dealt mainly with red clay contaminants in Lake Superior through Landsat 1 data, and turbidity dispersion in Lake Superior and in the Duluth-Superior harbor, through use of Landsat data. Stortz (1976) pointed out that "western Lake Superior is characterized by clean water periodically contaminated by the red clay particles, originating mainly from glacial-lacustrine deposits along the shores of Douglas and Bayfield counties, Wisconsin . . ."

Chemical loading was also examined by Bahnick et al. (1972), Bahnick et al. (1978), Bahnick (1977), and Bahnick et al. (1979). These studies focused on nutrient loading, especially orthophosphates, into southwestern Lake Superior. They reported up to 240 mtons of soluble orthophosphate from soil entering Lake Superior annually from shoreline erosion and 63 mton from river particulates (Bahnick 1977).

Swenson (1978) studied the influence of red clay turbidity on fish abundance in western Lake Superior. He found that light penetration in western Lake Superior is reduced significantly even at very low concentrations of red clay turbidity.

Although plant properties related to erosion abatement are accepted generally, the relative contributions of each applied to a specific problem are speculative. We have sought to define the capacity of vegetation to moderate erosion of the red clay zone of western Lake Superior. These investigations have had three main thrusts: (1) the description of the vegetation, presettlement and contemporary; (2) the influence of the vegetation on soil water content and the susceptibility to erosion; and (3) the distribution and strength of plant roots in the region. Our studies reported here describe the relationship of surface erosion and slumping with the distribution and strength of roots of selected species and vegetation types. Our hope is that slumping of red clay soils may be retarded by working with plants that have stronger roots.

The soil types encountered in the drainage basin of western Lake Superior fall into four general types: red clays, loam upland soil, northern sandy soil, and alluvial soil (Hole 1976). The red clay soils of the Superior plain consist of clays of glacial-lacustrine origin that are predominantly of the montmorillonite type, with small quantities of illite, chlorite, and kaolinite (Andrews 1979; Hole 1976). The characteristic red color results from extractable iron oxide that constitutes approximately 2% by weight. Lenses of unsorted sands, gravel, and cobble are encountered frequently in the otherwise uniform clay. The clay fraction has a bulk density (g cm^{-3}) of 1.05 + 0.10.

Several physical properties important in maintaining are influenced by the moisture content. At typical sites, especially below the root zones, moisture content ranges between 40% and 50%. Field capacity of the upper 15-cm zone generally approaches 55%, while the permanent wilting point is around 12%

(Kapustka et al. 1978). The plastic limit (the brittle solid state) ranges from 20% to 330%, while the liquid limit (fluid state) is 40–80%. Upon wetting, the dry clay swells to 120–140% of the original volume (Mengel and Brown 1976a, b).

The mechanical strength of soil of the red clay region is determined primarily by the montmorillonite fraction. Slow-rate triaxial shear tests indicated failure of soil slopes at 18–200. Natural slope angles, however, appear to be stable around 100. The cohesion of the clay changes from 0.05 kg cm^{-3} near the surface to 0.35 kg cm^{-3} at depths of 25 m (Mengel and Brown 1976a, b).

Methods

Erosion by Slumping

Field sites were selected in August 1975 to monitor slumping activity at ten locations in the Little Balsam Creek and at twelve locations in the Skunk Creek sub-basins of the Nemadji River Basin in northwestern Wisconsin and east-central Minnesota (Fig. 1). The vegetation of the transects represents a diverse cross section of the major types present in the Nemadji Basin. Four principal types are apparent: (*a*) hardwood forest dominated by *Populus tremuloides* Michx.; (*b*) coniferous forest dominated by *Abies balsamea* L.; (*c*) mixed hardwood coniferous forest with varying amounts of *P. tremuloides, A. balsamea, Betula papyrifera* Marsh, *Picea glauca* (Moench) Voss, and *Quercus macrocarpa* Michx.; and (*d*) grassed areas (dominated by *Phleum pratense* and *Festuca* sp.). Each transect extended from the hilltop above the creek to the stream bank along a compass direction approximately perpendicular to the stream. A series of 50 cm long stakes were driven approximately 35 cm into the ground, above and below breaks (cracks) in the soil surface in areas where breaks occurred and at regular intervals where there were no apparent failure zones. A variety of vegeta-

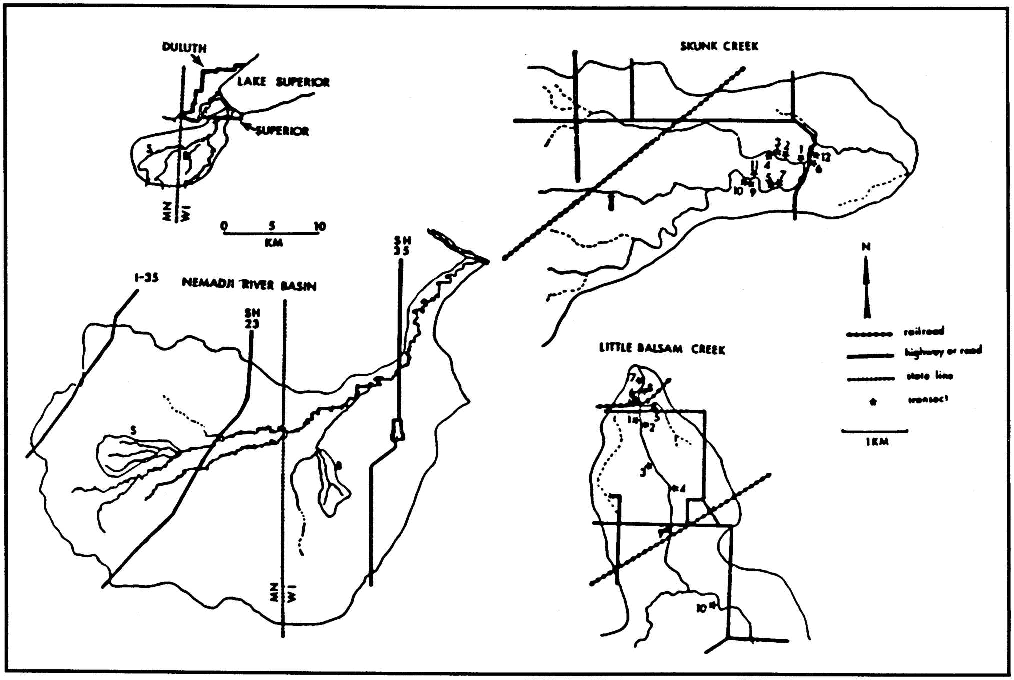

Fig. 1. Location map of Skunk Creek and Little Balsam Creek transects.

tional types was selected for the transects with *P. tremuloides, A. balsamea, B. papyrifera,* and grass cover, as well as bare soil represented. The difference from the base point at the top of the transect to each of the downhill stakes, as well as the distance between each of the adjacent stakes, was measured between 7–22 August 1975, 1–8 November 1975, 16–22 April 1976, 14–21 October 1976 and 12–23 May 1977, 5–11 August 1977, 12 November 1977, and 21–23 June 1978. Distances between stakes were recorded to the nearest 3 mm.

The precision of the transect stake measurements was determined by repeated measurements of Little Balsam transect no. 9. This transect was judged to be as difficult as any to measure due to topographic and vegetational features. Five replicate measurements were performed, and the standard deviation was used to calculate the 95% Confidence Interval for the values measured. The precision of the between-stake distances was 1.7 + 2.0 mm, while the precision of measurements from the crest to each stake was 2.9 + 1.7 mm. Based on these values, we conservatively judged that differences in measurements between sample dates greater than 6 mm indicated movements of the stakes rather than errors in measurements. Differences of less than or to equal 6 mm were ignored in our calculations.

Vegetation Cover of Stable and Slumped Sites

To compare the vegetational cover of stable and slump sites, quadrats were randomly placed in slumped sites and adjacent stable areas with similar physical features. All trees within a 10 m^{-2} area were tabulated and their diameter at breast height measured. In addition, all shrubs within a 5 m^{-2} plot nested within the tree quadrat were counted. All herbs within a 0.25 m^{-2} quadrat randomly placed within the larger tree quadrat were clipped at ground level, field sorted to species, and dried to constant weight. The dried weight was recorded as phytomass. From these data, relative dominance, relative density, and relative frequency for each species was calculated and used to derive the importance percentages.

Surface Runoff

Four sites in the vicinity of Little Balsam Creek (transects 5 and 8) were chosen to represent (1) tree cover—stable; (2) tree cover—slumping; (3) herbaceous cover—stable; and (4) herbaceous cover—slumping.

At each site five enclosures (1 m wide and 2 m long) characterized by different slope gradients and representative cover were constructed to monitor surface erosion during 1975 and 1976. The perimeters were defined with galvanized metal roofing, partially buried leaving as approximate 115 cm-border above the soil surface. A polyurethane border was added between the metal and the ground surface to ensure a proper seal. At the base of each enclosure, the surface runoff was collected in 20-l polyethylene carboys. A 140-l plastic garbage can was connected as overflow reservoir from the 20-l container. After each period with greater than 5 mm of rain, the volume of runoff was recorded. A 100-ml sample was filtered through a 0.45 um millipore filter system, and the dry weight of the suspended solids trapped on the filter was determined.

Root Distributions

Excavation sites for determining root distribution patterns were located adjacent to eight of the twenty-two transects established to quantify slope movement. Up to five sites (0.5 m wide x 1.0 long x 0.5 m deep) were selected from each transect to reflect the possible variation in soil and vegetation environment from the crest to the valley. Long was placed down-slope. At each site the following measurements and/or samples were taken:

1. The 0.5 m^{-2} quadrat served as the center for a larger quadrat (10m^{-2}) in which

a complete census of trees (greater than or equal to 10 cm dbh—diameter at breast height) was conducted. The following information was recorded for each tree: (*a*) species identifications; (*b*) geometric position from the center of the inner quadrat; (*c*) dbh; and (*d*) approximate canopy height.

2. Sapling and shrub counts were taken within a 5 m^{-2} quadrat concentric with the excavation quadrat.

3. The living herbaceous vegetation within the 0.5 m^{-2} quadrat was clipped at ground level and brought to the laboratory where it was sorted as to species or general growth forms when taxonomic separation was difficult. Subsequently, the phytomass (oven dry weight) was determined for each identifiable group.

4. The litter within the 0.5 m^{-2} quadrat was collected and treated in the same manner as the herbaceous cover.

5. Soil and root samples were obtained.

The excavation of the 0.5 m^{-2} quadrat was done in 10 cm increments. The visible root material within each 10 cm level was collected and brought to the laboratory. Adhering soil particles were washed from the roots. Subsequently, the roots were sorted into 12 size-classes based on root diameter (cm): less than 0.5, 0.5–0.99, 1.0–1.99, 2.0–2.99, 3.0–3.99, 4.0–4.99, 5.0–5.99, 10.0–14.99, 15.0–19.99, 20.0–24.99, and greater than 30. Oven dry weights of the roots were determined for each size class.

The soil from each 10 cm level was thoroughly mixed in the field, and a subsample (approximately 2 kg) was brought to the laboratory to extrapolate the total quantity of roots remaining in the soil. The roots in the subsample were carefully removed and sorted into diameter size classes. The mass of the roots from the subsample was adjusted by a multiplication factor (mass of soil excavated/mass of subsample × bulk density of the soil).

The relationship between root length and root mass was determined for roots less than 5 mm diameter (Table 1). These relationships were used to obtain an estimate of root length as a function of root mass. The length of roots greater than 5 mm diameter were measured to the nearest cm. The root distribution data for each sample therefore consist of (*a*) the measured mass of roots retrieved from each depth of each hole; (*b*) the measured mass of roots retrieved from the corresponding soil subsample; (*c*) the measured length of roots greater than 5 mm diameter; and (*d*) the calculated length of roots less than 5 mm diameter.

Root Tensile Strength

Roots of selected species were excavated in the field. To ensure proper identity, only roots that could be traced back to the stem of an identifiable shoot were used. The excavated roots were kept moist and brought into the laboratory where the adhering soil particles were washed away. Immediately after washing, the roots either were prepared for measurement of tensile strength or were preserved in a solution of 8 parts isopropyl alcohol and 1 part formaldehyde (Burroughs

Table 1. Length-weight relationships for small roots

Size class diameter (mm)	$\bar{X} \pm t_{05} S_{\bar{x}}$ *(cm·g⁻¹)*	$S_{\bar{x}}/\bar{X} \times 100$
< 0.5	1270 ± 120	3
0.5–0.99	298 ± 34	4
1.0–1.99	94 ± 14	6
2.0–2.99	40 ± 4	4
3.0–3.99	19 ± 2	4
4.0–4.99	13 ± 3	7

and Thomas 1977).

Roots having a generally uniform diameter were cut into segments approximately 7–8 cm long. One end of the root was secured in a rubber clamp attached to an Ametek force gauge; the end was clamped to a rubber clamp handle so that precisely 5 cm of root was exposed between the clamps. The root was subjected to a continually increasing force until breakage occurred. If the break occurred within approximately 2 mm of either clamp the data for that segment was discarded. Otherwise the tensile strength was recorded along with the average diameter of the segment obtained from three measurements made with vernier calipers. Approximately 75 determinations of tensile strength were made for each plant excavated. A log-log transformation of the tensile strength and diameter provided a linear distribution of the data. Subsequently, linear regression analysis was performed expressing the log tensile strength as a function of the log root diameter. No apparent differences in tensile strength between fresh and preserved roots were observed.

Additional measures of root tensile strength were obtained from plants grown under greenhouse conditions on flat surfaces. Seeds of *Bromus inermis* Leyss, *Coronilla varia* L., *Festuca arundinaceae, F. rubra, Lolium perenne, Lotus corniculatus* L., *Poa pratensis* L., and *P. tremuloides* were planted in red clay soil in boxes 15 cm in depth. Except for *P. tremuloides,* plants were harvested after seed set had begun.

Results and Discussion

Soil Slump Erosion

From the time of installation of the stakes, observations were taken at seven seasonal intervals over the 34-month period: I) August 1975–November 1975; II) November 1975–April 1976; III) April 1976–November 1976; IV) October 1976–May 1977; V) May 1977–August 1977; VI) August 1977–November 1977; VII) November 1977–June 1978. The summary of slumping as determined from between stake measurements indicates considerably more slumping activity occurred during periods II and VII than the other five periods. This is apparent in the number of transect intervals exhibiting displacement, the magnitude of individual displacements (both maximum displacements and the net displacement along the transect). During period II all 22 transects had net displacements of greater than 3 cm. In period VII all of the Skunk Creek sites and three of the Little Balsam sites had displacements greater than 3 cm. Periods I, III, IV, V, and VI had, 6, 14, 16, and 4 transects with greater than 3 cm respectively.

Significant soil movement occurred over the 34-month period with a maximum displacement of 2.02 m in Skunk Creek Transect 11 and 1.05 in Little Balsam Creek Transect 8. Seven other transects had greater than 30 cm elongation. In addition, Skunk Creek 11 and Little Balsam Creek 8 lost a total of 1.5 and 2.9 m of stream bank during floods of 1976, 1977, and 1978.

Three general types of soil movement are apparent in the data: (1) overall elongation of the transect (positive displacements); (2) overall compression of the transect (negative displacements resulting from the crest setting); and (3) combinations of positive and negative displacements relating to the ridge top (Fig. 2).

During the periods of higher activity most of the movement led to a general elongation of transect, while periods of lesser activity tended to have both positive and negative displacements. It is likely that both types were present even in the periods of higher activity but were masked by a general downward slippage.

Although the influence of freeze-thaw is generally considered to be a major stimulus to trigger slumping, our data suggest that soil moisture conditions may be equally critical. Our maximum activity occurred in the springs of 1976 and 1978. In both periods the soils were at or near saturation. The soils in the

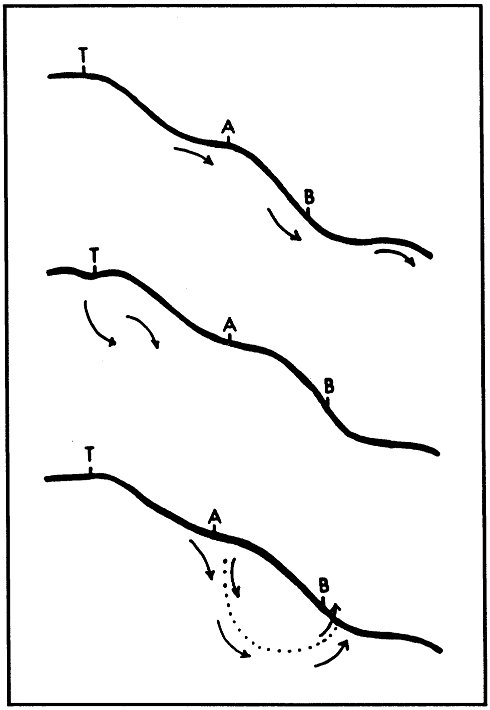

Fig. 2. Scheme of three types of slumping activity to account for (1) elongation of the transect, (2) compression of the transect, and (3) coupled internal positive and negative displacements, i.e. rotational slumping. A and B represent measurement stakes.

spring of 1977 were quite dry, and there was relatively little slumping.

Though several factors interact to affect erosion, the type of cover appears to be closely related to the magnitudes of slumping. The maximum displacements occurred in Skunk Creek 11, which is treeless, Little Balsam 6, a grassed slope, and Little Balsam 8, a sparsely covered *P. tremuloides* area. *P. tremuloides* covered sites exhibited a wide range of erosion activity. Generally, the moderately dense *P. tremuloides* areas having an understory with hazel (*Corylus* spp.) appeared to be more stable than stands with a less developed shrub layer. The mixed conifer-hardwood stands also appear to be correlated with greater stability.

Vegetation Cover of Stable and Slumped Sites

The results of cover analysis of vegetation on slumped and stable sites are recorded in Table 2. The slumped sites tend to be characterized by equal to slightly greater amounts of *P. tremuloides* and conifers than stable sites and with lesser amounts of *B. papyrifera*. In addition, the shrub layer of the slumped sites support lesser numbers of beaked hazel (*C. cornuta* Marsh) and dogwood (*C. stolonifera* Michx.) species which have higher tensile strengths.

Surface Runoff

Following the installation of the surface runoff enclosures a total of 29 rain periods were monitored during the late summer of 1975 and summer 1977. Our system was not suited to handle the spring melt runoff. Consequently, the runoff and sediment valves we report are applicable for summer conditions only.

The volume of runoff in areas with slumping was considerably higher than in stable areas for both grassed and wooded areas and tended to increase logarithmically with increasing amounts of rainfall, as is shown in Table 3. In both grassed and wooded areas the amount of runoff from the stable soils appears relatively high in the greater-than-60-mm-of-water category. Only three rains of this magnitude were recorded, and two occurred after the soil surface had frozen and leaf fall begun. Other than these three rains, the volume of runoff between the wooded and grassed areas is remarkably similar.

The sediment load was extremely variable, especially in the grassed areas. Again major differences are apparent between the slumped and stable areas. The major differences occurred between the grassed and the wooded areas with approximately 10–20-fold or more sediment in the runoff from the grassed areas. The estimated soil loss (mton · ha^{-1}) during the period 25 June–4 October 1976 was stable grass, <0.1; slumped grass, 1.7; and slumped woods, 0.2. During the period 15

Table 2. Comparison of major (I.P. values > 5.5) species of vegetation on slumped and stable sites, Nemadji River Basin (n = number of quadrats)

Taxa	Importance Percentage Slumped (n = 21)	Stable (n = 18)
Trees		
Populus tremuloides Michx. Quaking aspen	46.2	42
Abies balsamea (L.) Mill. Balsam fir	39.7	30.3
Picea glauca (Moench) Voss White spruce	7.6	—
Betula papyrifera Marsh. Paper birch	6.5	19.5
Shrubs		
Populus tremuloides Michx. Quaking aspen	11.7	10.6
Abies balsamea (L.) Mill. Balsam fir	8.8	8.6
Diervilla Lonicera Mill. Bush honeysuckle	8.7	—
Corylus cornuta Marsh. Beaked hazel	7.5	15.2
Rosa sp. Rose	6.9	7.4
Cornus stolonifera Michx. Red-osier dogwood	5.1	12.7
Herbs		
Fragaria sp. Strawberry	9.0	—
Equisetum sp. Horsetail	7.8	—
Carex sp. Sedge	5.9	5.4
Aster marcophyllus L. Large leaf aster	5.2	21.5

Table 3. Summary of surface runoff data $\bar{X} \pm S_{\bar{x}}$ for 5 replicate plots for 1976 and 1977. (The amount of rainfall during the monitoring periods for 1976 in 8 rain periods was 162 mm and for 1977 in 21 rain periods was 686 mm.)

	% Slope	% Cover[1]	Total runoff Liters ($L \cdot m^{-2}$) 1976	1977	Total sediment ($g \cdot m^{-2}$) 1976	1977	Conductivity[2] (umhos) 1976	1977
Grass								
Stable	21.5 ± 1.6	95 ± 4	1.0	58.3	1.1	21.5	96 ± 19	202 ± 15
Slumped	16.1 ± 1.2	26 ± 13	44.6	122.1	172.7	783.8	173 ± 16	195 ± 16
Woods								
Stable	16.9 ± 2.1	94 ± 5	nd	47.0	nd	3.6	nd	144 ± 37
Slumped	30.8 ± 2.8	18 ± 4	13.1	121.9	22.5	38.7	178 ± 10	220 ± 30

[1]Visual estimate includes vascular plant cover, litter, lichens, and bryophytes.

[2]$\bar{X} \pm S_{\bar{x}}$ for the five replicate plots. umhos were used as the measurements for conductivity, rather than SI units, as a conductivity meter was used.

May–15 October 1977 the soil loss was stable grass, 0.2; slumped grass, 7.8; stable woods, <0.1; slumped woods, 0.4.

Root Distribution

The mass and total length of roots within the soil profile were related to differences in vegetative cover and soil texture. On clay soils tree cover tended to have about twice as much root mass as herbaceous cover (Table 4). (Extensive tabular summaries are available from the authors). In addition, the roots from tree cover occurred in a relatively steep-sloped log-linear pattern with roughly 50% of the root mass in the 0–10 cm level. The rooting pattern under herbaceous cover declined very steeply with up to 90% of all roots confined to the 0–10 cm level. Furthermore, the differences in the amounts of roots in the various size classes were dramatic between grassed and wooded areas. Generally in the wooded areas, the less than 0.5 mm category constituted 15–22% of the total root mass. As root diameters increased, the mass gradually diminished per size class. In the predominantly grass-covered Little Balsam 6, approximately 60% of the root mass was distributed nearly uniformly among the four size classes between 0.5 and 5.0 mm. The composition of the two herbaceous cover transects was quite different in both quantity and type of plants. Little Balsam 5 was sparsely vegetated and had considerable amounts of horsetail (*Equisetum* sp.) rhizomes occurring uniformly throughout the 50 cm profile. In the sandy soils roots tended toward a gently sloping log-linear distribution (Tables 4 and 5) but with a greater variance than in the clay soils. From field observations it was apparent that 50 cm depth was sufficient to recover essentially all roots in the clay soils. However, in the sandy soils roots penetrated to much greater depths.

Among the species commonly used to stabilize roadside erosion areas, *Lolium perenne* and *Festuca arundinaceae* produced the greatest above ground phytomass and had 20–25% of their total phytomass as roots and rhizomes (Table 5). *Coronilla varia* produced a relatively good amount of root, but this occurred primarily as a thick tap root. Thus the amount of soil reinforcement was less than for plants with a more diffuse pattern for a similar amount of root mass (e.g., *P. tremuloides*, Table 6).

Table 4. Summary of root distribution data[1]

	Total root mass $\bar{X} \pm S_{\bar{x}}$ *g/plot*	*Mean percentage of total root mass (g) in*	
		0–10 cm	*10–20 cm*
Herbaceous cover—clay			
Little Balsam 5	446 ± 108	39	21
Little Balsam 6	578 ± 80	93	4
Combined	512 ± 67	66	13
Tree cover—sand			
Little Balsam 9	872 ± 88	44	18
Little Balsam 10	660 ± 83	34	21
Combined	766 ± 67	39	20
Tree cover—clay			
Little Balsam 8[2]	719	58	18
Skunk 1	824 ± 99	43	18
Skunk 6	1293 ± 382	50	30
Skunk 12	1277 ± 256	57	20
Combined	1124 ± 156	51	23

[1]Bulk density values used for the various soil textures were: sand, 0.95; sandy clay loam, 1.00; sandy clay, 1.05; clay, 1.10 determined previously.

[2]Only one sample excavated at this site.

Table 5. Summary of phytomass production of selected species grown in red clay soil under greenhouse conditions

	Above ground phytomass (g)	Below ground phytomass (g)	Shoot: Root Ratio
Bromus inermis Leyss Hungarian brome	70.3	66.0	1.07
Coronilla varia L. Crown vetch	33.3– 70.0	39.6–81.7	0.85
Festuca arundinaceae Schreb. Tall fescue	246.0–258.4	74.3–75.3	3.37
Festuca rubra L. Red fescue	68.0	8.6	8.0
Lolium perenne L. Perennial rye	213 –215	40.8–79.0	3.98
Lotus corniculatus L. Birds-foot trefoil	34.0– 96.4	15.8–23.5	3.14
Poa pratensis L. Kentucky bluegrass	51.7– 66.9	8.3–10.8	6.21
Populus tremuloides Michx. Quaking aspen	16.1– 42.0	39.0–81	0.46

Root Tensile Strength

Measures of root tensile strength show major differences among woody and herbaceous species (Table 6). Small roots (1 mm diameter) of woody plants were 1.5–8.5 times stronger than of herbaceous plants generally used in roadside stabilization.

The tensile strength of small roots of deciduous woody species may be correlated with the strength of wood as measured by the modulus of rupture. Wells (1976) demonstrated a relationship among numerous morphological features and the successional position of species in the Eastern Deciduous Forest Complex. The modulus of rupture was significantly and positively correlated with advancing successional development.

Representative values of the amounts of rupture (K Pa) for major taxa in our area are *Salix* sp., 33,000; *P. tremuloides* Michx., 35,000; *Fraxinus nigra* Marsh, 41,000; *B. papyrifera* Marsh, 44,000; *Ulmus americana* L., 50,000; *Acer rubrum* L., 53,000; *Quercus borealis* Michx. f., 57,000; *Acer saccharum* Marsh, 57,000; *A. balsamea* (L.) Mill, 34,000; *P. glauca* (Moench) Voss, 37,000; and *P. strobus* L., 34,000 (Forest Products Laboratory 1974). If the relationship between root tensile strength and the modulus of rupture is widespread, then the more advanced successional species can be expected to have the greatest per unit root strength. Our measures of root strength show *A. rubrum* to be substantially stronger than *P. tremuloides* in nearly the same proportions as the modulus of rupture would suggest (Table 6). The conifers do not seem to follow this pattern. *Abies balsamea, P. glauca,* and *P. strobus* exhibit a range of root tensile strength (Table 6) while the modulus of rupture for these taxa are similar.

Root Distribution and Root Strength

High erosion rates are often associated with high amounts of soil moisture. However, due to the special character of the clay with respect to water content, it is not always favorable to maintain low water levels. During the years with normal amounts of precipitation, the soils under all vegetation types tended to remain at or near field capacity throughout the summer. Under these conditions the clay acts as a liquid; therefore the ability of the vegetation to protect against erosion is due to a combination of root distribution and root strength. During the oc-

Table 6. Summary of root tensile strength measures

Species	Soil Type	No. of Specimens	Estimated tensile strenght (Kg) from regression equations for given diameters	
			1 mm	8 mm
Trees and shrubs				
Abies balsamea (L.) Mill.				
Balsam fir	Clay	4	1.2	98.0
Acer spicatum Lam.				
Mountain maple	Sand	3	2.0	198.7
Acer rubrum L.				
Red maple	Sand	1	3.4	715.9
Alnus rugosa (DuRoi) Spreng.				
Speckled alder	Clay	5	1.2	10.8
Betula papyrifera Marsh.				
Paper birch	Sand	3	0.9	52.4
	Clay	3	1.7	46.3
Cornus stolonifera Michx.				
Red-osier dogwood	Sand	2	1.4	37.0
	Clay	2	2.6	275.2
Corylus cornuta Marsh.				
Beaked hazel	Clay	2	1.8	219.4
Picea glauca (Moench) Voss				
White spruce	Sand	5	1.2	55.9
Pinus Strobus L.				
White pine	Sand	1	1.3	71.5
Populus tremuloides Michx.				
Quaking aspen	Clay	7	1.2	50.9
Ribes sp.				
Currant	Clay	3	1.1	35.5
Herbs				
Bromus inermis Leyss				
Hungarian brome	Clay	1	0.5	nd
Coronilla varia L.				
Crown vetch	Clay	1	0.6	nd
Lolium perenne L.				
Perennial rye	Clay	1	0.4	nd
Festuca rubra L.				
Red fescue	Clay	1	0.9	nd
Lotus corniculatus L.				
Birds-foot trefoil	Clay	1	0.5	nd
Poa pratensis L.				
Kentucky bluegrass	Clay	1	0.6	nd

casional dry year certain vegetation types with high rates of evapotranspiration, such as grassed areas and *P. tremuloides* forests, reduced the soil moisture content to near the permanent wilting point, which is well above the plastic limit for the clay (Kapustka et al. 1978). Under these vegetation types the soil developed extensive fissures often up to 2 cm wide, several meters long, and 15 or more cm deep. Such fissures tend to remain in the soil for years. Thus during subsequent wet periods moisture drains down these openings and promotes deep seated failures below the root zone. When this occurs no vegetation is capable of withstanding the tremendous force exerted on its roots and a block of soil often several meters across slides downhill leaving a newly exposed soil surface. Once initiated, these erosional processes seem to perpetuate indefinitely. The more advanced successional vegetations tend to have a thicker litter layer and a lower apparent evapotranspiration rate and thus prevent the soil fissures from forming even during the dry years.

It appears that root distribution and root strength properties are the most critical vegetation features in reducing both slumping and surface erosion of the red clay soils. Extensive litter cover can be valuable especially as it relates to maintenance of the surface soil moisture. Later successional species tend to provide both more litter and a stronger root system than earlier successional types.

General Conclusions

Our work on the root properties and erosion in the red clay region revealed that

a. essentially all roots occur in the upper 50 cm of clay soil;
b. for similar sites with respect to soil conditions, areas with tree cover tended to have about twice the root mass per unit volume of soil compared to areas with only herbaceous cover;
c. the rooting pattern for wooded sites followed a log-linear relationship for root mass vs. soil depth, with approximately 50% of the root mass occurring in the 0–10 cm zone;
d. on sites with herbaceous cover up to 90% of the root mass was in the 0–10 cm zone;
e. on wooded sites 15–22 % of the total root mass was in the 0–0.5mm diameter size class and as root diameter increased the mass per size class decreased;
f. on herbaceous sites approximately 60% of the root mass was in the 0–0.5mm size class with essentially all roots confined to less than 2 mm diameter;
g. the strength of small roots (up to 1mm diameter) was 1.5–8.5 times stronger in woody species than in herbaceous species;
h. among woody species later successional species tended to have stronger roots than early successional species;
i. vegetation comprised of woody, advanced successional species appeared to offer the best protection against both surface and deep-seated erosion;
j. certain species tended to afford greater protection against deep-seated soil movement than others.

P. tremuloides-dominated sites exhibited a wide range of slumping activity. Generally, moderately dense *P. tremuloides* dominated areas with a well developed shrub understory were more stable, especially when *C. cornuta* Marsh was dominant. Mixed conifer-hardwood stands were also quite stable. Additional data comparing vegetation on slopes with obvious slumping activity to apparently stable slopes revealed an approximate two-fold higher density of trees on the stable sites and higher amounts of *C. cornuta* and/or *C. stolonifera* in the understory. Furthermore, surface runoff rates (mton · ha^{-1}) during May through October 1977 were estimated at 0.2 for stable grassed areas, 7.8 for disturbed grass areas, <0.1 for stable wooded areas, and 0.4 for disturbed wood areas.

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Manifest Details and Latent Complexities in Flannery O'Connor's "A Good Man Is Hard to Find"

Paul J. Emmett

> You might say that [symbols] are details that, while having their essential place in the literal level of the story, operate in depth as well as on the surface, increasing the story in every direction . . . it is from the kind of world the writer creates, from the kind of . . . detail he invests it with, that a reader can find the intellectual meaning of a book . . . the novelist makes his statement by selection, and if he is any good, he selects every word for a reason, every detail for a reason . . . (O'Connor, *Mystery* 71–75).

These passages from Flannery O'Connor's "The Nature and Aim of Fiction" suggest O'Connor's insistence upon the importance of details in fiction. In light of this insistence, it is somewhat surprising that many critics have ignored the evocative details in O'Connor's own fiction. Even the details in "A Good Man Is Hard to Find," O'Connor's most popular short story, have been frequently overlooked. Indeed, in 1972 C. R. Kropf took critics of "A Good Man Is Hard to Find" to task for their tendency to focus almost exclusively on the conclusion of this short story. "The final scene is no doubt a crucial one," said Kropf, "but the story is full of vivid details for which such discussions fail to account" (177–80, 206). And Kropf's indictment was most apt since early O'Connor critics not only focused on the grandmother's climactic "moment of grace," they also tended to discuss broad themes rather than specific details. But by 1981 Hallman Bryant could say that his design was "to shed light on the significance of some small details in 'A Good Man Is Hard to Find' " (301–07), and this is characteristic of the swing toward detail that has taken place since 1972. Robert Woodward has discussed the latent implications of the route that Bailey chooses; James Ellis has examined the apparently inconsequential details of the grandmother's Edgar Atkins Teagarden Story; Frederick Asals has explored the strategic juxtapositions of seemingly unrelated details; Steve Portch has explained "subtle details" related to the grandmother's cat and the Misfit's spectacles; and Bryant himself has demonstrated O'Connor's deft use of place names in this short story (2–5; 7–8; 144; 19–20; 301–07).

So we are moving in the right direction, but still O'Connor's subtle details are even more subtle and detailed than has been supposed. The latent depths in which they "operate" are more complicated, and darker, than has been suggested. As O'Connor herself notes, every word is important and every detail increases the story's depth in numerous directions. "A Good Man Is Hard to Find" has, in fact, the density of dream. And to present this density, to probe the depths, and to penetrate the details I will make frequent use of Freudian theory. I will not be using Freud the philosopher that O'Connor was "against tooth and toenail"; I will be using the other Freud that she had "quite a respect for," the one she saw "bringing home to

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people the fact that they weren't what they thought they were'' (O'Connor, *Being* 110, 490–491). This Freud, who exposes people and depths, can help expose details in ''A Good Man Is Hard to Find.'' And this help is essential because Kropf's indictment—that vivid details as well as the final scene must be taken into account—was not strong enough. The final scene cannot be accounted for until we account for the vivid details that precede it. Statement comes from detail; detail provides ''the intellectual meaning of a book.''

There are, then, many reasons for looking at some of the details in ''A Good Man Is Hard to Find'' before considering the climactic confrontation between the grandmother and the Misfit. These details suggest both the density and the direction of the depths of Flannery O'Connor's fiction, and they lead us to the understanding of both prefatory and ultimate moments. Consider just one example. At Red Sammy's the children's mother plays ''The Tennesse Waltz.'' And it might not be surprising that this small detail has never been considered by critics since the most it seems to do is to add Southern flavor. Yet even if this detail seems obvious, its context demands explanation.

> The children's mother put a dime in the machine and played 'The Tennessee Waltz,' and the grandmother said that tune always made her want to dance. She asked Bailey if he would like to dance but he only glared at her. He didn't have a naturally sunny disposition . . . (121).

Why does Bailey glare at his mother? Why does his mother ask him to dance? Why, for that matter, is selecting ''The Tennessee Waltz'' the only action that the children's mother initiates throughout the entire story? The answers are in the ''obvious'' detail—''The Tennessee Waltz.'' The grandmother had wanted to go to Tennessee, but for once she didn't get her way, and now the mother is rubbing it in. But the mother's attack goes much deeper. As O'Connor says, detail increases the story in many directions. ''The Tennessee Waltz'' is about a woman who steals her friend's sweetheart away. And once we realize this, the context here becomes clearer. At the latent level of the story the mother is saying, ''I'm glad we're not going to Tennessee'' and ''you stole my husband.'' The grandmother counters by asking Bailey to dance, because she knows both the game and the lyrics—''while they were dancing my friend stole my sweetheart away.'' Bailey, in turn, responds with a glare. This son's overreaction suggests his own latent obsession with this unnatural game: most assuredly, he does not have ''a naturally 'sunny' disposition.''

Understanding this one detail does more than help us explicate the scene at Red Sammy's. It suggests the limitations of the common assumptions that the grandmother is superficial but kind, that the children's mother is completely passive, and that the story itself represents a contrast between a happy family and vicious killers. Even as an isolated detail that hints at the jealousies and passions raging beneath the surface of the story, it suggests the striking contrast between surface and depths, manifest and latent. But ''The Tennessee Waltz'' is much more than an isolated detail. It is part of a network of details that reinforce and refine each other as they lead us to ultimate meanings, a network of details that emphasizes and elucidates the latent relationship between Bailey and the grandmother. And since we have to understand this relationship before we can understand the one between the Misfit and the grandmother, we must begin with this network of reinforcing and refining details.

A close look at the accident itself, for example, reinforces and refines the implications of ''The Tennessee Waltz.'' And a close look is necessary since O'Connor's repetition of, and use of capitals in, ''ACCIDENT'' (125, 126) suggest that this accident is more than the automobile mishap that the children revel in.

> Pitty Sing, the cat, sprang onto Bailey's shoulder. The children were thrown to the floor and their mother, clutching the baby, was thrown out the door onto the ground; the old lady was thrown into the front seat . . . (124).

The children are discarded on the floor; the wife, with her baby, is cast out of the front seat, and the grandmother ends up alone in the front seat with Bailey. Again the grandmother takes the mother's place. This is the latent "ACCIDENT" that "destroys" the family, the accident foreshadowed in "The Tennessee Waltz."

Before considering how the accident refines "The Tennessee Waltz," we should note the extent of the reinforcement. The latent accident is suggested with the pairings in the very first lines of the story: John Wesley and June Star are reading on the floor and the mother is feeding the baby on the couch, while the grandmother is with Bailey at the table, showing him both her newspaper and her hip. " 'Now look here Bailey . . . see here, read this' . . . she stood with one hand on her thin hip and the other rattling the newspaper at his bald head" (117). The pairings suggest what the accident and "The Tennessee Waltz" later confirm: the grandmother has taken over Bailey. The details suggest that the grandmother is in the wife's place because she has never relinquished her own place as mother. With hip and newspaper, this temptress and chastiser rattles at bald Bailey. At the latent level they relive the nursery scene. They are stuck in the past, mommy and baby, because the grandmother will not let go. "She wouldn't stay at home for a million bucks . . . afraid she'd miss something . . . she has to go everywhere we go" (118). So Bailey remains "Bailey Boy" (128, 129, 131) and the children's mother is always called "the children's mother." She is never once called "Bailey's wife."

An understanding of the extent of the grandmother's control helps with, and is reinforced by, other subtle details. It's difficult to see, for example, why the children's mother goes calmly to certain death. " 'Lady,' the Misfit asked, 'would you and that little girl like to step off yonder with Bobby Lee and Hiram and join your husband?' 'Yes, thank you,' the mother said faintly" (131). And as manifest explanations come up short (could she be that traumatized?) we turn, almost of necessity, to the latent level where the difficulties fade once we focus on "join your husband." For once the grandmother can't come along; for once—and this is literally the only time—Bailey can be called "husband." In death the family achieves a union that the ever present grandmother has made impossible in life.

Now we can see why the grandmother doesn't really seem to lament Bailey's death until his wife is shot. When Bailey is taken away the grandmother says " 'Bailey Boy!' . . . in a tragic voice but she found she was looking at the Misfit . . ." (128). When Bailey is shot "the grandmother could hear the wind move through the tree tops like a long satisfied insuck of breath. 'Bailey Boy!' she called" (129). But when the wife is shot "the grandmother raised her head like a parched old turkey hen crying for water and called, 'Bailey Boy, Bailey Boy!' as if her heart would break" (132). And the incongruity here is difficult, until we again focus on "join your husband." The grandmother's heart does not break when she loses her son to death; it breaks when she loses him to her hated rival. And to see why the grandmother's reaction is so intense, we must turn to another detail of the accident since the accident not only reinforces the problem suggested in "The Tennessee Waltz," it also refines it by indicating the cause of the problem.

The surface accident, the automobile mishap, is initiated by the grandmother's cat, Pitty Sing, and to understand the latent accident, the family mishap, we must consider the symbolic implications of Pitty Sing. But Pitty Sing is another detail which is virtually ignored by O'Connor critics. Only two have spent any time at all on the grandmother's cat. In 1970, Josephine Hendin asserted that "the cat is too slender of a figure to carry much symbolic weight," and then flawed an otherwise perceptive analysis by discussing the male cat as female. In 1978, Steve Portch recognized the importance of the cat and of the Misfit picking up the cat at the end of the story, but because he did not discuss the "symbolic weight" of Pitty Sing, he could merely assert that the Misfit's gesture is "a moment of unconscious warmth" (150–51;

19–20). So Pitty Sing provides a paradigm of the critical dilemma concerning O'Connor's use of detail. When details are taken too lightly, crucial ones are ignored or misinterpreted. But even with the increasing concern for detail, the ending of the story cannot be analyzed without careful consideration of what Flannery O'Connor refers to in relation to Hulga's wooden leg in "Good Country People" as "accumulating symbolic meaning" (*Mystery* 99). And like Hulga's leg, the grandmother's cat is an exemplary O'Connor symbol: it "operates in depth as well as on the surface, increasing the story in every direction" (O'Connor, *Mystery* 99).

At one level "Pitty Sing" takes us to Pitti Sing of *The Mikado*. This allusion, confirmed by the Misfit's repeated concern that society should "let the punishment fit the crime," reinforces what we' ve learned in the accident since *The Mikado* is about an old man who wants to marry his ward and an old woman, Katisha, who wants to marry the Mikado's young son. At another level, the grandmother's cat is like the grandmother's son. Like Bailey Boy, the cat cannot get free of mother: "She didn't intend for the cat to be left alone in the house for three days because he would miss her too much and she was afraid he might brush against one of the gas burners and accidentally asphyxiate himself" (118). Like "Bailey *Boy*," the cat is rendered puerile by the grandmother's denominations: Pitty Sing is the infantile form of "pretty thing." Like Bailey Boy, the cat is emasculated by the grandmother: Pitty Sing/Pitti Sing/pretty thing. The cat could "accidentally asphyxiate himself," but Bailey is asphyxiated by the accident: both are smothered.

It is, however, Pitty Sing's leap from beneath the smothering hippo's head valise that initiates the accident, and to understand this incident, there is one more level that must be considered. In the accident Pitty Sing is associated with the grandmother: both fly into the front seat; the grandmother ends up catlike "curled up under the dashboard" (125); Pitty Sing ends up grandmother-like "clinging to Bailey" (125). And this is typical since throughout the story subtle details associate cat and grandmother—the grandmother, for example, takes "cat naps" (123). This crucial association is itself reinforced in an earlier draft of the story. "Granny thought that she was the only person in the world that [Pitty Sing] really loved, but the truth was he had never really looked any farther up than her middle, and he didn't even like other cats" (Manuscript). The ambiguous syntax here suggests that Granny is one of the other cats; Pitty Sing's restricted vision suggest that he is associated with Granny's lower half, her animal nature. And although the crude pun on pussy is toned down in the final version, the sexual overtones are still there. Granny hides the cat, for example, because "Her son, Bailey, didn't like to arrive at a motel with a cat" (118).

Pitty Sing, then, increases the story in many directions. Indeed, for the purposes of interpretation there might seem to be too many directions. For example, if Pitty Sing represents Bailey Boy's sexuality, stunted and suppressed, then his leap from Grandmother's basket onto Bailey's shoulder would seem to be a leap to freedom. But how could a leap to freedom initiate the accident: how, that is, could a leap to freedom cause the grandmother to take the wife's place? If, on the other hand, Pitty Sing represents the grandmother's sexuality, potent and primal, then his leap from basket to shoulder would seem to be an attack. But why would the cat then cling to Bailey "like a caterpillar" (125): why, that is, would there be the suggestion of rebirth as a butterfly? To answer these difficult questions and to understand the accident, we must see that these two latent directions fit together because Pitty Sing is both the phallus of Bailey Boy and the phallus of the grandmother. Indeed, he is the phallus that the grandmother now possesses because she has taken it from her son. Pitty Sing is the male rendered female by the grandmother's denomination, but he is also the male under female guise—the lost potency of the son and the dominating potency of the grandmother.

In the drafts, Pitty Sing has a "yellow hind leg," and this fairly transparent phallic image is related to Bailey's yellow shirt because yellow is the point. If Bailey Boy weren't afraid, he could recapture the phallus. This is why Pitty Sing clings like a caterpillar that could become a butterfly: the escape of this caterpillar offers sexuality and rebirth. Bailey, however, can't cope with the cat, and his failure is what actually causes the accident. Pitty Sing springs from beneath the valise that the drafts refer to as "the grandmother's grip" to Bailey's shoulder. But even though the phallus is out from under the "grip" of the grandmother and Bailey should have control, he doesn't. He loses control of the car and causes the accident. Mother replaces wife because Bailey Boy wants both what he should have, the phallus, and what he can't have, the mother.

After the accident, Bailey still has the phallus and, hence, a chance to take charge. "The car turned over once and landed right-side-up in a gulch off the side of the road. Bailey remained in the driver's seat with the cat—gray-striped with a broad white face and an orange nose—clinging to his neck like a caterpillar" (124, 125). The phallus has been turned over once and is now right-side-up, back to its original owner, and as the pause for the parenthetical phrase here emphasizes, "with the cat" Bailey is indeed "in the driver's seat." Even the grandmother cowers: "The grandmother was curled up . . . under the dashboard, hoping she was injured so that Bailey's wrath would not come down on her all at once" (125). But ultimately Bailey wants neither phallus nor control: he flings away the cat, and immediately gets out of the driver's seat.

Like the mythic Attis who castrates himself under a pine tree out of frustrated desire for his mother, Bailey, who tosses the phallic cat "against the side of a pine tree" (125), emasculates himself. And the very next lines of the story emphasize that the cause is frustrated desire for mother.

> Then he got out of the car and started looking for the children's mother. She was sitting against the side of the red gutted ditch, holding the screaming baby, but she only had a cut down her face and a broken shoulder. 'We've had an ACCIDENT!' the children screamed in a frenzy of delight. 'But nobody's killed,' June Star said with disappointment . . . (125).

Bailey's tossing away the cat and looking for the children's mother might for a second seem to be moves in the right direction. Yet, already he's made a few mistakes: he should bring the cat/phallus with him, and he should be looking for "his wife," not "the children's mother." We know, however, that these are not mistakes. Like Attis, Bailey rejects the phallus because he is really still looking for mother, and mother is inaccessible because of the incest taboo. So when Bailey finds his potentially vaginal wife in a "red gutted ditch" (125) he doesn't even talk to her. He merely notes "but she only had a cut down her face and a broken shoulder." And the apparent incongruity in "*but* she *only* had" suggests the ultimate horror. Like June Star, who says, " 'but nobody's killed!' " with disappointment, Bailey looks for his wife in hopes of finding her dead. Only when his wife is completely out of the picture could mother become wife.

Bailey's wife, however, is not dead, and although the grandmother has lost the phallus, she has not lost control over her son. Saying, "I believe I have injured an organ," the grandmother "limps" out of the car (125). Since anyone as well read as O'Connor in mythology knows that a limp is the mythical representation of castration (Jobes 2: 931), these two actions reinforce each other. Since hats have phallic connotations (Freud 5: 1900–01) both actions, in turn, are reinforced by the damage done to the grandmother's hat. "The grandmother limped out of the car, her hat still pinned to her head but the broken front brim standing up at a jaunty angle and the violet spray hanging off the side" (125). The imagery here is particularly telling: although the hat is battered, it is not lost completely. The "violet spray" is "hanging off the side," not gone completely, and this is important since after his emasculation, Attis—who is sometimes hanged on the pine tree—reappears as violets. So the hanging violet spray emphasizes that despite her "limp" the grandmother, who wears another violet spray at her bosom (118), still keeps hold of her castrated Attis.

Without the phallus Bailey ends up lost in the feminine. Sitting in the vaginal ditch, "Bailey's teeth were clattering. He had on a yellow sport shirt with bright blue parrots designed in it and his face was as yellow as the shirt" (125). Since Bailey is as yellow as the cat's hind leg that he has lost, grandmother is quickly back in power. She cuts off the next words that Bailey utters, just as she has "cut off" Bailey all his life. " 'Look here now,' Bailey began suddenly, 'we're in a predicament! We're in . . . ' The grandmother shrieked . . . " (127). O'Connor's deft juxtaposition, "we're in a predicament, we're in the grandmother," emphasizes that the grandmother is the predicament that Bailey Boy is lost in. And Bailey is lost. He does nothing to defend himself or his family against the Misfit. As he is led off to death our final view of him reinforces the problem one last time. "They went off toward the woods and just as they reached the dark edge, Bailey turned and supporting himself against a gray naked pine trunk, he shouted, 'I'll be back in a minute, Mamma, wait on me!' " (128). The recurring image of the pine tree which in myth represents both Cybele and Attis; the details "supporting himself against a gray naked pine trunk"; the first use of "Mamma"; and the fact that Mamma is Bailey's only concern—all tell the latent story. By supporting himself on Mamma and rejecting the phallus, Bailey has castrated himself. In a few moments he will be shot, but at the latent level his impotence and dependence, his inability to act, have rendered him lifeless. Like Attis he has sacrificed himself to the grand-mère, the Great Mother.

The Great Mother will not be without a son, however, and even before Bailey is shot the grandmother has found a new potential victim. " 'Bailey Boy,' the grandmother called in a tragic voice but she found she was looking at the Misfit squatting on the ground in front of her" (128). The grandmother says "Bailey" but looks at the Misfit—who is squatting just like Bailey was a minute ago (128)—because the Misfit is to be her new Bailey. But our study of the details of the latent relationship between Bailey Boy and the grandmother demonstrates that the Misfit is not Bailey. Indeed, we can discover a lot about both the Misfit himself and his climactic relationship with the grandmother just by contrasting details. Unlike Bailey who has "clattering teeth," (125) the Misfit has "a row of strong white teeth" (127). Unlike Bailey, the Misfit won't put up with the grandmother's fabrications: " 'We turned over twice!' said the grandmother. 'Once,' [the Misfit] corrected. 'We seen it happen' " (126). Unlike Bailey, the Misfit cuts the grandmother off: " 'Pray, pray,' the grandmother began, 'pray, pray . . . ' 'I never was a bad boy . . . ' " (130). And most importantly, unlike Bailey, the Misfit won't be mothered. The climactic scene is a most violent rejection of the grandmother as mamma and of the maternal breast.

> She saw the man's face twisted close to her own as if he were going to cry and she murmured, 'Why you're one of my babies. You're one of my own children.' She reached out and touched him on the shoulder. The Misfit sprang back as if a snake had bitten him and shot her three times through the chest. (132)

We could emphasize these contrasts to see "A Good Man Is Hard to Find" as a story of the ultimate defeat of the Great Mother. And since the Misfit sees the grandmother as a snake and picks up Pitty Sing after he kills the snake, we could see the story as the defeat of the Phallic Mother, the son's violent repossession of the phallus. And there is some validity to this view—but only some. The Misfit, for example, makes a correct association: the grandmother/snake has even "hissed" earlier in the story (121). But the snake is not just phallic, it also represents temptation. The Misfit suspects what the grandmother needs: a hard man is good to find. But his realization, "she would have been a good woman . . . if it had been someone there to shoot her every minute of her life," (133) is far too extreme. The Misfit accepts the phallus: he picks up the cat that has been rubbing against his leg (133). But the phallus has been neutered since Pitty Sing is now referred to as "it," not "he" (133). And the qualifications here emphasize just what we might expect from an author already renowned for manifest complexities: the latent story is not just a schematic presentation of the defeat of one son and the victory of another. It is not just a story of contrasts.

The Misfit is not simply "unlike Bailey." There is, in fact, some validity to the grandmother's feeling that the Misfit is the new Bailey. After all they do both squat, and squatting is feminine. The Misfit does put on Bailey's yellow shirt; he is scrawny like Bailey. And there's another particularly telling parallel between the two. Before Bailey goes to the woods and death he has one last moment of passivity, one last moment of talk without action.

> "Listen," Bailey began, "we're in a terrible predicament! Nobody realizes what this is," and his voice cracked. His eyes were as blue and intense as the parrots in his shirt and he remained perfectly still. (128)

Since voices have phallic connotations (Bunker 392), Bailey's cracking voice, like his immobility, reinforces his castration. But these reinforcements are particularly important later when the Misfit's voice changes: " 'Listen, [just what Bailey said] lady,' The Misfit said in a high voice, 'if I had of been there I would of known and I wouldn't be like I am now.' His voice seemed about to crack . . . " (132). The Misfit's voice is "about to crack," but it never actually does because he stops talking and starts shooting. The shooting of the grandmother, that is, is the Misfit's desperate attempt to shore up his tenuous and threatened masculinity. His voice almost cracks; he almost becomes Bailey: " 'Why you're one of my babies. You're one of my own children!' " (132). And almost is far too close for this man who is made nervous by children (126, 127) because he is nervous about still being a child. The Misfit will not be Bailey Boy; he will not be rendered puerile; he will not be smothered; he will not be caught in the Oedipal trap. Inept, insecure, and intimidated, he overcompensates with violence.

The Misfit's very assertion of maturity and independence manifests his immaturity and dependence. No one is more lost in Mother than Oedipus, and the Misfit resembles Oedipus. He has killed his father[1], and now with this phallic gun he attacks the mother. He fires three shots and after the attack his first concern is for his "red-rimmed" eyes (132). No wonder he sees the Great Mother as snake: she is the Oedipal temptation that cannot be avoided. Indeed, the intensity of the Misfit's aggression suggests the intensity of the temptation he's struggling to avoid. But even as he kills the temptress, at the latent level he succumbs to her. The grandmother smiles in death.

The Misfit is controlled just when he seems to take control, and this dilemma is reinforced by subtle details throughout the story. The sun and cloud imagery, for example, provides a perfect paradigm of the Misfit's plight. Before the Misfit comes on the scene, the children play their shape guessing game with a cloud "the shape of a cow," (120) and we are told twice that the sun is out (119, 122). Since we are also told that Bailey doesn't have "a naturally sunny disposition," (121) the latent implications here are not too subtle. The cloud which is the cow, the maternal principle, blocks off Bailey Boy, this most unnatural "sun." But when the Misfit arrives, he seems to rectify the situation. "Ain't a cloud in the sky . . . Don't see no sun but don't see no cloud neither" (127). The manifest improbability of this abrupt shift in the weather emphasizes the latent facts, which seem to be that, unlike Bailey, the Misfit is not lost behind the mother and that mother/sun imagery is not even relevant to the Misfit. These seem to be the facts—until we realize that the Misfit is not much of a meterologist.

A day that seems to be without sun or clouds really isn't. When the sun is not visible, it is being completely obscured by high level layered clouds, cirrostratus. It's no wonder that the grandmother responds to the Misfit's assertion that there is neither sun nor clouds with the seemingly incongruous " 'Yes, it's a beautiful day' " (127). It's beautiful for the Great Mother because this "son" doesn't even know he's lost in the clouds, lost in the maternal.[2]

And there appears to be little hope for the Misfit to escape the maternal since the Great Mother is as encompassing on earth as she is in the heavens. Since the Misfit has "plowed Mother Earth" (129) we might assume that, unlike Bailey who groans when the grandmother tricks him into going on a dirt road, (124) the Misfit has confronted and transcended the Maternal. But again this is not the case. The Misfit describes his later stay in prison in terms of the Maternal principle.

> "I never was a bad boy that I remember of . . . but somewheres along the line I done something wrong and got sent to the penitentiary. I was buried alive," and he looked up and held her attention to him by a steady stare. (130)

This bad boy Oedipus, killed his father and was "buried alive," lost in the maternal: The Earth Mother is his penitentiary. That his "escape" from the penitentiary only seems to distinguish him from Bailey who never escapes alive is emphasized in the last line here. The Misfit's staring at the grandmother immediately after he says "buried alive" emphasizes that the Earth Mother, the real penitentiary, is omnipresent.[3] The Misfit's stare holds her attention to him, but it's her "attention" that "holds" Bailey Boy, Pitty Sing, and the Misfit. That's why the Misfit still "plows" Mother Earth. "The Misfit pointed the toe of his shoe into the ground and made a little hole and then covered it up again . . . the Misfit . . . drew a little circle in the ground with the butt of his gun . . . the Misfit kept scratching in the ground with the butt of his gun" (127, 128, 129). Like the shooting of the grandmother, the union of toe or gun and Mother Earth—the union both dirty and obsessive—is the symbolic rendering of the repressed Oedipal union that the Misfit both dreads and desires.

The union of gun and ground is, however, more than the sublimated fulfillment of repressed desires. The Misfit is struggling to find—struggling to free—his own self that is still buried alive. And "struggling" is the key word. This is what makes the Misfit unlike Bailey. The Misfit struggles; Bailey gives up. It's a case of "approach-avoidance": the Misfit approaches; Bailey avoids. The Misfit, as his daddy said, is one of those " 'that has to know why,' " (129) and from his first appearance in the story he is struggling to see so that he can comprehend.

> In a few minutes the family saw a car some distance away on top of a hill, coming slowly as if the occupants were watching them . . . It came to a stop just over them and for some minutes, the driver looked down with a steady expressionless gaze to where they were sitting . . . The driver got out of the car and stood by the side of it, looking down at them. (125, 126)

The Misfit's gaze, which will soon be focused solely on the grandmother, distinguishes him from Bailey, who is also characterized by his initial visual response to the grandmother—her hip, her newspaper, and her efforts to go to Tennessee: "Bailey didn't look up from his reading" (117). Bailey, that is, avoids dirt, cat, *and* grandmother: he fears the filth of his phallic Oedipal desires. The Misfit approaches dirt, cat, and grandmother: he is not afraid to discover his "dirty" self. And if he doesn't understand what he sees, he at least looks; if he overreacts, he at least reacts; if his voice almost cracks, he at least stops talking; if his masculinity is threatened, he at least cares. And if he repeats, symbolically, his unconscious Oedipal longings, at least he repeats those longings. Bailey does not. Bailey's longings are so repressed that he never even enacts symbolic sexual union. The Misfit has a better chance to find himself in, and free himself from, the Earth Mother because his desires which he must come to "know" are closer to the surface, and his symbolic confrontations provide him opportunities to understand. If he succumbs to the temptress, at least he has a chance to understand the nature of the temptation. Indeed, it seems that the violent intensity of the Misfit's killing/possessing of the Great Mother thrusts him forward towards knowledge and freedom. He at least has removed the blocking figure. When the grandmother is dead the weather changes again. Now there is merely a "cloudless sky" (132).

The cloudless sky emphasizes that the blocking mother is gone and suggests that it is no longer necessary to talk of "sun." The Misfit, who first moved from looking at grandmother to "looking beyond her," (132) has now moved from confronting Mother to transcending her. After the shooting he immediately "[puts] his gun down on the ground and takes off his glasses and begins to clean them" (132). Now he will be able to see beyond the dirt of the obsessions he has just confronted. He knows instinctively that he will no longer need the gun for shooting or digging: the mother has been encountered, possessed, and purged; the Misfit has plowed Mother Earth and he no longer needs to look for himself in the dirt. He is free. He no longer needs to assert his masculinity. "Without his glasses, the Misfit's eyes were red-rimmed and pale and defenseless-looking" (132, 133). He is, then, not only beyond the violent masculinity implicit in his gun, he is beyond gender. He picks up "the cat that is rubbing itself against his leg" (133). And it is now "the cat" not "Pitty Sing", "itself", not "himself" because now the phallus is neither feminized nor masculinized. Like the only androgyne in O'Connor's work, the cat is "it."[4] Beyond mother, beyond Oedipal violence, beyond gender, the Misfit has come to knowledge. Bobby Lee, tugging the grandmother out of the ditch to throw her with Bailey, yells "some fun," (133) but the final word is the Misfit's "shut up, Bobby Lee, it's no real pleasure in life" (133). The Misfit has come a long way from "No pleasure but meanness" (132). He has come a long way from the Oedipal "pleasures" that Bobby Lee still "wrestles" with, a long way from the ditch that he wrestles in. The Misfit, because he approaches, ends up with knowledge. Bailey Boy, because he avoids, ends up with Grandmother.

We, in turn, end up with an understanding of the story's depths because we began with "The Tennessee Waltz;" we began by considering subtle details. And this is how all of O'Connor's work must be read. Throughout her fiction, apparently inconsequential details reveal themselves under the scrutiny of a Freudian frame of reference. And it is these revelations that lead to ultimate understanding. Still, even a listing of details that could lead us into other O'Connor stories would be quite lengthy. But all of O'Connor's work forms an intricate whole: she herself says, "In the future, anybody who writes anything about me is going to have to read everything I have written in order to make legitimate criticism" (*Being* 450). O'Connor's stories reinforce and refine each other. So the process of finding and explicating details is not as formidable as it might seem since many pivotal details are recurrent, and their latent associations are being continually refined and reinforced. Consider a few examples of how our understanding of "A Good Man Is Hard to Find" can suggest places to penetrate other stories by shedding light on details that might initially seem inconsequential or incomprehensible. In "Comforts of Home" Thomas thrusts his gun into Sarah Ham's purse, and since we've seen that guns are, among other things, phallic, we should suspect that Thomas' action has latent implications. Indeed, once we know where to look, the latent implications are almost transparent since the details reinforce the symbol. "He grabbed the red pocketbook. It had a skin-like feel to his touch and as it opened, he caught an unmistakable odor of the girl. Wincing, he thrust in the gun and then drew back" (402). When Thomas' mother "[collapses] full-length on his couch lifting her small swollen feet upon the arm of it" (387) we see how the swollen feet, which takes us to Oedipus (Jobes 2: 931), help us with the scene because we know how O'Connor uses Oedipal concerns and subtle allusions. When Thomas, bareheaded, talks to the imposing Farebrother with his "Texas type hat," (400) Thomas uses a "lamer voice" (400) and we know what's going on because we've seen some of the association of hats, limps, and voices.

This, too, is typical O'Connor: the images we have learned to deal with in "A Good Man Is Hard to Find" reinforce each other throughout O'Connor's work. In "A Circle in the Fire," for example, guns and hats help us understand Sally Virginia's attempt to become the dangerous phallic male. "[She] had put on a pair of overalls over her dress and had pulled a man's old felt hat down as far as it would go on her head and was arming herself with two pistols" (190). In "The Partridge Festival" guns and hats expose Singleton's phallic nature right before Singleton exposes his phallus. "On his head was a black hat, not the kind countrymen wear, but a black derby hat such as might be worn by a gunman in the movies" (442). In "Greenleaf" guns and hats along with suns and our awareness of the mother and son's struggle for the phallus help us with a more complex passage. "[Mrs. May] was conscious that the sun was directly on top of her head, like a silver bullet ready to drop into her brain" (325). Mrs. May is hatless so her unprotected head is most vulnerable to the phallic shaped sun—the son's gun. But when the mother wears a hat as LucyNell Crater does in "The Life You Save May Be Your Own" things are different.

> She was about the size of a cedar fence post and she had a man's gray hat pulled down low over her head . . . The old woman watched him with her arms folded across her chest as if she were the owner of the sun. (146)

This hatted post, this phallic mother is most assuredly the "owner" of this one-armed son. Pitted against this devouring mother, "ravenous for a son-in-law," (150) it is Mr. Shiftlet "deeply hurt by the word milk" (153) who is vulnerable. Our images demonstrate that Shiftlet's attempts to avoid and suppress mother are—as we might expect—futile. After Shiflet has taken LucyNell Crater's car and abandoned her daughter.

> A cloud, the exact color of the boy's hat and shaped like a turnip, had descended over the sun, and another, worse looking, crouched behind the car. Mr. Shiftlet felt that the rottenness of the world was about to engulf him. (156)

Since we've seen that clouds can be maternal, we might be surprised that Shiflet links this cloud with a boy's hat. But we must recall that the boy's hat is gray (155) just like Mrs. Crater's hat. So the engulfing gray turnip shaped cloud is really the Earth Mother, the phallic mother, and Shiftlet's focus on the boy's hat demonstrates his own desires to repress the mother and retrieve the phallus. However, these desires are ineffectual; the "sun" is lost; Shiftlet, who has repeatedly fed the Crater women because he has always feared that he himself might be their next meal, is engulfed. And not only does our study of "A Good Man Is Hard to Find" help us with his defeat, the oral nature of his defeat helps us with "A Good Man Is Hard to Find." The devouring mother in "The Life You Save May Be Your Own" points us toward the devouring mother—the oral precursor of the Oedipal phallic mother—in "A Good Man Is Hard to Find." Now we can understand certain details in this story. We can see why Bailey, with his "clattering teeth" (125) makes sure that the grandmother gets two lunches, one on the road and one at Red Sammy's. And we can see why the Misfit with his "strong white teeth" (127) shoots the grandmother in the chest when she bites him.

The process, of course, is endless. Latent obsessions reinforce and refine each other; stories reinforce and refine each other; image clusters reinforce and refine each other in a particular story and throughout the O'Connor canon. It's all quite complicated, but it all began with "The Tennessee Waltz." And we should learn from Bailey: ''ya dance with who brung ya.'' Careful consideration of manifest details takes us into and through O'Connor's maze of latent complexities.

Endnotes

[1] The illogic of the Misfit's denial of this murder suggests that he has suppressed his patricide. ''It was a head doctor at the penitentiary said what I had done was kill my daddy but I know that for a lie. My daddy died in nineteen ought nineteen of the epidemic flu and I never had a thing to do with it. He was buried in the Mount Hopewell Baptist churchyard and you can go there and see for yourself'' (130). That the tombstone reads, ''died of the epidemic flu'' is almost as unlikely as it reading ''19019.'' In any case Eggenschwiler has demonstrated that is makes little difference whether the Misfit's patricide is actual or symbolic. (143)

[2] It's interesting to note here that even the only possible manifest ''excuse'' for the Misfit's error actually reinforces the latent point. Perhaps the Misfit is too deep in the ditch to view the sun and clouds—well perhaps, but he's either lost in the clouds or lost in the ''red gutted ditch'' (125).

[3] The grandmother is most assuredly the Earth Mother. The first earth we see is the ''blue granite . . . the brilliant red clay banks slightly streaked with purple; and the various crops that made rows of green lacework on the ground'' (119). The grandmother has the blue, her blue hat and dress (118); the red, her red face (124); the purple, her purple spray of violets (118); and even the lace, her lace trimmed collar and cuffs (110). She is just like the earth—except for the green. She offers neither Bailey Boy nor the Misfit fertility. The children's mother, on the other hand, never takes off her ''green head-kerchief that [has] two points on the top like a rabbit's ears'' (117).

[4] The androgynous ''freak'' in ''A Temple of the Holy Ghost'' is referred to as ''it'' (245).

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Population Ecology of Painted and Blanding's Turtles (*Chrysemys picta* and *Emydoidea blandingi*) in Central Wisconsin

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Abstract. *A Blanding's turtle* (Emydoidea blandingi) *population was studied for six years in central Wisconsin. To date, five studies of Blanding's turtle populations have appeared in the literature. Females matured at 172-mm plastron length and at about 18 years of age. Size and age at maturity in males remains unknown. Density and biomass were 27.5 turtles/ha and 45 kg/ha; these densities are greater than those found in Michigan marshes but less than densities reported for Missouri pond populations. Biomass was greater than that found in Michigan marshes. As in three other studies, no small juveniles were captured. Similar to two other studies, growth rate was greatest early in life and steadily declined thereafter. The Wisconsin population exhibited faster growth than that reported for Ontario and Massachusetts populations. The rapid growth rate, especially in the first several years of life, is probably related to organic substrates in the wetlands and associated high productivity of animal food items. Individuals were recaptured frequently and often moved among several adjacent wetlands. Habitat for* E. blandingi *should be set aside to preserve populations of this species.*

Male and female painted turtles (Chrysemys picta), *studied simultaneously with* E. blandingi, *matured at about 85-mm and 130-mm plastron lengths, respectively. This is similar to that found in southern Minnesota, but both sexes mature at larger sizes than those in southern Michigan. Density of the* C. picta *population was 104 turtles/ha, less than that found in other studies. Ages at maturity were three and seven years for males and females, respectively. Males matured at an earlier age than those in southern Michigan and at the same age as those in New Mexico and Illinois. Females matured at the same age as most other upper Midwest populations. Growth rate was rapid during the first several years of life, similar to other Midwest populations. Interspecific competition for food and basking sites may exist between* E. blandingi *and* C. picta.

Data are available from several studies on the population dynamics of Blanding's turtle (*Emydoidea blandingi*) (Gibbons 1968a; Graham and Doyle 1977; Congdon et al. 1983). The State of Wisconsin lists *E. blandingi* as threatened (NR 27.03, effective October 1979). Only one study (Ross and Anderson in press) has been conducted on Blanding's turtle in Wisconsin. That study examined habitat use and movements in the present population. Painted turtle (*Chrysemys picta*) ecology has been studied in Wisconsin (Pearse 1923; Ream and Ream 1966) and other parts of midwestern North America (Cagle 1942, 1954; Sexton 1959b; Gibbons 1968; Ernst and Ernst 1972; Wilbur 1975;

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MacCulloch and Secoy 1983). The objectives of this study were to examine size class distribution, size/age at maturity, population density, and biomass (*E. blandingi* only) of sympatric populations of painted and Blanding's turtles in Wisconsin.

Study Area and Methods

The study was conducted on the Petenwell Wildlife Area (PWA), a 291 ha wetland complex located in the Town of Strongs Prairie, Adams County, Wisconsin (T18N, R4E). The PWA wetlands consist of small (<0.2 ha) ponds, marshes, creeks, ditches, alder swamps, and oak (*Quercus* spp.) and aspen (*Populus* spp.) woods. Dominant emergent vegetation includes cattail (*Typha* spp.), sedge, and bulrush (*Juncus* sp.). Dominant submergent vegetation includes coontail (*Ceratophyllum demersum*), elodea (*Elodea canadensis*), and pondweeds (*Potamogeton* spp.). The PWA is located in the flat, sandy glacial outwash plain of central Wisconsin (Martin 1965).

Turtles were trapped in ponds (hereafter, pond complex), with hoop nets (Legler 1960) during June to September 1985, and May to July 1986, for a total of 1,290 trap nights. Recapture data of turtles marked during 1982 and 1983 (Ross and Anderson in press) were used in some of the present analyses. Traps were baited with frozen fish that were renewed daily. The surface area of the pond complex was 0.8 ha. Occasionally, individuals were captured by hand, mainly nesting females on land. All turtles were individually marked by notching marginal scutes with a hacksaw (Cagle 1939). *Emydoidea blandingi* were classified as male if a concave plastron was present and as female if the plastron was flat (Graham and Doyle 1977). *Chrysemys picta* were classified as male if elongated claws were present on the front feet and as female if the individual was larger than the largest mature male and lacked male secondary sex characters. Turtles less than the smallest mature male were classified as immatures. X-ray photography (Gibbons and Greene 1979) and specimen dissection (Tinkle 1961) are accurate methods for determining the age of turtles at sexual maturation. However, inspection of secondary sexual characters (i.e., females are classified as those individuals lacking male sex characters greater than the smallest known male) were the best methods available for this study. Shell measurements were taken with calipers, and body weights were obtained with spring scales. Plastral growth annuli, when distinguishable, were measured with dial calipers and were used to age turtles (Sexton 1959a). The relative lengths of the abdominal laminae and the plastron remain about the same throughout the life in *Emydoidea* (Graham 1979). Previous annual growth was estimated by applying the equation $L_1/L_2 = C_1/C_2$ where C_1 represents the length of the annulus, C_2 the length of the abdominal scute, L_2 the plastron length (PL), and L_1 the length of the plastron at the time the annulus was formed (Sergeev 1937). Population size was calculated according to the Schnabel method (Schnabel 1938) using Chapman and Overton's (1966) method of calculating confidence limits (CL). Biomass was estimated as the sum of the weights of all *E. blandingi* captured in the pond complex during 1985 and 1986. Daily air temperatures were obtained from the Necedah Weather Station, about 6 km west of the PWA.

Results and Discussion

A total of 32 *E. blandingi* were trapped in the pond complex (Fig. 1). Twenty-three (72%) turtles were recaptures from previous years of study (1982 and 1983) (Ross and Anderson in press). Of the total Blanding's turtles, 9 (28%) were males and 23 (72%) were females. Of these, there were 4 immature females and 1 possibly immature male. The sex ratio was 1 (male): 2.5 (female) and significantly different from 1:1 ($P<0.05$, $X^2 = 6.2$). However, the relatively small sample size and statements by Ream and Ream (1966) and Gibbons (1970) question the validity of sex ratios differing from 1:1. Of the total adult painted turtles, 72 (58%) were

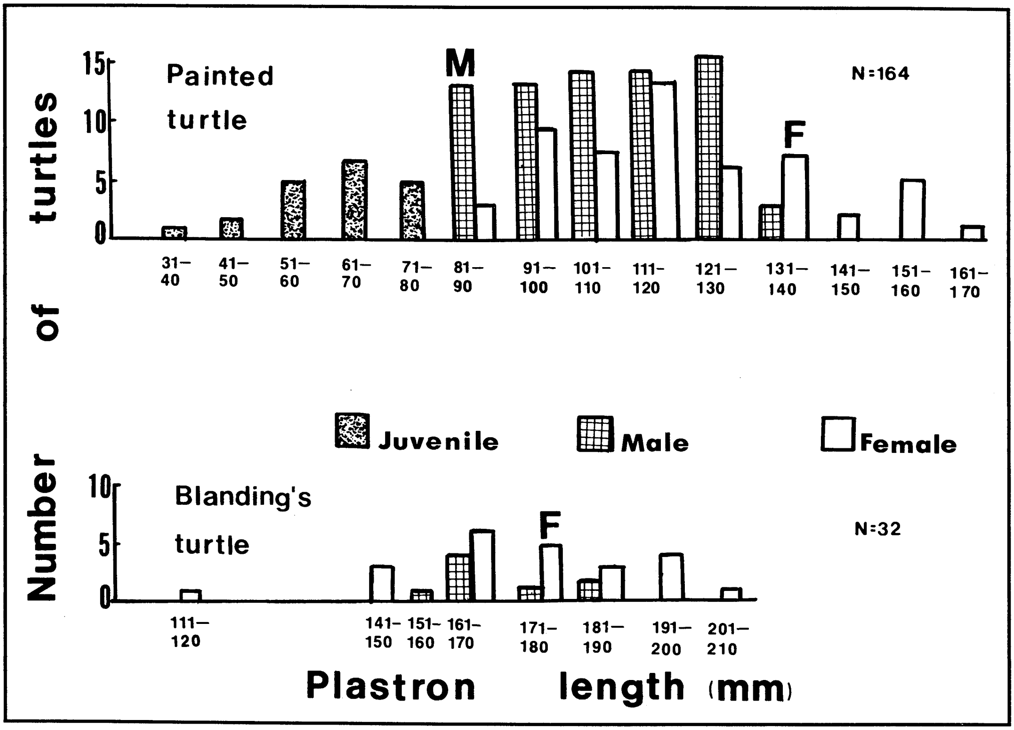

Fig. 1. Size classes of Blanding's and painted turtles. M and F indicate size at maturation in males and females, respectively.

males, and 53 (42%) were females. The sex ratio is not significantly different from 1:1 ($P>0.05$, $X^2 = 2.8$). This is similar to that found in other studies (Table 1). Immatures represented about 35% of the population (Fig. 1); the immature to adult ratio was 1.8:1. Age ratios in *C. picta* vary widely among studies (Table 1). Such variation is due to sampling design and a variety of other factors (e.g., predation, longevity, and habitat quality).

No *E. blandingi* smaller than 111 mm PL were captured. Gibbons (1968) and Graham and Doyle (1977) all noted an apparent scarcity of juvenile Blanding's turtles. Congdon et al. (1983) believe that considering probable high mortality and predation of eggs and hatchlings, a true scarcity of younger age classes exists. However, on 25 May and 9 June 1987, two road-killed *E. blandingi* (65 mm PL and 114 mm PL, respectively) were collected near shallow (<0.5m) marshes adjacent to the PWA. Perhaps juveniles use habitats separate from adults, thus rendering them less vulnerable to sampling techniques employed in this study.

The Blanding's turtle population in the pond complex was estimated at 21 individuals (CL = 15–29), providing a density estimate of 27.5 Blanding's turtles/ha. Blanding's turtles occur at lower densities in marshes in southern Michigan (8.8 and 10.0 turtles/ha) (Congdon et al. 1986), while a pond in Missouri held densities of 55 turtles/ha (Kofron and Schreiber 1985) (Table 2). These density estimates are low in comparison to those of other freshwater turtle populations (Iverson 1982). Painted turtles attained an estimated density of 104 turtles/ha in the pond complex, lower than that of other similar studies (Iverson 1982). The biomass estimate for the Blanding's turtle population in the pond complex is 45 kg/ha. Biomass estimates for two Michigan marshes (Congdon et al. 1986) were

Table 1. A comparison of age compositions in painted turtles (*Chrysemys picta*)

Locality	*Immatures* Total	%	*Adults* Total	%	*Ratio* Juv. = 1	Reference
Saskatchewan	27	18	125	82	4.56	MacCulloch and Secoy 1983
Illinois	98	41	139	59	1.41	Cagle 1942
Illinois	124	51	120	49	0.97	Cagle 1954
Pennsylvania	180	19	374	81	2.08	Ernst 1971b
Minnesota	17	24	54	76	3.18	Ernst and Ernst 1972
Michigan	141	58	102	42	0.72	Cagle 1954
Michigan	305	39	480	61	1.57	Gibbons 1968
Wisconsin	51	10	479	90	9.39	Ream and Ream 1966
Wisconsin	58	35	106	65	1.83	This study
					$\bar{x}$ = 2.86 SD = 2.721	

Table 2. A comparison of estimated densities in Blanding's turtle (*Emydoidea blandingi*) populations

Locality	Habitat	Density no./ha	Source
Massachusetts	Marsh	6.3[a]	Graham and Doyle 1977
Michigan	Marsh	8.8	Congdon et al. 1986
Michigan	Marsh	10.0	Congdon et al. 1986
Michigan	Marsh	15.8[a]	Gibbons 1968
Missouri	Pond	55.0[a]	Kofron and Schreiber 1985
Wisconsin	Pond	27.5	This study
		$\bar{x}$ = 20.6 SD = 16.88	

[a]Extrapolated data.

7.9 kg/ha and 8.8 kg/ha, respectively. The differences between the two localities may be a reflection of the concentrated habitats found in the present study (there is little similar habitat nearby), as well as the apparent abundance of aquatic prey. Aquatic macroinvertebrates (e.g., *Odonata* sp., leeches, and snails), small fish, and frogs are common in the pond complex. Iverson (1982) states that populations within ponds tend to have higher biomasses than those in marsh habitats. Biomass in reptiles and amphibians often exceeds that of sympatric higher vertebrates (Burton and Likens 1975; Fitch 1975; Iverson 1982; Reichenbach and Dalrymple 1986) that receive greater management attention. Conservation agencies should give more consideration to reptiles and amphibians because, ecologically, they are equally as important as more highly managed (i.e. game) species.

Female *E. blandingi* reached sexual maturity at about 172 mm PL as all gravid females with visible annuli captured were greater than or equal to this length ($\bar{x}$ = 191.4, range 172–215 mm PL). Age at sexual maturity in males remains unknown. All females greater than 172 mm had at least 18 visible annuli. This indicates that maturity, in Wisconsin individuals, may be related to size rather than age, the opposite for *Emydoidea* in Massachusetts (Graham and Doyle 1977). This characteristic has been noted in other species of turtles as well (Bury 1979). Blanding's turtles in Michigan mature at about 162 mm PL, the age at maturity remaining unknown (Congdon et al. 1983). The largest *Emydoi-*

dea in this study was a 215 mm PL female.

Sexual maturity was attained in *C. picta* at 80–85 mm PL and 130 mm PL in males and females, respectively. All gravid females captured were between 130 mm and 158 mm PL, similar to measurements of gravid females found in other midwestern populations (Gibbons 1968; Christiansen and Moll 1973; Tinkle et al. 1981). Females and males reached sexual maturity at about seven and three years of age, respectively, similar to findings by Ernst and Ernst (1972) and Christiansen and Moll (1973). Gibbons (1968) and Tinkle et al. (1981) found that females and males mature at about seven and five years of age in southern Michigan. Cunningham (1922) found that males and females mature at 88 mm and 130 mm, respectively, in Wisconsin. Males and females matured at 90 mm PL and 112 mm PL, respectively, in southern Michigan (Tinkle et al. 1981). Southwestern Minnesota *C. p. belli* display variable growth rates after the first season, with the growth rate declining as turtles increase in size. Maturity in males is reached at a PL of about 95 mm in the third or fourth year. Females mature at about 110 mm PL and in their fourth or fifth year (Ernst and Ernst 1972). Male *Chrysemys* typically reached maturity before females (Fig. 1). The largest *Chrysemys* captured in the PWA was a 168 mm PL female.

Percent growth in *Emydoidea* was greatest during the first year of life (85.9%), and thereafter growth steadily declined until year 8 (Table 3), after which many annuli were indiscernible. These growth rate data correspond with Graham and Doyle's (1977) data, except that growth in their Massachusetts population was slightly less (81.4%) during the first year of life. Two Blanding's turtle populations in Ontario grew at an even slower rate in the first year (65.5% and 58.5%) (Petokas 1986) than did PWA turtles. The growth rate during the following seven years in the Ontario populations was also less than that of the PWA population. This should be accepted with caution because Petokas (1986) aged *E. blandingi* that were greater than 11 years of age, which was not possible in the present study due to excessive plastral wear. Prey abundance may be greater in PWA habitats, thus increasing the growth rate in the population (Graham and Doyle 1977). Turtles inhabiting wetlands with organic substrates display more rapid growth than turtles from sand-bottomed (low organic) wetlands (Quinn and Christiansen 1972; Moll 1976). The pond complex has an organic substrate while Petokas's (1986) population inhabited wetlands with sand substrate. This phenomenon is probably related to the relatively high productivity of animal prey in organic substrates versus that of wetlands with sand substrate, resulting in faster growth rates (Gibbons 1967; Moll 1976; Quinn and Christiansen 1972). MacCulloch and Secoy (1983) sug-

Table 3. Estimated plastral growth of nine *Emydoidea blandingi* from the Petenwell Wildlife Area, 1986–1988. N refers to the number of individuals.

Year Class	N	Plastron Length (mm)			Mean Annual Increment (mm)	% Growth
		$\bar{x}$	Range	SD		
Hatchling	8	29.7	22.3– 35.3	4.75	–	–
1	8	55.2	47.0– 62.3	5.50	25.5	85.9
2	9	73.7	54.7–105.1	5.10	18.5	33.5
3	7	91.7	65.3–131.9	23.59	18.0	24.4
4	7	102.2	75.4–142.9	25.04	10.5	11.5
5	7	114.4	86.6–155.9	27.33	12.2	11.9
6	6	115.3	94.4–157.9	24.04	0.9	0.8
7	6	122.8	104.5–172.8	26.44	7.5	6.5
8	4	143.6	125.1–185.8	28.58	20.8	16.9
9	2	133.4	132.1–134.7	1.84	0.0	0.0
10	1	136.3	–	–	2.9	2.2
11	1	142.2	–	–	5.9	4.3

gested that the large body size and rapid growth rate observed in *C. p. belli* from Saskatchewan is probably due to a carnivorous diet.

Growth rate in *C. picta* was rapid during the first year of life (95.7%) and declined rapidly thereafter (Table 4). This growth rate is similar to that found by Ernst (1971a), Ernst and Ernst (1973), and Hart (1982). Attainment of maturity caused growth rate to slow even further (Table 4) as found in other midwestern studies (Ernst and Ernst 1972; MacCulloch and Secoy 1983).

Certain areas of the pond complex appeared to hold concentrations of *C. picta*. This was probably due to the availability of basking sites, food, or mating behavior (Vogt 1979). *Chrysemys* basked as early as 28 February due to sunny skies and air temperatures of 19°C. Vogt (1981) observed painted turtles active under the ice during early March in Lake Mendota, Wisconsin. Ernst (1971b) also observed painted turtles active as early as March in Pennsylvania.

During this study, many *E. blandingi* were recaptured. Time intervals spanning recapture varied from one day to four years; the length of time separating trapping dates may have affected these results. Increased trapping efforts during other seasons would probably have lessened the time span between recaptures. Movements were common among the wetland complex as shown in the trapping data. Blanding's turtles (N = 17) moved relatively long distances within the wetland complex ($\bar{x}$ = 396.2 m, SD = 114.47 m, Range 212–652 m). Fifteen other *Emydoidea* were considered "residents" of the pond complex as they were only captured within that complex. Congdon et al. (1983), working in Michigan, found that many individuals were "residents" of a particular area. Of 30 turtles recaptured within the pond complex or nearby (<600 m) wetlands, 27 (90%) turtles were trapped in that complex at least twice during the present study, indicating a resident population.

Most of the *C. picta* population on the PWA consists of subadults and young adults (Fig. 1), indicating a stable, growing population. Additionally, recaptures of many individuals indicates a well-defined sedentary population. The immature adult ratio is greater than that in other similar studies (Table 1). There also appears to be little difference in age at maturity of *C. picta* populations in the PWA as compared with that of other upper Midwest populations. Growth rate of PWA *C. picta* is rapid early in life (Table 4), similar to that found in other studies.

Low-density freshwater turtle populations may be related to a scarcity of basking sites (Pritchard and Greenwood 1968; Harless 1979). *Chrysemys* populations attaining higher densities are found in shallower habitats (Gibbons 1968b; Ernst 1971b) than those in the present study; maximum depth in PWA habitats is 0.7 m—1.3 m. *Chrysemys* and *Emydoidea* may be competing for food and basking sites. In Wisconsin, *C. picta* and *E. blandingi* feed on similar prey (Vogt 1981).

Table 4. Estimated plastral growth of 53 *Chrysemys picta* from the Petenwell Wildlife Area, 1985–1988. N refers to the number of individuals.

Year Class	N	Plastron Length (mm) $\bar{x}$	Range	SD	Mean Annual Increment (mm)	% Growth
Hatchling	30	25.7	20.5– 39.4	4.75	–	–
1	35	50.3	37.0– 59.4	7.37	24.6	95.7
2	28	65.1	54.1– 94.5	8.90	14.8	29.4
3	17	79.4	66.1–111.2	9.88	14.3	21.9
4	18	88.4	73.0–116.0	10.86	9.0	11.3
5	9	102.5	81.0–124.1	12.57	14.1	16.0
6	7	115.0	92.0–135.4	16.51	12.5	12.2
7	4	131.7	119.8–137.0	9.06	16.7	14.5
8	1	127.0	–	–	–	–

However, *E. blandingi* attains a greater size than *C. picta* (Fig. 1), allowing speculation that *E. blandingi* feeds on larger prey than does *C. picta*. Within the PWA, few basking sites exist disjunct from shore; both species frequently bask in close proximity to one another during April and May. The turtles may not be using the best available basking sites as 26% of the *C. picta* population was depredated apparently while basking in April, 1987 (Ross 1988). Spring predation of immatures and adults may be a factor in limiting the *C. picta* population in the PWA. Similarly, both species reach their greatest densities in pond habitats. (*E. blandingi*, Table 2; *C. picta*, Bury 1979; Iverson 1982). *Chrysemys* males exhibit higher rates of growth in pond habitats than in river habitats (Gibbons 1967). Petokas (1986) speculated that in one high-density Ontario population of *E. blandingi*, intraspecific competition for food resources was present.

Competition between sympatric species often limits the population size or growth rate of either or both species. Despite apparent basking sites and, perhaps, food competition, *E. blandingi* and *C. picta* in this study attain larger body sizes than several studies of the respective species in southern Michigan. Growth rate early in life in PWA *E. blandingi* and *C. picta* is rapid. These characters are probably positively correlated with the wetland productivity in the PWA. Habitat quality in relation to population characteristics should be studied in other reptiles to provide baseline data for future protection and management guidelines.

Acknowledgments

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Racism and Its Limits: Common Whites and Blacks in Antebellum North Carolina

Bill Cecil-Fronsman

In 1802 the "Incorporated Mechanical Society of Wilmington" petitioned the North Carolina General Assembly to tighten up enforcement of the laws prohibiting slaves from hiring their own time. According to the petition, slaves were working for less than half the rate a white mechanic charged and were hiring apprentices who, with their employers, were free to consort and plot insurrections. The petition concluded that because the white mechanics served on juries, performed military duties, and paid taxes, it was unfair that "bread should be taken out of the mouths of themselves and families by persons, who circumstanced as they are, are the irreconcilable enemies of the Whites." [1]

In 1809 John P. Waters of Wilkes County, a county located on the western edge of the piedmont, drafted a petition asking that the State Legislature relieve him of a large fine. It seems that Waters had fallen in love with Elisabeth Culms, "a woman of colour," and had begun living with her. The petition stated that he knew this was wrong and that he wanted to marry her, but he knew that such a marriage was illegal. "In the mean while," he wrote, "an Intimacy took place which appeared Irresistable, the fruits of which has been six fine children." John and Elizabeth were convicted and fined twenty-five pounds each, a sum greater than the value of all he possessed. Although he knew that living with her was "unlawful and Irreligious," he refused to abandon his family. "He is from the love he bares his said little children and their kind mother, still desirous to keep them together to do a fatherly & Husbands part by them, as time or circumstance cannot alienate them from him." [2]

These two petitions, written only seven years apart, in the same state, by men of comparable status, demonstrate the range of common-white beliefs about race. Common whites were white nonslaveholders and small slaveholders who were perceived by themselves and others as not being members of the society's political, social, or economic elite. It is admittedly more difficult to determine who was not a common white than who was. An individual owning twenty slaves certainly would not have been a common white. Most individuals owning no slaves would have been, although some nonslaveholders were quite wealthy or politically and socially prominent. In North Carolina, where this study is focused, 70.8 percent of the whites owned no slaves in 1860. Of the nearly 35,000 slaveholders only around 9,100, or approximately 7.7 percent of the total population, owned as many as ten. For the purpose at hand one may assume that roughly eighty to eighty-five percent of North Carolina's white population was "common." [3]

It is a widely held assumption among historians that the common whites were extraordinarily racist and that their racism cemented their loyalties to the slaveholders' regime. This racism further led them to plunge themselves into a blood bath to preserve slavery in 1861. The standard accounts of the roles of common whites in the political crisis of the 1850s all emphasize this point. "The importance of the racial issue cannot be overemphasized," writes William L. Barney. "Racism was the secessionists' greatest weapon. They knew precisely what Southerners dreaded most and by constantly exacerbating this fear . . . [they] succeeded in

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building up tensions and hatreds which looked to secession as an outlet." The racism of the common whites was, in the words of William J. Cooper "omnipotent" and led them to have "no interest in challenging the social order guaranteed by the slave system, which provided social peace despite the presence of millions of blacks, a group white yeomen believed absolutely inferior." [4]

Historians who have grappled with the problems of common-white racism have recognized that this racism took a different form than the paternalism that some historians have ascribed to the planter class. Eugene D. Genovese argues that a sense of responsibility to the alleged inferiors on the plantation evolved among the slaveholding class. This argument, however, has little bearing on the individuals who did not own any slaves. Instead, most scholars have ascribed to the common whites a harsher racism, born out of a fear of competition. Steven Hahn writes how yeoman farmers viewed blacks as "symbols of a condition they most feared—abject and perpetual dependency." The slaves' strict subordination "provided essential safeguards for their [yeomanry's] way of life." As petty property owners, they sought to define "the dispossed out of the political community." [5]

For some commentators, common-white racism is chiefly defined by its competitive quality. Pierre L. van den Berghe's comparative study of race relations sets out two broad types of biracial societies. The first is the paternalistic type, in which wide gulfs in status, occupation, and income separate racial castes. The second, or the competitive type, is an arrangement in which a color bar exists, but the existence of that color bar does not prevent members of the subordinate race from approaching members of the dominant race. The result is often competition. In the paternalistic type, all persons know their places, and the dominant group needs relatively little violence to ensure its position. In the competitive type, roles are ill-defined and violence serves to enforce the dominant race's position. In these regimes a kind of *herrenvolk* democracy emerges, in which egalitarian ideals may flourish but are restricted to the dominant race. George M. Fredrickson has developed this perspective by contending that the southern elite class used the rhetoric of *herrenvolk* democracy to protect their positions from potential assaults from within the region and from real assaults from the North.[6]

The thesis of this essay is that these characterizations of common whites must be qualified. No one who has studied antebellum southern whites can deny their racism or deny that it played an important role in ensuring that they would take steps to protect slavery. But a close examination of the records they left behind suggests that there were limits to their racism. Some common whites rejected and others significantly modified the racism that was so pervasive. They set limits to their racism because they found that such limits met their personal needs for intimacy and friendship or because they found an "omnipotent" racism to be incompatible with their conflicts with the planter class.

For the purpose at hand, racism will be defined as the collection of norms that prescribe strict boundaries between the social space of whites and that of blacks. It is a cultural phenomenon that requires barriers separating blacks and whites. These barriers might include the way people act in public, the kinds of jobs they can hold, the sorts of people they can love, or with whom they can engage in sexual relations. Racist norms assert that the barriers are not only legitimate, but that steps must be taken to strengthen and maintain them.[7]

If one accepts the notion that racism is a phenomenon that designates strict barriers between whites and blacks, then certain racist actions start to make sense. For example, in 1818 an Iredell County militia company requested a law to prevent blacks from loitering while the company drilled. Although Iredell County was less than one-quarter black, the men complained about "the Numirous quantity of Negroes which generally assemble at Regimental or batalion Musters . . . which is productive of much vice & immorality." [8] By taking this action, common whites helped to widen the gulf between themselves and blacks by asserting that some kinds of activities were simply not appropriate for so degraded a caste. White observers, in contrast, were obviously not members of an inferior caste because their presence was welcome.

A second sentiment which these Iredell County petitioners asserted was that the black presence led to vice and immorality. This implied not only a generalized aversion towards blacks but also imputed to them a particular, inevitable quality. This projection helped ensure that the boundaries between the races would remain fixed. Common whites could define themselves in contrast to blacks: "they are given to vice and immorality; we are not." Common whites thus appropriated a certain status for themselves by assigning the opposite one to blacks.

Among the many characteristics which common whites projected onto blacks was that of thievery. In 1848 when James G. Mitchell of Raleigh asked for permission to erect a shanty on a state rock quarry, he offhandedly noted that it might protect the quarry from "negro and other plunderers." [9] There was a basic acceptance of this belief. Common whites humorously referred to the alleged "negro trait" in this popular folk ditty:

> Some folks say a nigger won't steal
> But I caught seven in my corn field
> One had a bushel and the other had peck
> One had a roas'n ear strung around his neck.[10]

By conceiving of black people as thieves the common whites thus defined themselves as something else and hence worthy of admiration.

Not only did common whites differentiate themselves from blacks by conceiving of them as transgressors of the law, as shown by the folk ditty and the example of the Wilmington mechanics cited in the introduction, they also used their beliefs about black sexuality to set themselves apart. A joke from eastern North Carolina illustrates a widely held common-white assumption about black men. A planter had a slave, Sam, whom he used for breeding. A friend of the planter's asked to borrow him for the women on his own plantation. The owner left the decision up to Sam. The slave was reluctant; his owner encouraged him, saying there were some "nice black gals waiting there." —"How many?" —"five or six" —"Boss, if it jes' as well wid you, I druther not go. Too far a piece fer jes' a half-day's work."[11]

In 1802 there was an insurrection scare in the northeastern part of the state. The anxieties expressed suggest something of what lay behind the fears of common whites and their planter neighbors. According to the reports of this alleged conspiracy, the rebels planned to burn the town of Windsor. They were then to kill all the white men and older black women. After accomplishing this deed they would keep the white women for themselves while using the black girls as servants. From then on, the reports claim, "they were to have their freedom and live as white people." [12]

Common-white men believed that possessing white women was one of the symbols that set them apart from black men. When they imagined blacks on a rampage, it was natural that they believed the slaves would seek to capture the whites' own prized possessions. In order to have freedom and live as white men, blacks would need white women. By denying blacks access to their women, whites believed they were denying something that was necessary for living as free men. The racial and sexual double standard that permitted white men to indulge themselves with black women (but denied white women and black men a comparable privilege) reinforced this symbolic division. Common-white men who used some form of coercion to gain sexual access to black women were strengthening the barriers between themselves and blacks. They were asserting power over blacks. They were asserting that "we can have access to your women but you cannot have access to ours." The legal system tolerated this practice as well. The law severely punished white women who bore mixed-race children; it left unpunished white men who fathered mulattoes.[13]

When law and custom tolerated common-white abuses of blacks but prevented blacks from replying in kind or even defending themselves, a clear message was being given: common whites could act like free men; blacks could not. However poor and degraded a white man might be, he could still rent a slave from one of his wealthy neighbors and expect deferential behavior from him. Should this behavior not be forthcoming, common whites could then take steps to coerce it.[14]

Common whites seeking to strengthen the barriers might turn to actions that humiliated or degraded blacks. In 1842 Lunsford Lane, a former slave, returned to Raleigh to buy some of his family and take them to the North. A mob, which one commentator called "some of our rowdies," met him. They accused him of preaching abolition and tarred and feathered him. After the mob had completed its task the mood changed. The people returned Lane's clothes, and, to his surprise, his watch. "They all expressed great interest in my welfare, advised me to proceed with my business the next day, told me to stay in the place as long as I chose, and with words of like consolation, bade me good-night. They felt that they had now degraded me to a level beneath themselves."[15]

Lane's comment was perceptive. The mob was interested in reminding Lane (and more importantly themselves) that his status was beneath theirs. Although he might have been a well-dressed, articulate man with contacts in some important places, he was still a black man whom they could abuse without fear of retribution. An unbridgeable gap separated them from him, and they were going to make sure the differences were widely known.

It is actions like these that lend credence to characterizations of the common whites as universally racist. And one cannot deny the pervasiveness of their racism. But one must keep in mind how racism helped to establish clear, definable boundaries between common whites and blacks. Common whites did not normally think of blacks as "the irreconcilable enemies of the whites" (to use the expression employed by the Incorporated Mechanical Society of Wilmington). But when boundaries were crossed, and when that crossing threatened the common-white position, they would take actions or make characterizations that rigidly and racistly defined the black sphere.

However pervasive these racist attitudes may have been, they tell only part of the story. If common-white racism insisted on perpetuating certain boundaries, there were, nevertheless, areas of social space allotted to blacks. Within those areas common whites and blacks could interact in a manner approaching equality and engage in behaviors that would challenge the rigid social boundaries in other areas. Different individuals, naturally, drew the lines in different places. A wide spectrum of beliefs about the appropriate distinctions between white and black emerged, challenging any notion that the common whites were uniformly, unthinkingly, or omnipotently racist.

At the extreme end of the spectrum were the religious antislavery advocates. They believed that not only were all people equal in the eyes of God but that society must structure itself along more equal lines by abolishing slavery. Levi Coffin, who grew up in the Quaker community of New Garden, Guilford County, recalled, "Both my parents and grandparents were opposed to slavery, and none of either of the families ever owned slaves; and all were friends of the oppressed, so I claim that I inherited my anti-slavery principles."[16] Coffin's antislavery principles led him to action. Although one might doubt his claim to being the president of the underground railroad, Coffin did help slaves escape their bondage at considerable personal risk. Coffin was exceptional, of course, and the Quaker sect to which he belonged was a minority, but Coffin was a common white who did what he could to end slavery.

Coffin was not alone. In 1807 Eli and William Copeland of Hertford County sought to free their mulatto slave because "they have considered for a length of time that it is incompatible with the tenets of Christianity" to enslave a man.[17] Not only were the Copelands sacrificing a substantial portion of their estate, they were also obliterating the basic distinction between themselves and this particular slave. They could not change his skin color; they could not change his manner of speaking, way of dressing, style of religion, or any number of other symbols that separated him from themselves. But they could undermine the greatest boundary between them; they could destroy the distinction whereby they were free and another man was a slave.

More typical examples of common-white resistance to slavery were ad hoc measures to help runaway slaves. Slaveholders were suspicious at times that local common whites had abetted their runaway chattel. An 1803 advertisement from Franklin County describes a slave and adds, "I have Reasons to believe that the Negro obtained a Pass from a trifling Person." Another advertisement from 1801 notes "The Negro is so well known in the Neighborhood of Waynesborough . . . where I presume he is harboured by white persons, that there needs no particular Description."[18]

When common whites had personal relationships with slaves, they might run the risk of assisting in escapes. This seems to have been more prevalent among common whites who shared degraded positions with blacks. Daniel O'Rafferty worked as a journeyman tailor in the same Craven County shop as a slave, Albert. O'Rafferty was said to be "greatly under the influence and control" of Albert who "possessed the entire confidence" of O'Rafferty. When his owner died in 1846, Albert convinced O'Rafferty that he was to be freed. O'Rafferty then tried to help his friend leave the state. O'Rafferty's Irish background may have led him to be more sympathetic with his friend's plight. As the former slave, Charity Austin, recalled of her youth in Granville County: "We children stole eggs and sold 'em during slavery. Some of de white men bought 'em. They were Irishmen and would not tell on us."[19]

At times common whites and slaves became a good deal more than friends. In 1825 Jim, a slave of Abraham Peppinger of Davidson County, and Polly Lane, a hired white girl on the farm, became lovers and planned to escape together. A visitor to the farm lost his pocketbook containing $260 and the consensus of those in the neighborhood was that the two had stolen the money in order to get away. Unfortunately for Jim, when the news broke, Polly abandoned him and accused him of raping her. When her mulatto child was born considerably less then nine months after the alleged rape, her story lost credibility.[20]

Common whites did not have to take dramatic measures to soften the lines separating them from blacks. Some common whites who would never have dreamed of helping slaves escape formed friendships with slaves that challenged the harsh racial boundaries. Children in particular seem to have been freer of the culture's stifling racism. In areas where lower-class whites, upper-class whites, and black children grew up together, one playmate might well be as good as another. Elias Thomas, an ex-slave from Chatham County, recalled: "we thought well of our poor white neighbors. We colored children took them as regular playmates. Marster's boys played with 'em too." After childhood some common whites continued the friendships they had started in their youth. Archibald Campbell, also of Chatham, was convicted of playing cards with a black man. A nonslaveholder, Campbell lived "in a section of country where the same thing is often done." In addition, Campbell's petition asserted that "[he] knew no difference between playing with a white man or sporting with a coloured one, not knowing that the laws of the county forbid the latter." Campbell was not the only common white to get in trouble with the law for this offense. The small slaveholders, Simon D. Pemberton and John Smith of Richmond County, were convicted because they "unlawfully did play at cards with certain slaves . . . to the evil example of all others."[21]

Twentieth-century sociological studies suggest that the poorest whites have not been the most virulent racists. Rather, the worst racists tend to be whites whose social position approaches the boundary between nonelite and elite status without fully entering the higher position. John Dollard noted in his 1937 study that blacks believed their real antagonists were "strainers." Those straining to get on in the world stressed racial differences because they were unsure of their own positions. The lowest-status whites also suffered various forms of discrimination and hence, developed a certain sympathy towards blacks. Studies of bigots corroborate Dollard's findings. Individuals with "authoritarian personalities" normally come from the lower-middle class. They are unsure of their own positions relative to those above and below them and feel safe only if everyone stays in his or her place. The lower-middle class, then, would be the group most dependent on overt social statements of racial superiority, not the lowest class. One should not assume that the poorest whites have been the staunchest proponents of rigid racial boundaries.[22]

The antebellum record seems to have been similar; associations between blacks and whites occurred with the greatest frequency among the poorest elements of the common whites. The Irish tailor who helped his black fellow journeyman to escape and the servant girl who stole a purse to bankroll her and her black lover's aborted flight did so because their sense of common plight allowed them to broaden their racial boundaries. This same sentiment was present in 1836 when two whites and three slaves joined forces and bored a passage out of the Tarboro jail. Feelings of a common plight were again present in Asheville where, according to George Swain (father of the future governor), a grog shop was so infamous that nobody went there "by daylight except Negros and Drunkards." In Fayetteville crime reports reveal relaxed color prohibitions in which some poor whites and blacks drank, whored, and plotted crimes together.[23]

Not only did low estate lead some common whites to disregard some of the racial boundaries, but so, too, did strong emotions and powerful passions. The common-white males' racial code set white women apart for themselves. This did not prevent some common-white women from having sexual relationships with black men. For example, Lewis Tombereau petitioned the State Legislature in 1824 for a divorce from his wife. The French-immigrant shoemaker living in Martin County described her in his petition as "one of the most frail, lewd, and depraved daughters of Eve." The petition claimed that she abandoned her husband, took up with a mulatto barber, and bore a racially mixed child. After this she "became and continues to be, a public and notorious prostitute in the most unlimited sense of that word. She [is] indulging in an unreserved, and promiscuous intercourse with men of every colour, age, class, and description she meets. In a similar instance John Hancock of Hertford County asked for a divorce from his wife, Tabetha, in 1813. The woman "abandoned herself to the most vile prostitution and debauchery—has had Children of various colours and complexions." A supporting statement added, "She Cohabbets and Equallises her Self with Mulattoes and Negroes in all Cases and . . . Lives at a Negro Quarter among Negroes."[24]

Despite enormous social pressures to the contrary, some common whites formed deep attachments with blacks. The divorce proceedings show numerous white women with black lovers, though this was probably because white men could more easily conceal forbidden love affairs than white women. Sometimes, however, the women did try. In 1821 Caleb Miller asked for a divorce from his wife Rachael. Six months after their marriage she gave birth to a child. Miller was away for much of the time, and Rachael kept the baby in a dark room. Although Miller did not suspect anything, local gossip began claiming that the child was a mulatto. He took it to a doctor, and another woman pronounced it black. In another case, Sarah Cowan of Rowan County gave birth to a mulatto child in 1794. Although it was clear to the neighborhood that the child was not white, "such was the exalted opinion which he entertained of the decency and virtue of his wife," that her husband, Isaac, "could not believe or harbor an unchaste thought" of her. He waited, and as the child grew older he saw that it was obviously not his own. He remained loyal and maintained hope of her repentance "until the birth of a second of the same hue with the first." In 1802 he asked for a divorce.[25]

It was not always necessary for children to bear witness to a woman's infidelity. Sometimes the women made no secret of their love affairs. In 1832 John Johnson of Orange County petitioned the legislature to dissolve his marriage, "being distitute of Land of his Own he was induced to become a Partner in a farm with a free Negro during which time his wife Peggy formed an attachment to said negro and consequently treated your Petitioner in such a way that he was forced to abandon her." Between 1800 and 1835, 7.5 percent of all divorces were granted for cohabitation with blacks.[26]

Common whites who formed romantic attachments with blacks did so at considerable risk. The story of John P. Waters and Elisabeth Culms cited earlier is one example of the consequences befalling those who violated their society's norms.

Most common whites did not fall in love with blacks. But many of them did interact with neighboring slaves and free blacks in a manner that approached equality and blurred of racial boundaries. Common whites and blacks attended churches together, prayed together, and went to revivals together. They might partake of the same extrareligious beliefs as well. For instance, James Reel of Pitt County, who owned a few slaves, regularly visited a black conjuror who told him he was being tricked by persons who wanted his property. The two groups might also join in illegal activities. Thomas Jones of Chowan County stole four pigs from his uncle and sold them to a free black woman.[27]

However, most of the joint thefts apparently worked the opposite way. Slaves would steal from their masters and sell or trade the goods to local common whites. The practice seems to have been commonplace. David Thomas of Bladen County ran into trouble in 1827 for trading with slaves. Thomas pointed out that he was a "very poor man," afflicted with rheumatism, "and if in this instance he has violated the laws of his County, he has done nothing more than what others more able to support themselves then he is are in the daily habit of doing, with impunity."[28]

To engage in this kind of traffic, common whites and slaves had to develop a relationship and trust to carry on the exchanges and avoid getting caught. One ex-slave from Wake County complained that sometimes owners made blacks violate this trust. A master might force a slave to take things from his house and sell or trade them to local common whites. Then the slaveholder would come along, discover his property, and swear out a writ. The owner would then give the poor white the chance to sell out to him and leave or face the consequences.[29] But this kind of setup was probably rare.

Not only did the slaves and common whites have to develop a degree of trust, but they also had to engage in a comparable amount of planning. In 1844 in Northampton County, James Hart found himself on trial for trading stolen goods with a slave. A witness described what had taken place: about two hours before dawn a slave took a bag of cotton and a jug to Hart's house. A short while later the slave left the house with an empty bag and a full jug.[30] No slave would have ever gone up to a strange house in the middle of the night with a bag of stolen cotton. The transaction had to have been arranged some time before.

The common whites in these situations were in effect hiring slaves to steal from their masters. However much they might dislike blacks, the common whites' greed and hostility towards the planters prompted them to make common cause with blacks. William D. Valentine recalled that when he was a boy on his father's eastern plantation "a few mean and occasionally scoundrally families did for a long time keep a familiarity and traffic with our black portion of the family. There were no other negroes in the neighborhood." The Valentines, the only slaveholders in the neighborhood, were a ready target for common-white hostility. The traffic with slaves was in many ways comparable to the poaching that supplemented the diets of eighteenth-century Englishmen. One could not injure the interests of another lower-class Englishman by poaching game, only the interests of the lord who owned it. Similarly, nonslaveholders could not be injured when slaves stole goods from their masters and traded them to common whites. In both cases the law served to protect the interests of the ruling classes at the expense of the lower classes. Yet the common whites had sufficient solidarity to tolerate the practice of trading stolen goods with blacks. When their numbers were large enough they might refuse to convict offenders or merely slap them on the wrist. Apparently the trade was impossible to curtail. A group of planters from Pasquotank County complained in 1848: "Efforts have been made, and are constantly being made by our citizens to bring these offenders to justice, some times successfully—but not to such an extent as to remedy the evil."[31]

The common whites' ability to get along well enough with neighboring blacks calls into question blanket assumptions about their racism. They did not have to like blacks in order to hire them to steal. But common whites did have to be willing to treat them with a modicum of respect and dignity. Blacks certainly did not have to go to a particular common white with their stolen goods. Unless he treated them decently, there was little reason to suppose slaves would keep coming back. By trading with slaves common whites were allowing the racial boundaries to become fuzzy. Their own self-interest demanded that they see slaves as sharing in a common predicament.

The common whites, then, were willing to let the boundaries between the races become blurred when it was in their own interest. When they could get a particular good at a cheap price (and have the added pleasure of causing a neighboring planter fits), they would lower the barriers. When they could get love or friendship at a time when they felt alone in the world or during some other curious set of circumstances, they would abandon the sharp lines of racial separation in favor of ones that were less distinct. Here, then, were the limits of racism.

The common whites' perceptions of slavery were scarcely monolithic. They were quite aware that slavery was anything but a benign system for upgrading the welfare of contented blacks. In 1845 the leading Democratic Party newspaper, the *North Carolina Standard,* which claimed to be the advocate of the common man's interests, printed a joke under the heading "African Candor." The joke describes a conversation between a slave named Cudjo and his master. The master asks him if he had attended church. Cudjo says he had and adds, "an' what two mighty big stories dat preacher did tell." The master asks him what stories (that is, what lies) the preacher told. "Why he tell the people no man can serve two massas—now dis is de fuss story, 'cause you see Old Cudjo serves you, my old massa, an' also young massa John. Den de preacher says, 'he will lub de one and hate de other' while de Lord knows, *I hate you boff.*" At one level, common whites recognized that the slaves had every reason to despise the men who enslaved them.[32]

Common whites were not unaware of the horrors that took place in slavery. Their general reaction was to ignore them, rationalize them, or even participate in some of them. But at the same time common-white culture recognized that slavery could be a cruel system capable of making a man insane. A folk tale collected in Burlington in the 1930s illustrates the cultural memory that existed long after slavery had ended. The story tells of an A. M. Duncan, who allegedly lived around 1800. Duncan was known to be cruel to his slaves. He hung them by their thumbs in the smokehouse; he would cut off their ears and hang them up. He was alleged to have twenty pairs of black ears hung in that smokehouse alone. He would tie his slaves to stakes, beat them with a cat-o'-nine-tails, and rub salt and vinegar on the wounds.

Duncan's favorite target was a slave named Crazy Sam. Sam was a mulatto; some said he was Duncan's half-brother. Such talk only made Duncan beat him more frequently. One moonless night Sam had taken enough. He went to the master's bedroom and drove an ax into the head of the person asleep on the bed. Unfortunately for Sam, he had not killed Duncan but a boy who lived with him. The next morning Duncan came with gun in hand, looking for the murderer. Sam rushed Duncan with his ax and split his master's head to his shoulders.

Word of the incident reached the community. The neighbors and constable came. Sam held them off with Duncan's gun and killed the constable. Stray shots hit another white man, Sam's wife, and his children. Finally, Sam was killed. According to legend, from then on the house was haunted. Every night Duncan's ghost would bind Crazy Sam's ghost to the whipping stake, lash him, pour salt on his cuts, and hang him by the thumbs in the smokehouse. Any traveller hearing Sam's screams would be instantly turned stone deaf.[33]

The folktale says a great deal about the people who created it. The common whites thought of slavery as a brutal institution that might drive men crazy. Crazy Sam apparently lost his sanity under the pressure from his tormentor. Sam murdered his master, but his response did not seem unreasonable. Clearly the brute in the story was Duncan, not his black slave. Although the story showed the common whites' sympathy for the plight of the slave, it also showed that they would not allow the slaves to resort to insurrection to alter their condition. The community rallied to kill Sam even though they knew what kind of beast his owner was. Common whites were willing to defend slavery even though they might believe it was wrong. In general, this was the common-white view of slavery. Although they approved of the institution's ability to define the black place in society, they also recognized the essential inhumanity inherent in the system. Elmina Foster's recollections of her childhood attitudes towards slavery were probably typical of many common whites. Although she grew up in a nonslaveholding family of Quakers, she remembered pitying the slaves' conditions: "Brought up as I was in a slave holding neighborhood, accustomed to seeing slaves at work on all sides, in the fields, I supposed conditions to remain the same always, for slavery was a vast, far reaching thing, so deeply entrenched in society, it did not seem possible that it should ever be eradicated." [34]

Endnotes

[1]This petition is found in Legislative Papers North Carolina State Division of Archives and History, Raleigh, NC, Box 192 (hereafter cited as LP 192).

[2]LP 237.

[3]For a more thorough discussion of the definition of common whites see Bill Cecil-Fronsman, "The Common Whites: Class and Culture in Antebellum North Carolina," Chap. 1 in Ph.D. diss., University of North Carolina, Chapel Hill, 1983.

[4]William L. Barney, *The Secessionist Impulse: Alabama and Mississippi in 1860* (Princeton: Princeton University Press, 1974), pp. 229–30; William J. Cooper, Jr., *Liberty and Slavery: Southern Politics to 1860* (New York: Alfred A. Knopf, Inc., 1983), p. 249.

[5]Eugene D. Genovese's theories of paternalism are best stated in *The World the Slaveholders Made: Two Essays in Interpretation* (New York: Alfred A. Knopf, 1969), Book II. For an alternative reading of the slaveholders that emphasizes the harsher side of their racism see James Oakes, *The Ruling Race: A History of American Slaveholders* (New York: Alfred A. Knopf, 1982). The quotations from Hahn are from Steven Hahn, *The Roots of Southern Populism: Yeoman Farmers and the Transformation of the Georgia Upcountry, 1850–1890* (New York: Oxford University Press, 1983).

[6]Pierre L. van den Berghe, *Race and Racism: A Comparative Approach* (New York: John Wiley & Sons, Inc., 1967), Ch. 1. George Fredrickson has stated his position in several places. A good introduction to his use of the *herrenvolk* concept is *The Black Image in the White Mind: The Debate on Afro-American Character and Destiny, 1817–1914* (New York: Harper & Row, 1967), pp 58–70.

[7]There is, of course, an extensive literature on racism. In addition to the works cited in this article, I have found James M. Jones, *Prejudice and Racism* (Reading, Mass.: Addison-Wesley, 1972) to be of particular help. Space limitations prevent a discussion of the process by which these norms evolved within common-white culture. See Cecil-Fronsman, "The Common Whites," chapter 3 on this point. Readers should note that most scholars believe that however racist common whites may have been in the antebellum period, their descendants were far more racist in the postbellum pe-

riod. See Joel Williamson, *The Crucible of Race: Black-White Relations in the American South Since Emancipation* (New York: Oxford University Press, 1984).

[8]LP 312.

[9]LP 631.

[10]Newman Ivey White, gen. ed., The *Frank C. Brown Collection of North Carolina Folklore* (Durham, NC: Duke University Press, 1952, 1961), III 508. See also George P. Rawick, ed., *The American Slave: A Composite Autobiography* vols. XIV and XV: *North Carolina Narratives* (Westport, Conn.: Greenwood Publishing Co., 1972) (hereafter cited, Rawick, *NC Narratives*) XIV 424 where a former slave discusses how slave patrollers sang this song.

[11]Roy Johnson, "A Sampling of Eastern Oral Folk Humour," *North Carolina Folklore Journal* XXIII (1975):5.

[12]This incident is well discussed in John Scott Strickland, "The Great Revival and Insurrectionary Fears in North Carolina: An Examination of Antebellum Southern Society and Slave Revolt Panics," *Class, Conflict, and Consensus: Antebellum Southern Community Studies,* ed. Orville Burton and Robert C. McMath, Jr. (Westport, Conn.: Greenwood Publishing Co., 1982), pp 62–63.

[13]See Katherine Ann McGreachy, "The North Carolina Slave Code," Master's thesis, University of North Carolina, Chapel Hill, 1948.

[14] This practice was confirmed by the North Carolina Supreme Court in the case of *State v. Jowers* 11 Iredell 55 [1850].

[15]William G. Hawkins, *Lunsford Lane: or Another Helper From North Carolina* (New York: Negro Universities Press, 1969 [1853]), p. 156. The comment about the mob is by David W. Stone and is found in a letter to Supreme Court Chief Justice, Thomas Ruffin. See J. G. deRoulhac Hamilton, ed., *The Papers of Thomas Ruffin* (Raleigh: Publications of the North Carolina Historical Commission, 1918) II 205.

[16]Levi Coffin, *Reminiscences of Levi Coffin: The Reputed President of the Underground Railroad,* 2d ed. with appendix (Cincinnati: Robert Clarke & Co., 1880), p. 11.

[17]LP 226.

[18]*Raleigh Register* 12-12-1803, 1-17-1801.

[19]Governors Papers, North Carolina Division of Archives and History, Box 116 n.d. [1846] (hereafter cited as GP 116); Rawick, *NC Narratives* XIV 59.

[20]See documents in GP 55.

[21]Rawick, *NC Narratives* XV 345; GP 94; State v. Pemberton and Smith 2 Devereux 281 [1829].

[22]John Dollard, *Caste and Class in a Southern Town.* 2d ed. (New York: Harper & Brothers, 1937, 1949), p. 77–78; Joel Kovel, *White Racism: A Psychohistory* (New York: Pantheon Books, 1970), p. 56.

[23]*North Carolina Standard* 1-11-1836; George Swain to David Swain 8-16-1822, Swain Collection, Southern Historical Collection, University of North Carolina; Harry L. Watson, *Jacksonian Politics and Community Conflict: The Emergence of the Second American Party System in Cumberland County, North Carolina* (Baton Rouge: Louisiana State University Press, 1981), p. 44.

[24]LP 377; LP 276.

[25]LP 336; LP 192.

[26]LP 485; Guion Griffis Johnson, *Ante-Bellum North Carolina: A Social History,* (Chapel Hill: University of North Carolina Press, 1937), p. 211.

[27]*Reel v. Reel* 2 Hawkes 53 [1822]; State v. Jones 3 Dev. and Bat. 2 [1833].

[28]LP 415.

[29]Rawick, *NC Narratives* XIV 319.

[30]*State v. Hart* 4 Iredell 246 [1844].

[31]William D. Valentine Diary, 10-23-1842, Southern Historical Collection, University of North Carolina; Eugene D. Genovese, *Roll, Jordan, Roll: The World the Slaves Made* (New York: Pantheon Books, 1974), p. 642; LP 637. On poaching see Douglas Hay, "Poaching and the Game Laws on Cannock Chase," *Albion's Fatal Tree: Crime and Society in Eighteenth-Century England* ed. Douglas Hay et al., (New York: Pantheon Books, 1975), pp. 202–12.

[32]*North Carolina Standard* 11-5-1845.

[33]This remarkable tale was collected by an anonymous Federal Writers Project writer from Flora Fowler of Burlington. It is printed as "The Old Duncan House," *North Carolina Folklore* 1(1948):7–8. It is impossible to tell with complete certainty whether this tale was fashioned before or after the Civil War. The references to slavery and the year 1800 suggest that it had antebellum origins. Moreover, a similar tale was collected in Lincoln County, Kentucky, which sets the incident about the same time. See William Lynwood Montel, *Ghosts Along the Cumberland: Deathlore in the Kentucky Foothills* (Knoxville: University of Tennessee Press, 1975), p. 117. There were no A. M. Duncans living in Alamance County, where Burlington is located, nor were there any in Orange County, the county from which it was formed. A. M. Duncan may be a corruption of

Duncan Cameron, a distinguished Orange County planter from the early nineteenth century. His reputation, however, was one of gentleness to his slaves and unlike the character in the story, he had seven children. See William S. Powell, ed., *Dictionary of North Carolina Biography* (Chapel Hill: University of North Carolina Press, 1979), 1:311. The story is clearly a white folktale. The 1943 Burlington city directory lists Florence Fowler as white.

[34]Elmin Foster Reminiscences, Typescript, Southern Historical Collection, University of North Carolina, p. 7.

Fluctuations of a *Peromyscus Leucopus* Population Over a Twenty-Two Year Period

James W. Popp, Paul E. Matthiae, Charles M. Weise, and James A. Reinartz

Abstract. *Fluctuations in population size of a* Peromyscus leucopus *population in southeastern Wisconsin over a twenty-two year period were determined by annual live-trapping. The population exhibited moderate fluctuations in size, but there was no evidence for regular or cyclic fluctuations. A severe ice storm in the middle of the study period caused dramatic changes in the woodland habitat of the population under study. Fluctuations in population size increased after the ice storm, with the largest relative increase in population size occurring immediately after the ice storm.*

Peromyscus populations have traditionally been thought to be relatively stable (Terman 1968). Recent studies indicate, however, that populations of *Peromyscus leucopus* may exhibit fluctuations of over ten fold in population size (Sexton et al. 1982; Wolff 1985, Vessey 1987). Some authors suggest these fluctuations may reflect regular or cyclic fluctuations similar to those reported for microtine rodents (Wolff 1985).

A better understanding of population fluctuations in *P. leucopus* has been hampered by the paucity of long-term studies of the species. In this study, we report results of twenty-two years of annual live-trapping data for a *P. leucopus* population in southeastern Wisconsin. Our analysis centered on two areas. First, we investigated the magnitude of population fluctuations and whether these fluctuations were regular or cyclic using the criteria of Henttonen et al. (1985). Second, we examined what effect a major change in habitat, caused by a severe ice storm in the middle of the study period, had on the magnitude of population fluctuations. *Peromyscus leucopus* is a habitat generalist, found in habitats ranging from grasslands to mature forest (Adler and Wilson 1987). The species shows a preference for wooded habitats with complex vertical structure, including a definite shrub layer and presence of fallen trees, stumps and logs (M'Closkey and Lajoie 1975; Kaufman et al. 1983). An ice storm in 1976 resulted in increased canopy openings, increased density of herbaceous and shrub species, and increased the number of fallen branches and dead trees. The ice storm generally improved habitat quality for *P. leucopus* in the study area.

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Methods

This study was conducted between 1966 and 1987 at the University of Wisconsin-

Milwaukee Field Station, Ozaukee County, Wisconsin. The study area was in mature upland forest dominated by sugar maple *(Acer saccharum)*, white ash *(Fraxinus americana)*, American beech *(Fagus grandifolia)*, basswood *(Tilia americana)*, hophornbeam *(Ostrya virginiana)* and shagbark hickory *(Carya ovata)* (Dunnum 1972). Live-trapping was done on a 0.5625 ha grid. The grid consisted of 25 trap stations, 15 m apart in a 5 × 5 array. From 1966 to 1979, two Sherman type traps were placed on the ground at each station; from 1980 on, two Longworth traps were used at each station. Trapping was conducted in September or early October of each year. No trapping was done in 1980, and insufficient data were collected for analysis in 1985 because of heavy trap raiding by raccoons *(Procyon lotor)*. Animals received temporary ear marks. Trapping was done as a class demonstration but was always conducted by one of the authors and was standardized.

Population sizes were estimated using the Bayesian approach of Gazey and Staley (1986). We used the standard deviation of the logarithm of population size *(s)* to test for regular or cyclic fluctuations (Henttonen et al. 1985). Henttonen et al. (1985) have shown that a value of *s* greater than 0.5 is a good indicator of cyclic fluctuations in microtine populations. In March 1976, a severe ice storm occurred at the study site, which caused considerable damage to the trees. Before the storm, the canopy was essentially closed, herbaceous vegetation was low, and shrub cover was patchy at a low density, with little downed wood or litter on the forest floor. After the ice storm, macro-litter volume of downed wood on the floor was 19.4 m^3/ha, which accounted for a loss of approximately 35% of the canopy (Bruederle and Stearns 1985). Because of the greatly increased light penetration after the canopy loss, the herbaceous and shrub cover increased.

Results

Population sizes of *P. leucopus* exhibited moderate fluctuations (Fig. 1). The greatest continuous increase in population size was between 1976 and 1978, when a 3.2-fold increase occurred (peak population size/previous low size), following the ice storm of March 1976. Annual changes in population size (higher population size/lower population size) ranged from 1.0 to 2.9 (mean = 1.8, SD = 0.66). There was no evidence for cyclic or regular fluctuations. The value of *s* was 0.18, which is well below the 0.5 used by Henttonen et al. (1985) to distinguish cyclic populations.

Annual fluctuations in population size appeared to be greater in the years after the ice storm. A comparison of mean annual change in population size for 1966–1976 and 1977–1987 support this suggestion. Mean fluctuations were greater for the period after 1977 (1966–1976: mean = 1.41, SD = 0.45, versus 1977–1987: mean = 2.11, SD = 0.72; T-test: t = 2.39, d.f. = 14, $P < 0.05$). When comparing years in which population size increased, the mean finite rate of increase was greater after the ice storm (1966–1976: mean = 1.52, SD = 0.57, versus 1977–1987: mean = 1.98 SD = 0.69). This difference, however, is not significant, probably because of the small sample size (t = 1.09, dif. = f, $p > 0.05$). Mean population size was not significantly different between the two periods, but the variance of the population size was different (1966–1975: mean = 36.13, SD = 10.09, versus 1977–1987: mean = 47.13, SD = 21.26; T-test for unequal variances: t = 1.42, d.f. = 11.2, $P > 0.05$; F-test: F = 4.44, d.f. = 8.9, $P < 0.05$). Values of *s* calculated for before and after the ice storm showed greater variation after the ice storm but still provide no evidence for regular fluctuations (1966–1975: *s* = 0.15; 1977–87: *s* = 0.20).

Discussion

The *P. leucopus* population under study exhibited moderate fluctuations in population size. The fluctuations were, however, not as great as recently reported for other populations (Sexton et al. 1982; Vessey 1987). The fluctuations observed in this population showed

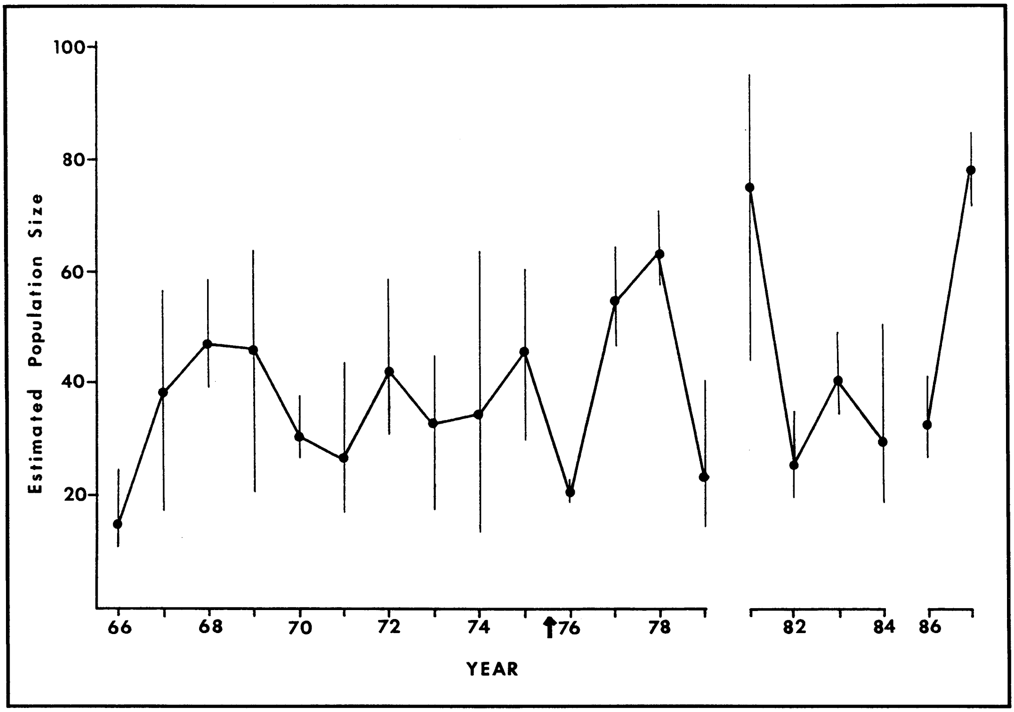

Fig. 1. Estimated size of a population of Peromyscus leucopus in southeastern Wisconsin over a twenty-two year period. Vertical bars represent .05 and .95 quantiles. The arrow indicates occurrence of ice storm.

no evidence of being regular or cyclic and probably reflect annual changes in population size rather than multiannual cycles. The value of *s* from this study (0.18) was within the range of values previously reported for this species. Values reported have ranged from 0.07 to 0.56, with most values between 0.16 and 0.27 (Ostfeld 1988).

The occurrence of the ice storm in the middle of this long-term study provided an opportunity to examine the effects of a large change in the environment on the size fluctuations of a population. Although in this study the mean population size was not significantly greater after the ice storm, the population had its greatest increase in size after the ice storm, presumably because of improved habitat conditions. After this peak, the population then experienced a series of its largest size fluctuations, perhaps representing a period of instability as the population adjusted to the new environmental conditions.

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The Aquatic Macrophyte Community of Black Earth Creek, Wisconsin: 1981 to 1986.

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Abstract. *The biomass and relative species abundance of the submersed aquatic macrophyte community of Black Earth Creek, Wisconsin were examined in 1986 at three sites and compared to data gathered in 1981 and 1985. Although total biomass was significantly lower in 1986 than 1985, the relative frequency of species was similar from 1981 to 1986. Macrophyte species are segregated along the length of the stream, with* Potamogeton crispus *dominant upstream and* Potamogeton pectinatus *dominant downstream, due to changes in water temperature. In reviewing species associations for Wisconsin streams,* P. crispus *and* P. pectinatus *were typical of eutrophic streams, and native species were typical of unimpacted mesotrophic streams. In summary, this study indicates that although total macrophyte biomass and abundance may fluctuate dramatically due to physical events (e.g., flooding), the relative frequency and dominance of species both spatially and temporally remain relatively constant.*

Although studies of submersed aquatic macrophytes in lakes are relatively common, studies of the ecology of this group of plants in streams are relatively rare. This paucity of research on stream macrophytes does not reflect the importance of controlling stream ecosystem structure and processes (Westlake 1973, 1975). Macrophytes are important to productivity in some stream systems and may play an important role in nutrient dynamics, particularly phosphorus (Dawson 1976; Minshall 1978; Madsen 1986). Macrophytes provide habitat for fish and macronivertebrates (Dawson 1978; Haslam 1978) and are substrate for epiphytic microflora that control water column chemical processes and contribute to primary productivity and community oxygen metabolism.

Within the state of Wisconsin, relatively few studies on stream macrophytes have been published. In the northeast, Smith (1978) studied the distribution of submersed macrophyte species in the Pine and Popple River systems. He found stream communities to be dramatically different in composition from adjacent lake communities. In a Wisconsin Department of Natural Resources (WDNR) report, Mace et al. (1984) discussed the results of an intensive survey of submersed

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macrophytes in southeastern Wisconsin streams in which they modeled biomass and community oxygen metabolism based on nutrient loadings from point sources. In another WDNR study, Hunt (1979) indicated that the removal of streamside woody vegetation improved trout fisheries by stimulating stream macrophyte growth. Badfish Creek has been studied for several years, first by Madison Metropolitan Sewerage District staff, and subsequently in dissertation work by Madsen (1986).

Of the macrophyte communities in all Wisconsin streams, that of Black Earth Creek has been most extensively studied. Field studies on the macrophyte community of Black Earth Creek were conducted in 1981 (Madsen 1982; Madsen and Adams 1985) and in 1985 in conjunction with a joint program by the WDNR, U.S. Geological Survey (USGS), and the University of Wisconsin-Madison Institute for Environmental Studies Water Resources Management Workshop (Born 1986; Bouchard and Madsen 1987). In 1986, this study was conducted in conjunction with further studies by the USGS. Relative frequency data for 1981 and both biomass and relative frequency data for 1985 and 1986 allow for inter-annual comparisons. In addition, data from various stream sites throughout the summer allow a comparison of species distribution and seasonal succession between years.

Plant biomass and species composition in streams may be sensitive to many factors; however, most factors do not change greatly from year to year. For instance, plant productivity and resultant biomass is often light-limited, yet the shading regime of a given stream changes little from year to year, barring windthrow or human activity (Peltier and Welch 1969; Kullberg 1974; Ham et al. 1982). However, flooding events of varying magnitude and duration may greatly affect species composition and total biomass of macrophytes both within a single year and from year to year (Bilby 1977; Dawson et al. 1978). Therefore, historical events are the most important factors explaining year-to-year variation in total biomass and species succession.

Materials and Methods

Site Description

Black Earth Creek is located in south-central Wisconsin in the western portion of Dane County (Fig. 1) on the edge of the nonglaciated "Driftless Area." Black Earth Creek is a calcareous, highly productive stream classified as a "class-one" trout habitat, meaning that natural reproduction maintains the trout population (Brynildson and Mason 1975). It is undoubtedly the most productive trout stream in Wisconsin and, coupled with its location close to Madison, one of the most important trout fishery resources in the state (Born 1986).

The baseflow of the stream is predominantly groundwater and artesian spring flow. Storm runoff and overland flow may produce substantial flooding. Land use in the drainage basin is predominantly agricultural (Born 1986).

In this study, biomass was sampled at three of the sites used in the 1985 study: sites 1,

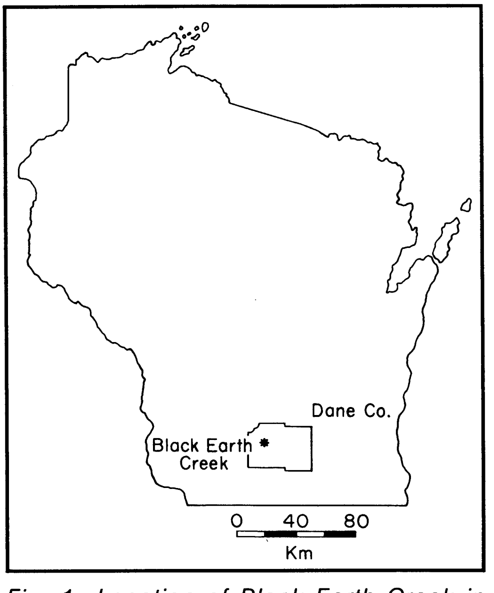

Fig. 1. Location of Black Earth Creek in Wisconsin.

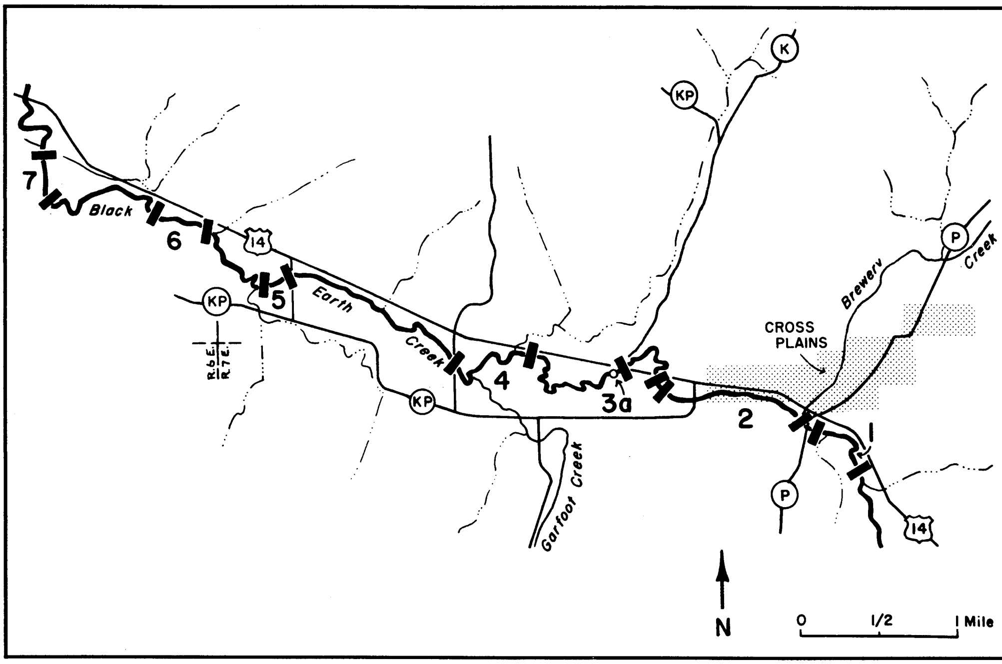

Fig. 2. Sample sites on Black Earth Creek.

3 (labeled 3a), and 7 (Fig. 2). Biomass data from 1986 were compared to biomass data from 1985 sampled at sites 1, 3, and 7 (Bouchard and Madsen 1987; Born 1986), and relative frequency data from biomass samples in 1986 were compared to relative frequency data from cover for sites 1 through 7 from 1985 and sites 1 through 4 from the 1981 study (Madsen 1982; Madsen and Adams 1985).

Methods

At each sample site, twenty biomass samples were taken based on a stratified-random pattern, sorted to species, and dried at 70°C to constant weight. Biomass was sampled on three dates during the summer of 1986: 23 June, 15 July, and 7 August. Relative frequency of each species, a measure of dominance, was calculated as a percentage of total biomass. Relative frequency from biomass is comparable to, but not the same as, relative frequency from cover. Although these values are compared, no statistical tests are used in the comparison of relative frequency data due to this difference.

Species nomenclatrue is based on Gleason and Cronquist (1963), although Fassett (1957) and Voss (1972) were used for initial indentification. Species observed in Black Earth Creek in 1986 were *Callitriche stagnalis* Scop., *Elodea canadensis* Michx., *Potamogeton crispus* L., *Potamogeton pectinatus* L., *Ranunculus longirostris* Godr., and *Zannichellia palustris* L. Voucher specimens were deposited in the University of Wisconsin-Madison herbarium.

Results and Discussions

Total Biomass

Total submersed macrophyte biomass was significantly higher at sites 1 and 7 in 1985 than in 1986 (789 and 512 vs. 323 and 19 g dw m^{-2}, respectively), while site 3 shows little variation between the years (335 vs. 347 g dw m^{-2}, respectively; see Fig. 3). Since biomass for 1985 was sampled on 1 July 1985, this value is best compared to the biomass for 23 June 1986. We interpret this wide divergence in biomass to be the result

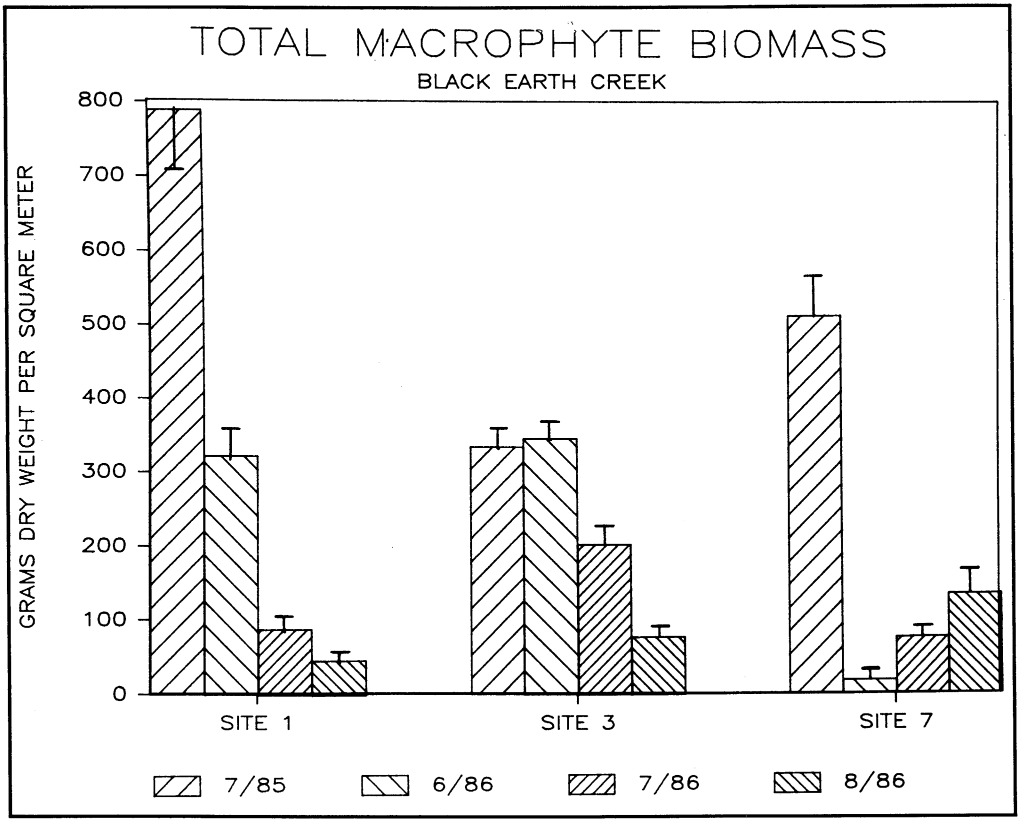

Fig. 3. Total biomass in Black Earth Creek at sites 1, 3, and 7 for 1985 and 1986. Bars indicate +1 standard error.

of flooding after a major storm on 25 July 1985 (Steven Field, USGS, pers. comm.). The flood scoured the soft sediments at sites 1 and 7, removing both the plant shoots present and the propagules in the sediment resulting in lower biomass the following year. Site 3, with its more stable gravel substrate, was relatively unaffected in terms of sediment scour.

Biomass at sites 1 and 3 peaks in late June due to the early phenology of its dominant species, *P. crispus,* which peaks in mid-June and senesces by mid-July (Sastroutomo 1981). *Potamogeton pectinatus,* the dominant at site 7, peaks in early August (134 g dw m^{-2}), as has been observed for *P. pectinatus* in nearby Badfish Creek (Madsen 1986).

Interannual Species Dominance

Despite the large variation in total biomass, the relative frequency of species has varied little over the five-year period examined (Fig. 4). The species, *P. crispus* and *P. pectinatus,* have remained dominant throughout the period. Some variation can be explained by a shift in methodologies; 1981 and 1985 data were computed from cover data gathered over extensive reaches, whereas 1986 data were calculated from biomass from more limited stretches. For instance, *R. longirostris* is commonly found in riffle areas, a habitat that is underrepresented within biomass sample sites. Also, 1981 data were collected for only sites 1 through 4, emphasizing reaches in which *P. crispus* is dominant. Lastly, distinct but minor changes in species occurrence have been observed between the years. *Elodea canadensis* was below one percent of the total cover for sites 1 through 4 in 1981 but now is frequently found in those stretches. The two dominant species have changed little.

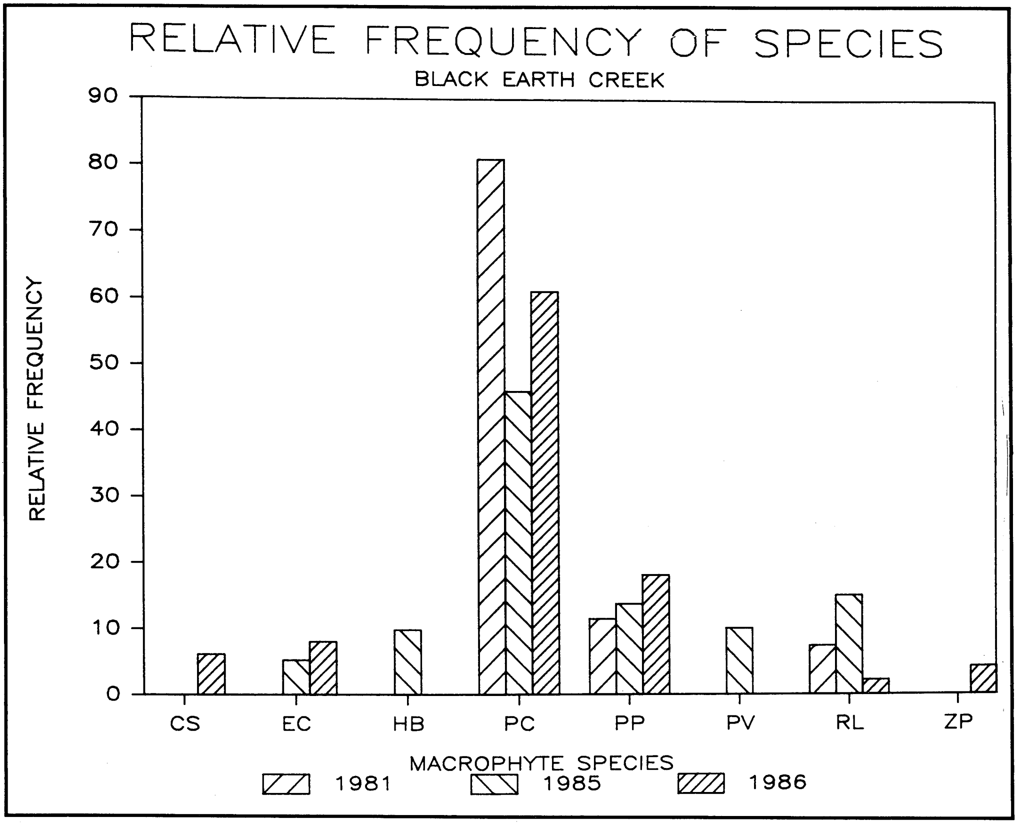

Fig. 4. Relative frequency of macrophyte species for 1981, 1985, and 1986. Species codes: CS, Callitriche stagnalis; *EC,* Elodea canadensis; *HB,* Hypericum boreale; *PC,* Potamogeton crispus; *PP,* Potamogeton pectinatus; *PV,* Potamogeton vaginatus; *RL,* Ranunculus longirostris; *ZP,* Zannichellia palustris.

Flooding acts to initially remove shoot biomass in the first year. This effect is definitely differential with respect to species, resulting in a change in species composition (Bilby 1977; Madsen and Adams 1985). However, the primary effect is to remove biomass. A major flooding event could affect biomass the following year if a sufficient proportion of propagules were also removed, as apparently happened in 1985–1986. Theoretically, a major flooding event could alter species composition in following years if flood scour had a differential impact on the proportion of propagules of each species removed. In this instance this was not observed. Species composition has been relatively stable from 1981–1986. One factor in this stability could be the overwintering adaptations of the dominant species (Table 1). The only species that reproduce significantly by seed are those inhabiting the edges of the stream or very stable substrates (e.g., *C. stagnalis* and *Z. palustris*). The other four species are cited by Haslam (1978) as flood tolerant. *Elodea canadensis* is generally found in sheltered sites and can overwinter as either dormant apices above the sediment level or as dormant rhizomes. *Ranunculus longirostris* also utilizes dormant shoots but is mostly found in very stable substrates. The two dominants, *P. crispus* and *P. pectinatus,* are capable of overwintering in dormant structures under the sediment surface that are resistant to all but heavy scour. These two species also produce an abundance of highly dispersable propagules, which are an important aspect of their ability to dominate in eutrophic waters. None of these last four species appears to

Table 1. Forms of overwintering propagules and flood tolerance (Haslam 1978) for submersed macrophyte species in Black Earth Creek.

Species	Propagule	Reference
Callitriche stagnalis	Fruit/Seed	Voss 1985
Elodea canadensis	Dormant Apices Turions Rhizomes "Flood Tolerant"	Haslam 1978 Sculthorpe 1967 Engel 1985
Potamogeton crispus	Turions Rhizomes "Flood Tolerant"	Haslam 1978 Sculthorpe 1967
Potamogeton pectinatus	Tubers Rhizomes "Flood Tolerant"	Voss 1972 Haslam 1978
Ranunculus longirostris	Dormant Stems Dormant Apices "Flood Tolerant"	Haslam 1978
Zannichellia palustris	Fruit/Seed Significant Seed Production	Voss 1972 Hutchinson 1975

have propagules more tolerant of flood scour than the others.

Drastic changes in the species composition of Black Earth Creek would result from changing the light regime. Open stretches, which are common, tend to form the highest biomass and to be dominated by either *P. crispus* or *P. pectinatus*. By allowing riparian tree vegetation to grow, a more diverse community with lower biomass would result. Such a management strategy would be employed if macrophyte biomass was considered so high as to be deleterious to the the trout fishery (Born 1986; Bouchard and Madsen 1987). Still, a certain amount of macrophyte biomass is desirable (White and Brynildson 1967; Hunt 1979), and we suggest the best strategy would be to allow a mixture of open areas with high macrophyte biomass and shaded areas of lower biomass and higher plant diversity.

Seasonal Succession–1986

Seasonal succession follows a fairly consistent pattern in Black Earth Creek (Fig. 5). *Potamogeton crispus* dominates throughout most of the stream in June and begins senescing by mid-July. By August, *P. crispus* biomass is only in the form of dormant and propagules. Other species peak after *P. crispus* based on their distribution within the stream, with *E. canadensis* or *P. pectinatus* being a common late season dominant. The late season dominants for sections 1 and 3 were *E. canadensis* or remaining *P. crispus* biomass, while *P. pectinatus* continued to dominate at site 7 throughout the season, as has also been observed at Badfish Creek (Madsen 1986). Discriminant analysis indicated three species as having significant seasonal changes in biomass: *P. crispus* ($p = 0.0000$), *P. pectinatus* ($p = 0.0036$), and *E. canadensis* ($p = 0.0889$). This type of seasonal pattern was observed in 1981, except that *E. canadensis* was not a significant component of the community at that time, and flooding removed most of the submersed macrophyte cover in early August of 1981.

Distribution between Sites–1986

As mentioned before, *P. crispus* was the dominant species in sites 1 and 3, and *P. pectinatus* was the dominant at site 7 (Fig. 6). Among the nondominant species, only *R. longirostris* had a significant presence at site 7. The near-monoculture of *P. pectinatus* at

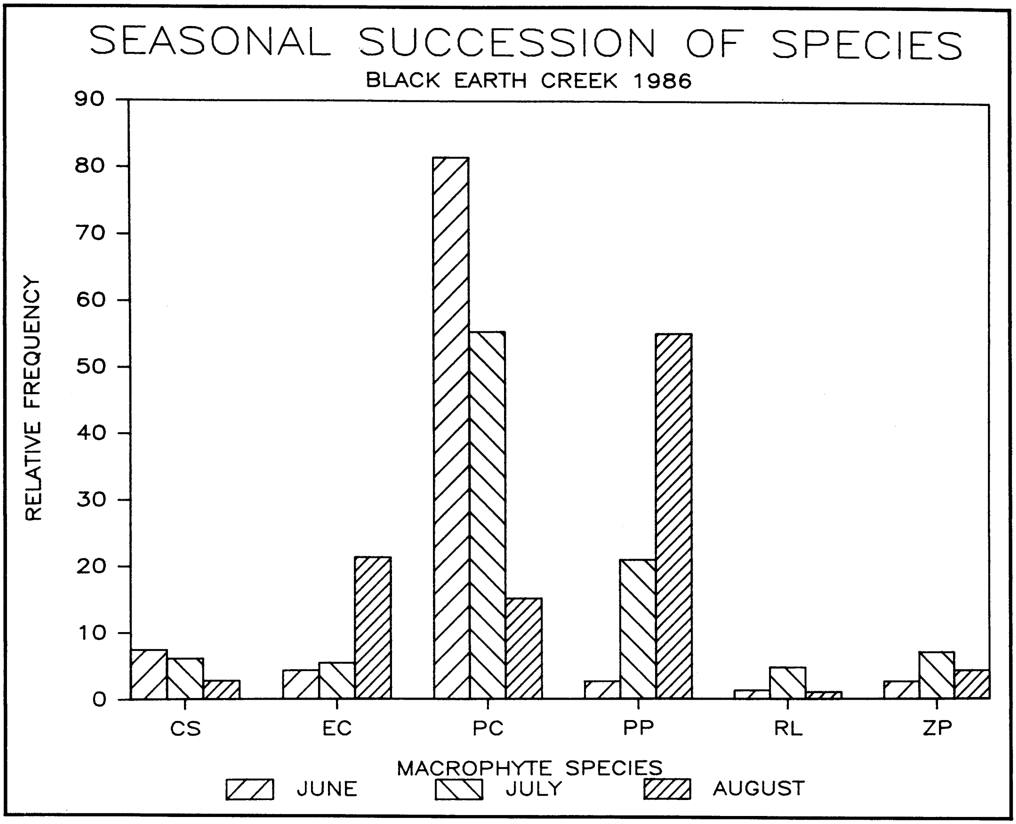

Fig. 5. Seasonal succession of species in Black Earth Creek during 1986 as based on relative frequency. Species codes: CS, Callitriche stagnalis*; EC,* Elodea canadensis*; PC,* Potamogeton crispus*; PP,* Potamogeton pectinatus*; RL,* Ranunculus longirostris*; ZP,* Zannichellia palustris.

site 7 was also observed in 1985, except that *P. vaginatus* was also present in significant proportions. *Potamogeton vaginatus* was seen at site 7 in 1986 but not quantified. *Potamogeton pectinatus* often forms a dense monoculture in warmer eutrophic streams (e.g., Badfish Creek, Madsen 1986), whereas *P. crispus* tends to be the dominant species in cooler eutrophic environments. The dominance of *P. crispus* at sites 1 and 3 is consistent with observations made in 1981 and 1985. Discriminant analysis indicated that all species except *R. longirostris* ($p = 0.1398$) were significantly different in their biomass distributions between the three sites (e.g., $p \leq 0.05$), indicating the sharp divergence of vegetation in sites 1 and 3 from that in site 7.

Increased water temperature is the environmental factor most likely responsible for the shift in dominance from *P. crispus* at sites 1 and 3 to *P. pectinatus* at site 7. Although both *Potamogeton* species are common dominants in eutrophic, high alkalinity waters, *P. crispus* tends to be dominant either in cooler lakes and streams or earlier in the season while water temperatures are low (e.g., Sahai and Sinha 1976; Engle 1985; see Table 2). In each case reported in the literature, *P. crispus* reaches maximum biomass and senesces at lower water temperatures or earlier in the growing season for given regions (Table 2). This is especially noticeable where the two species occur together in the same community. *Potamogeton crispus* often senesces when water temperatures exceed 20°C.

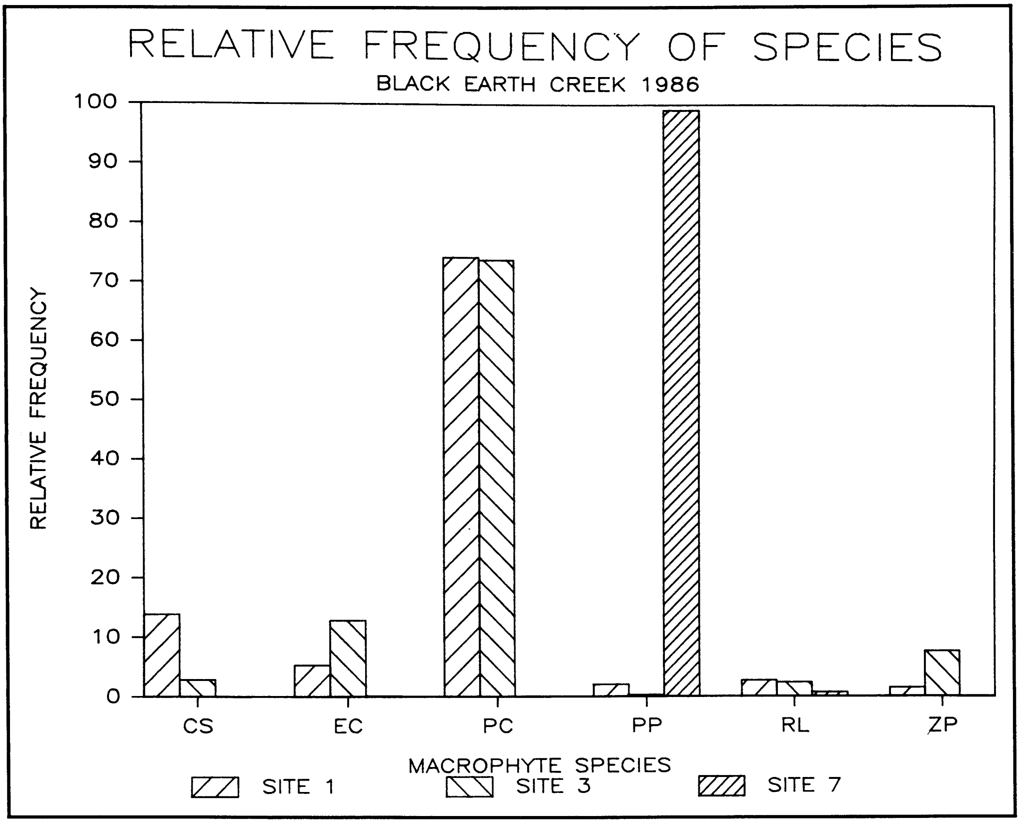

Fig. 6. Relative frequency of macrophyte species at sites 1, 3, and 7 in Black Earth Creek during 1986. Species codes: CS, Callitriche stagnalis; *EC,* Elodea canadensis; *PC,* Potamogeton crispus; *PP,* Potamogeton pectinatus; *RL,* Ranunculus longirostris; *ZP,* Zannichellia palustris.

Potamogeton pectinatus, on the other hand, is relatively insensitive to high temperature in the temperate zone and may form dense monocultures in streams with maximum daily temperatures above 23°C (Wong et al. 1978). In this respect, Badfish Creek and Black Earth Creek near Black Earth are similar in their thermal regimes. The longitudinal trend for warming downstream creates the conditions that promote a *P. pectinatus* monoculture at site 7.

Although the monthly maximum temperature at Black Earth is only 1–2°C higher than at Cross Plains, the critical temperature to initiate the senescence of *P. crispus* (approximately 20°C) is reached in May rather than late June (Fig. 7). Therefore, the phenologies of the two sites would be radically different. *Potamogeton crispus* theoretically would senesce much earlier at site 7 than sites 1 and 3, which may either mean that it was already senescent by the time that research began or its potential for success at site 7 is too poor for it to survive or compete against *P. pectinatus.*

Cover data from 1985 for sites 1 through 7 do not indicate a gradual transition from *P. crispus* to *P. pectinatus,* but rather a dramatic increase in *P. pectinatus* in site 7 from low relative percentages upstream. The relative percentage of *P. crispus* is also reduced in sites 5 and 6 from sites 1 through 4. We expect this is due to increased shading and lack of suitable substrates in sites 5 and 6, rather than to the observed temperature shift.

The effect of temperature was further in-

Table 2. Water temperature (°C) range or season of the year* for the growth and dominance of *Potamogeton crispus* and *P. pectinatus.*

Location	*P. crispus*	*P. pectinatus*	*Reference*
Otsego L., NY	max 21		6
Ojaga-ike, Japan	10–22		10
Collins L., NY	10–22		19
Pongolo R., SA	16–22		14
Bhagalpur, India	1–5*		15
L. St. Clair, MI	4–6*		18
Ltl. Conesus Cr, NY	max 5*		12
Japan	10–5*	4–7*	8
Halverson L., WI	4–7*	5–8*	4
Ramgarh L., India	8–6*	5–8*	16
Naini Tal, India	max 3*	max 5*	13
Jaipur, India	max 5–6*	max 6–7*	17
Ontario Rivers	max 19–22#	max 23+	20
Badfish Cr., WI		15–23	11
Eau Galle Res., WI		12–27	2, 5
Fox L., ND		16–28	9
Swartvlei, SA		16–28	7
L. Mendota, WI		5–7*	3
Delta Marsh, Man.		max 6*	1

* Month of the year rather than temperature (°C)

Indicated as *Potamogeton* sp.

1, Anderson and Low 1976; 2, Barko et al. 1984; 3, Carpenter 1980; 4, Engel 1985; 5, Filbin and Barko 1985; 6, Harman 1974; 7, Howard-Williams 1978; 8, Kadono 1984; 9, Kollman and Wali 1976; 10, Kunii 1982; 11, Madsen 1986; 12, Peverly 1979; 13, Purohit and Singh 1985; 14, Rogers and Breen 1980; 15, Saha 1986; 16, Sahai and Sinha 1976; 17, Saxena 1986; 18, Schloesser et al. 1985; 19, Tobiessen and Snow 1984; 20, Wong et al 1978.

vestigated by examining the submersed macrophyte flora of streams in south-central Wisconsin, both from literature sources and by a one-time confirmatory visit to most of the ten streams (Table 3). Unfortunately, there is insufficient data on both the occurrence of *P. crispus* and *P. pectinatus* to draw any conclusions, other than that the two *Potamogeton* species are not the typical macrophyte species of the average south-central Wisconsin stream. Both sites with *P. crispus,* Black Earth Creek and Vermont Creek (a tributary to Black Earth Creek), are enriched by nonpoint source pollutants. The only stream other than Black Earth Creek and Badfish Creek to have *P. pectinatus* is Rutland Branch, where it only grows in the 100 m of that stream above its confluence with Badfish Creek. Therefore, these two *Potamogeton* species appear to be restricted to the most eutrophic streams in the area. In the absence of excessive cultural eutrophication, Black Earth and Badfish Creeks would probably have vegetation more typical for calcareous streams of the region, namely, *Elodea canadensis, Nasturtium officinale* (a semi-emergent macrophyte), *Ranunculus longirostris,* and *Veronica catenata.*

When sites from across Wisconsin tabulated from literature sources are examined, a distinct pattern emerges when comparing the four previously mentioned native, or mesotrophic, species and the two nonnative, eutrophic species (Table 4). *Potamogeton pectinatus* and *P. crispus* do indeed tend to be found in the most eutrophic of streams, while *Elodea, Nasturtium, Ranunculus, Veronica* are the predominant species of relatively clear, clean, cool streams. Because of its combination of species, both mesotrophic and eutrophic, Black Earth Creek appears to be transitional between the two, with a trend from mesotrophic in the headwaters to eutrophic near Black Earth. This trend is in

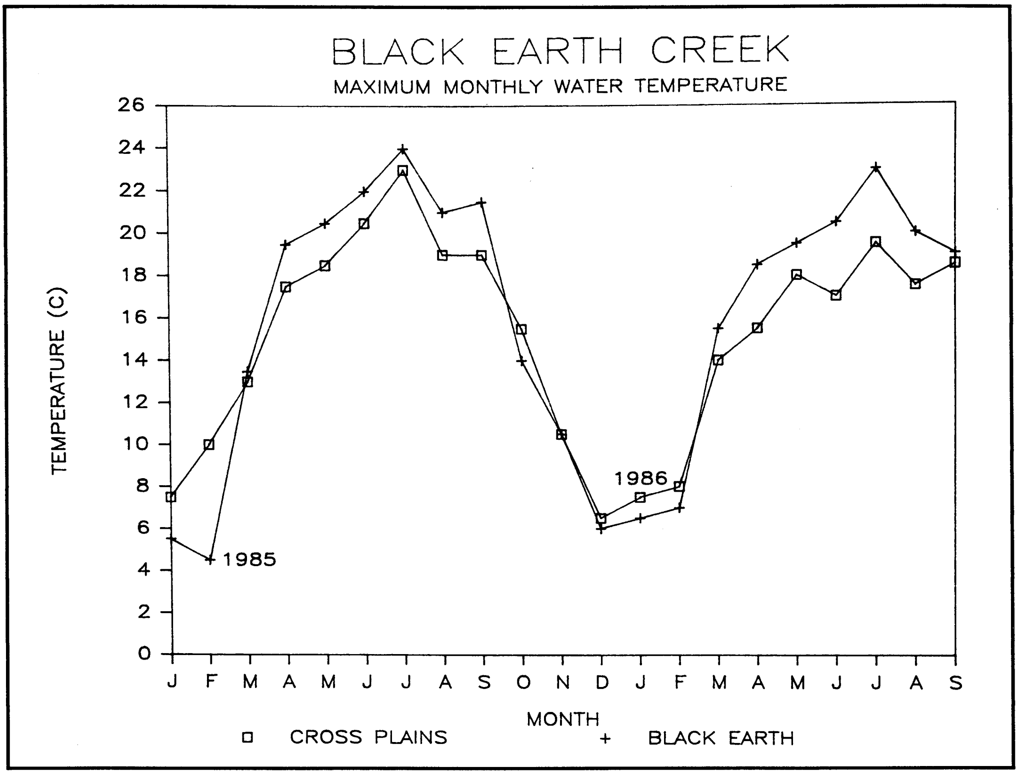

Fig. 7. Maximum monthly temperatures from 1985 through 1986 for Black Earth Creek at Cross Plains (site 2) and Black Earth (site 7). Data provided by Steve Field, U.S. Geological Survey.

large part due to the change in water temperature along its length but is also due to heavy nonpoint and point inputs of nutrients (Born 1986). Our conclusion of decreasing water quality in the downstream direction is substantiated by the Hilsenhoff Biotic Index on macroinvertebrate species for three separate years of collections (Born 1986).

A statistical analysis of the occurrence of these species throughout the state by the Fisher's Exact Test indicate some interesting ecological relationships *Elodea canadensis* was found to inhabit both mesotrophic and eutrophic streams with no partiality ($p = 0.25$). However, *N. officinale* ($p = 0.009$) and *R. longirostris* ($p = 0.0003$) occurred most commonly in mesotrophic streams. *Potamogeton crispus* ($p = 0.08$) and *P. pectinatus* ($p = 0.0009$) occurred significantly more often in eutrophic streams. However, this trend should not be construed as being a set of obligate "indicator species" for water quality, good or bad. *Nasturtium officinale* would best indicate cool, spring-fed streams, but not a range of nutrient concentrations. The occurrence of *P. pectinatus* does not necessarily indicate eutrophic conditions as it can occur in pristine, mesotrophic streams, especially those with sandy substrates. For instance, *P. pectinatus* is a common submersed macrophyte on sandy substrates in Lawrence Creek (Madsen 1982) and in the Bois Brule River (Thomas 1944), both very clean streams. However, *P. pectinatus* is a very common species in eutrophic streams throughout North America.

Conclusions

Total biomass at sites 1 and 7 was significantly lower in 1986 than 1985 but was similar for the two years at site 3. The difference

Table 3. Occurrence of submersed macrophyte species and maximum summer water temperature (°C) in south-central Wisconsin streams, and frequency* among the ten streams.

	Streams										
Species	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*Freq.**
Callitriche verna						X					1
Elodea canadensis	X	X		X	X	X			X	X	7
Nasturtium officinale		X	X	X	X	X	X		X	X	8
Potamogeton crispus						X		X			2
Potamogeton pectinatus	X			X		X					3
Potamogeton zosteriformis						X		X	X	X	4
Ranunculus longirostris		X		X		X	X	X	X		6
Veronica catenata				X	X	X		X	X	X	6
Zannichellia palustris				X	X	X			X		4
Maximum Water Temperature (C)	23	20	25	16	—	21	18	25	19	21	
References	1	4	4	1	1	1	2	6	1	6	
	4	6	6	4		to	6		4		
			8	6		7			6		
						9			7		

Streams: 1, Badfish Creek; 2, Frogpond Creek; 3, Oregon Branch; 4, Rutland Branch; 5, Spring Creek; 6, Black Earth Creek; 7, Garfoot Creek; 8, Vermont Creek; 9, Mount Vernon Creek; 10, Little Sugar River.

References: 1, This Study; 2, Born 1986; 3, Brynildson and Mason 1975; 4, *DCRPC* 1980; 5, Johnson 1969; 6, Lathrop and Johnson 1979; 7, Mace et al 1984; 8, Madison Metropolitan Sewerage District unpubl. data; 9, WDNR 1977.

between the two years' biomass is attributed to flood scouring, which greatly affected the sediments at sites 1 and 7, but not at site 3. Although total biomass is significantly different, species composition is consistent for the three years examined. For sites 1 and 3, *P. crispus* is dominant, with an assemblage of *C. stagnalis, E. canadensis, P. pectinatus, R. longirostris,* and *Z. palustris*. At site 7, a near-monoculture of *P. pectinatus* occurred with only a small percentage of *R. longirostris* as a marginal plant. This species shift is due to increased water temperature and eutrophication downstream. Seasonal succession patterns were also typical of previous years, with *P. crispus* as an early season dominant and *E. canadensis* and *P. pectinatus* as late season dominants. The two *Potamogeton* species are typical dominants of eutrophic streams, whereas native species, such as *Nasturtium* and *Ranunculus,* dominate in relatively unpolluted mesotrophic streams. Black Earth Creek is at the transition between a mesotrophic and eutrophic state, with water quality decreasing downstream. In general, historical factors, such as floods, may greatly alter total biomass for the current and following years but were not observed in this case to significantly alter species composition in the following year.

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Table 4. Occurrence of six macrophyte species common to either mesotrophic or eutrophic streams in Wisconsin, and p-value for a Fishers Exact Test.

Stream	TS	EC	NO	RL	VC	PC	PP	Reference
Ashippun R.	E						X	6
Badfish Cr.	E	X					X	8
Bark R.	E	X				X	X	6
Black Earth Cr.	E	X	X	X	X	X	X	1
Cedar Cr.	E						X	6
Milwaukee R.	E	X					X	6
Mukwonago R.	E	X					X	6
Pewaukee R.	E					X	X	6
Scuppernong R.	E	X						6
Beaver Cr.	M			X				3
Bois Brule R.	M	X		X			X	10
Emmons Cr.	M		X	X				4
Frogpond Cr.	M	X		X				1
Garfoot Cr.	M		X	X				1
Kinnikinnic R.	M	X		X				5
Lawrence Cr.	M	X	X	X	X		X	7
Ltl. Plover R.	M		X	X	X			5
Ltl. Sugar R.	M	X	X		X			1
McCann R.	M		X					5
Mecan R.	M		X	X				4
Mt. Vernon Cr.	M	X	X	X	X			6
Pine-Popple Rs	M	X		T			X	9
Radley Cr.	M		X	X				4
Rutland Br.	M	X	X	X	X		X	1
Seas Branch Cr.	M		X	X				2
Spring Cr.	M	X	X		X			1
Spring Cr.	M			X	X			5
Vermont Cr.	M			X	X	X		1
Wedde Cr.	M		X	X				3
Frequency:								
Eutrophic:	9	6	1	1	1	3	8	
Mesotrophic:	20	9	13	17	8	1	4	
Total	29	15	14	18	9	4	12	
Fisher's Test								
$p < 0.10$:			*	*		*	*	
$p < 0.01$:			*	*			*	

TS, Trophic Status (M, Mesotrophic; E, Eutrophic); EC, *Elodea canadensis*; NO, *Nasturtium officinale*; RL, *Ranunculus longirostris*; VC, *Veronica catenata*; PC, *Potamogeton crispus*; PP, *Pontamogeton pectinatus*.

References: 1, This Study (see Table 3); 2, Avery 1978; 3, Avery 1985; 4, Avery and Hunt 1981; 5, Hunt 1979; 6, Mace et al 1984; 7, Madsen 1982; 8, Madsen 1986; 9, Smith 1978; 10, Thomson 1944.

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