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## **WISCONSIN DESERT – The Sand Barrens of the Lower Wisconsin River**

When Glacial Lake Wisconsin drained at the end of the last ice age, it catastrophically flooded the Lower Wisconsin River Valley. This flooding deposited massive amounts of glacial sand, which then, through a process of down cutting, formed terraces along the river. Today, there are areas on these terraces that have desert-like features. These places, called sand barrens, consist of areas dominated by open sand, occasional xerophytic plants, prairie grasses, and scattered trees. What makes the sand barrens so unique is that they provide habitat for species of plants and animals found nowhere else in Wisconsin. These species are adapted to the extreme environmental conditions of the sand barrens, which is a consequence of their sandy, nutrient poor soil combined with the effects of agricultural use in the past.

We are exploring this interesting mix of natural conditions and human land use history that characterize sand barrens of the Lower Wisconsin River. We look at how the two have contributed to the landscape we see today. We are focusing on five sites with sand barrens: Blue River Sand Barrens, Spring Green Preserve, Arena Pines and Sand Barrens, Gotham Jack Pine Barrens, and Woodman Lake Sand Prairie. These areas are now designated State Natural Areas and owned by the Wisconsin DNR or Nature Conservancy. We examine the histories of these sites to find similarities and differences

among them that will help shed light on their creation and how they respond to changes in land use.

## LITERATURE REVIEW

Literature on the sand barrens in the Lower Wisconsin River Valley in particular is very limited. However, there is some literature on sand barrens found elsewhere, and a great deal of writing on the related dry prairie and savanna communities that help to put sand barrens in context. First of all, the terms “barrens”, “prairie”, and “savanna” have no precise definitions. Their meanings seem to vary regionally and through time. It would be useful to start by looking at the way these terms have been used and defined by others.

The term barrens was originally used by settlers to refer to areas with little or no timber sized trees, although smaller trees that were not useful to them may have been present. Savanna was used almost interchangeably with barrens to describe the same type of vegetation in different parts of the country. They were both areas where tree growth was somewhat restricted in density and/or size (Anderson, Fralish, and Baskin 1999). To further complicate things, the term barrens has been used in the singular or plural to mean the same thing (White 1994:26). We will use the plural because it is the most common usage today. The term prairie has been used fairly consistently to mean open grasslands with very few trees, although some early writing by settlers refers to this type of landscape as barrens too. The cutoff between prairie and savanna is fairly arbitrary and varies quite a bit in the literature. Curtis classifies prairies as having less

than 5% canopy coverage, and savannas as having between 5% and 50% coverage, with forest after that (Anderson, Fralish, and Baskin 1999:2).

By the mid 1900s the term barrens was being used a little differently than savanna in that, instead of focusing on amount of tree cover, it was being used more exclusively to identify areas with particularly infertile soils. So rather than describe a general landscape, it was being used more to identify unique areas. Some examples are: the New Jersey Pine Barrens, serpentine barrens of Maryland and Pennsylvania, the Mid-Appalachian shale barrens, as well as the Jack Pine barrens and sand barrens of the northern Great Lakes region. However, also at this time biologists and ecologists were subdividing prairies and savannas into classes based on things like moisture availability and predominant trees. Consequently, there is a lot of overlap between the drier end of the prairie and savanna scales and the barrens communities. For example, sand barrens may also be considered dry oak savannas or sand prairies. This confusion of terms is revealed by Anderson et al.: “Dry sand savanna (sand barrens) is associated with sandy, low-nutrient, droughty soils of the glacial moraines, outwash plains, sandy lake beds, and dune systems located relatively near former glacial margins. In the early 1800s, most of these areas were recorded as open barrens or savanna by government land surveyors.” (Anderson, Fralish, and Baskin 1999:135). This passage also provides a good description of the locations where sand barrens are found.

The first good description of a vegetation community explicitly called “sand barrens” in the historical literature appears to be by the UW botanist and plant ecologist John Curtis in his seminal *Vegetation of Wisconsin* from 1959. Curtis includes the effects of agriculture in his definition of Wisconsin sand barrens. He says that if these areas had

been left undisturbed they would have qualified as dry prairies or oak barrens, but plowing of the prairie sod resulted in the movement of sandy soil by wind. This created “blowouts” from which the sand is removed, and dunes where it is deposited. Much of the flora and fauna that then colonize this open sand are distinctive and are what characterize sand barrens. In a study made by J. T. Curtis and H. C. Greene of 20 sand barrens in Wisconsin (7 of them along the Lower Wisconsin River), almost all of the prevalent species were restricted to sandy habitats and several are essentially confined to the sand barrens in particular (Curtis 1959:313).

As far as the environmental conditions of sand barrens documented by Curtis, he calls them “Wisconsin’s closest approach to true desert.” Measurements of surface soil temperatures in midsummer were from 140° to 155° F. This is probably because, as Anderson et al. (1999:2) explain, barren soil results in very high levels of irradiance on the soil surface which generates high temperatures that are harmful to many plant species. Curtis’ analyses of the sand also showed an almost total lack of available nutrients: trace amounts of calcium, 17 ppm of potassium, 30 ppm of phosphorus, and 5 ppm of ammonia nitrogen. The average pH was 6.2 and the water-retaining capacity was between 20 and 30 percent (Curtis 1959:312). This gives an idea of the extreme conditions plants and animals have to put up with in the sand barrens.

One species that takes advantage of these extreme conditions is the six-lined racerunner. Joel Stein (1995) did a study of these lizards at two of our study sites – the Spring Green Preserve and the Blue River Sand Barrens. The six-lined racerunner is commonly found in southern states but in Wisconsin is restricted to the lower Wisconsin River sand barrens which make up the northern limit of its range. Stein found that for the

time that the six-lined racerunners are active each year, the sand barrens habitat is thermally similar to their southern habitat. The main difference is that, due to Wisconsin's overall cooler climate, the length of time over a year that they can be active is much shorter. In Wisconsin they have just enough time in the summer to lay one set of eggs (instead of the normal two sets in their southern habitat) that will incubate for 50 to 60 days before hatching and then foraging for a couple weeks before the climate forces them into their first long hibernation (Stein 1995). If their active season was any shorter the offspring would not survive. This example illustrates how the local conditions of the sand barrens are distinctive enough to provide habitat for a species not common to the region, and how that species must adapt to conditions on the edge of its habitat.

As for plant life, Curtis (1959:312) documents several adaptations that have allowed plants to exist in the sand barrens. One common desert strategy is to develop water storage organs to get through drought periods. The prickly pear cactus is one example of this found in Wisconsin sand barrens. There are actually two species which migrated here after deglaciation: the plains prickly-pear from the south-west and the eastern prickly-pear from the south-east (Cochrane 2000:43). The fame flower is another plant that is adapted for water storage. It is a rare flower that is endemic to the sand barrens of the region, and also has the uncommon habit of opening its flowers only in the late afternoon. Some plants, such as the sand goldenheather, have leaves that are small, hard, and tough so that they are able to be among the first to colonize the blowouts because they can endure the blowing sand. Many other plants have developed very deep tap roots to take advantage of moister conditions up to three meters below the surface (Curtis 1959:311). Other important sand stabilizers are varieties of lichens, mosses, and

fungi more characteristic of the arid western states (Anderson, Fralish, and Baskin 1999:144). One of the things that make the sand barrens so interesting and important is that they are refuge for these, and many other species adapted to extreme environmental conditions.

Curtis gives an interesting account of the creation of blowouts found in the sand barrens, some of which covered more than 40 acres, with the associated dunes covering another 10. With the sand that was deposited on these terraces, a small percentage (as compared to the amount of sand) of pebbles was also deposited. These pebbles are evenly spread at about 60 to 75 per cubic meter. When a blowout is forming, the winds don't have enough velocity to move the pebbles; so when the blowout reaches a certain depth, enough of these stones have concentrated on the surface to protect the underlying sand from the wind. This bottom surface of blowouts is called "desert pavement." The blowout is not able to get deeper than this surface, but can continue to spread laterally with the sand-blast of the winds killing plants on its edge. Curtis notes that in this way sand barrens can even encroach into areas which had not been disturbed by agriculture (Curtis 1959:310). However, post-settlement disturbance is one of the main elements of Curtis' definition of sand barrens, unlike other references such as Anderson et al. (1999) above which classify them more as 'naturally occurring dry sand savannas and prairies.'

Definitions and classifications are probably less important to understanding a plant community than examining how they change over time and space relative to the changing conditions. Several literature sources help shed light on this dynamic aspect of Vegetation. Vegetation composition is controlled by many elements. A site's particular mix of the environmental conditions of climate (temperature, precipitation, etc.), soil

characteristics (nutrients, texture, drainage, etc.), topographic position, and disturbances (fire, flooding, drought, grazing, etc.) results in particular mixes of plants and animals. As these elements change, so too does the species composition. Weaver stated this concept (minus disturbances) very eloquently in his book on prairies: “The prairie itself is an intricately constructed community. The climax vegetation is the outcome of thousands of years of sorting of species and adaptations to soil and climate” (Weaver 1954:325). Looking at vegetation this way, it seems reasonable to assume that before European settlement the species composition of the Lower Wisconsin River sand terraces generally shifted back and forth from drier, open sand barren types to oak savanna, depending on changes in climate and occurrence of fire.

An example of sand barrens reacting to climate change is provided by the Anoka Sandplains of Minnesota. Like the Lower Wisconsin River, The St. Croix River Valley also has sandy river terraces and outwash plains formed by glacial meltwater. Dunes formed in a large area called the Anoka Sandplains starting about 8,000 years ago during a period that was dryer and warmer than today. Sparse vegetation and strong winds caused the erosion of the sandy plain creating shifting dunes that have been more or less active depending on the changing climate. Dry periods about 6,000 and 5,000 years ago caused the further development of the dunes (Wovcha 1995:13). These dates generally correspond to the timeframe mentioned by Clayton in *Geology of Sauk County, Wisconsin* of a “dry episode” between about 4,000 and 8,000 years ago when dry prairies and dunes were more widespread in south-west Sauk County (Clayton 1990:49).

The Anoka Sandplain dunes are now mostly stabilized by vegetation, but do have some areas of wind-scoured blowouts. Apparently, most of the dune areas of the Anoka

Sandplain have never been cultivated because of their infertile soils and steep topography. This has allowed them to maintain some of their native vegetation, although large areas were planted with pines following the droughts of the 1930s (Wovcha 1995:13). The Anoka Sandplains appeared very similar to the sand barrens of Wisconsin in 1922. When mentioning the terraces of the lower Wisconsin River at this time, Paul MacClintock stated: "Its similarity to the St. Croix outlet of [glacial] Lake Duluth is noticeable. This latter is also a broad sandy plain with dunes and blowholes upon its surface" (MacClintock 1922:NP). The Anoka Sandplains demonstrate that intensive agriculture may not be a necessary prerequisite to sand barrens creation. Environmental and climatic conditions were enough to create sand barrens on the St. Croix River outwash plains.

Fire is the other crucial element that had a large influence on the vegetation composition of sand barrens before European settlement. Prairies, savannas, and barrens were all maintained by frequent fires. Some of these were no doubt caused by lightning, but Curtis (1959:461) emphasizes the importance of Native American lit fires which must have greatly influenced the distribution of plants during the entire postglacial period. Fire restricts tree growth and prevents the development of closed-canopy forest. However, the frequency and intensity of fires varies geographically because of the influence of topographic features and climate. This, as well as other disturbances, cause a patchy mix of different plant communities, especially in savanna regions like South-West Wisconsin (Anderson, Fralish, and Baskin 1999:142). Patchy environments are thought to be essential in maintaining biological diversity (Pickett and White 1986:72).

After European settlement fires were much less common, primarily because of the removal of Native Americans from their lands. The remaining fires were suppressed both directly and as a consequence of fragmentation of land and fire breaks caused by development and roads (Curtis 1959:464). This resulted in invasion of trees and conversion of open areas to woodland. Associated with this is the loss of the shade-intolerant grassland species because of the newly closed canopy. However, the sand barrens may have been a little less effected by this because of their extreme conditions. According to a study of degraded oak savanna remnants, unlike black-soil savannas, sand savannas are much slower to close in the absence of fire and invasion of exotic species is less common (Apfelbaum and Haney 1988).

Of course the other major impact of settlement has been the conversion of nearly all prairie, savanna, and barrens land to agriculture. No other ecosystem was more impacted. In Wisconsin these communities have been reduced to less than one percent of their original area (Anderson, Fralish, and Baskin 1999:137). Today, the scattered remnants that remain are mostly either land that was already so infertile at the time of settlement that it was never plowed, or areas that were so marginal that agriculture was abandoned after plowing had further degraded it. Once the prairie sod was broken, erosion by wind and water of the exposed soil was rapid (Cochrane 2000:26). One aim of our research is to examine these post-settlement impacts on our study sites and look at how they have shaped the current conditions.

## METHODS

There are several ways we are obtaining historical information on each of our study sites. The earliest data is from the original General Land Office surveys of Wisconsin made during the 1830s and 1840s. These records are often used to reconstruct presettlement vegetation. Plat maps were drawn for each township, and written descriptions of the landscape, including types and diameter of trees present, are given for each section within the township. A fairly good idea of the vegetation composition and structure for each of our sites before agricultural use can be attained from this source.

Other early plat maps made after the original surveys are also useful, although these maps typically don't offer as much information on land cover. Most were created only to show land ownership; however this is useful because it tells us when these pieces of land were first bought from the government and likely put into agriculture. It also reveals when this was relative to the surrounding area, which can be used as a proxy for relative fertility of land because the most fertile land was presumably settled first.

More recent information on land cover is obtained from other sources. Aerial photos provide a visual means of comparing vegetation structure through time. In particular, aerial photos allow us examine horizontal distributions of plants and compare the area of exposed sand at each site over time. Another visual data source is provided by photos taken at one of our sites by the UW-Madison plant ecologist Virginia Kline in the 1970s. By comparing her photos to our own at the same location, we can see change in vegetation and dune extent.

Finally, we are looking through files at the Wisconsin Department of Natural Resources on each of the sites. This data is valuable because it provides information on

management of the areas since they were purchased by the State. This, combined with the data obtained from the other sources, will allow us to find historical and physical similarities and differences among the sand barrens that help explain their creation and how they respond to changes in land use.

## RESULTS

Our study sites are five properties designated as State Natural Areas (SNAs) by the Wisconsin Department of Natural Resources. The goal of the SNA program is to protect remaining examples of Wisconsin's native biological communities. Most of our SNA sites contain several types of communities, but what they have in common are areas of sand barrens vegetation and open sand. They are the best examples of this landscape in the Lower Wisconsin River Valley. We were able to create a map which includes these five sites (see appendix A). For each study site we give a brief description of the SNA's location and current features before presenting our findings from plat maps, other historical documents, and DNR files. We then discuss our aerial and still photography research findings for each site.

### 1. Blue River Sand Barrens

Blue River Sand Barrens (BRSB) offers the best example of sand barrens in the region. The site is on an elevated, well drained sand terrace of the Wisconsin River. This terrace is situated between a lower, wetter floodplain terrace next to the Wisconsin River to the north, and the Blue River at the base of bluffs to the south. It is approximately 2 miles east of the Town of Blue River and 4 miles west of Muscoda. This 160 acre site

includes: flat sandy areas resembling dry prairie with many prickly pear cacti; actively moving sand dunes and blowouts with false heather, mosses, and lichens; and old dunes that have been stabilized by scattered black and hill's oak. BRSB borders a bottomland forest to the north, cultivated fields on its south side, and pine plantations to the east and west. It is about 3,300 feet from the main channel of the river.

The Wisconsin Public Land Survey Records: Original Survey Notes and Plat Maps are a valuable source of information on land cover before the influence of European settlement (<http://digicoll.library.wisc.edu/SurveyNotes/>). The township containing BRSB was first surveyed in 1833. The interior field notes were particularly useful because they give brief descriptions of the soil quality and vegetation for each section boundary. The notes for the east and south border of BRSB read as follows: "Land level + poor, Timber oak." Notes for other sections on the terrace refer to the area as the English Prairie. Most of the soil descriptions for the prairie are "poor" with some "2<sup>nd</sup> rate" ones further east on the prairie near the current site of Muscoda. A couple of the other notes near the study site mention a "few scattering scrubby pine and oaks." These accounts do not show the pre-settlement conditions of the study site to be exceptional compared to the rest of the sand terrace. However, the field notes for the upland bluffs and bottomland forest in the area refer to the soil there as mostly "1<sup>st</sup> rate" or "good" and the tree cover is not described as thin or scattered as it is on the English Prairie. This demonstrates the rather stark differences between the sand terrace and its neighboring communities, as well as the impressions they made on the surveyors as to the fertility of the land.

Other plat maps and atlases made since the original surveys are also useful. (State Historical Society of Wisconsin 1924:72) has a plat of the township with farm ownership and statistics from 1860. It shows that the BRSB property was bought by L.G. Dimmock in 1855 but does not show number of acres cultivated as it does for other properties in the area. This name appears on little pieces of land all over the plat so he is probably a speculator and didn't cultivate the land. The atlas mentions that speculators bought up much of the land before settlers arrived. This 1924 atlas has other information about the early agriculture of the township which is interesting. It says "the sand prairie was practically worthless for agricultural purposes" and that the township "contained much waste land which never came into cultivation." It also states that from 1880 to 1885 there was a decline in the amount of "improved land" because the less productive land was already being taken out of cultivation. The only positive thing it had to say about the sand prairie was that watermelons were grown plentifully there, and that some rye and barley was grown for the local brewery (State Historical Society of Wisconsin 1924:74). This source reveals that if the BRSB site was ever cultivated, it was likely only for a short period of time.

Further evidence for this is provided by the 1938 Wisconsin Land Economic Inventory (<http://digital.library.wisc.edu/1711.dl/EcoNatRes.WILandInv>). This work of the Wisconsin State Planning Board is often referred to as the Bordner Survey because of its director John Bordner. The Muscoda plat classifies the BRSB property as "permanent pasture" with an island of "thinly scattered hardwoods" in the middle. Most of the surrounding land is classified as "cleared crop land" or "poor land previously cropped." If the study site had been cultivated it probably would have been labeled "poor land

previously cropped” and it would not have the only piece labeled “thinly scattered hardwoods” outside of the lower terrace forest. This is evidence that, unlike most of the English Prairie, the BRSB may have always been infertile enough that it was never plowed. However, it was still likely grazed. Interestingly, the Bordner Survey calls the classes “permanent pasture” and “poor land previously cropped” non-tillable land and recommends forest planting. Somehow BRSB was able to escape this fate, unlike much of the area including the properties to the east and west that are now thick pine forests.

In 1959 Curtis specifically mentions these jack pine forests near Muscoda: “These stands now occupy many square miles of land that were prairie at the time the first settlers arrived in the 1830’s. Injudicious plowing of these sand flats was quickly followed by wind movement of the sand and the production of sand dunes. The jack pines spread from a few isolated remnants to the new dune areas, where such spread continues.” He goes on to say that the flora beneath these stands is made up mainly of prairie and sand barrens plants (Curtis 1959:216).

A 1960 Grant County farm plat book shows the BRSB as part private and part public land (Rockford Map Publishers 1960). In 1968 it was owned by the WDNR and designated a SNA. At this time it was called The Blue River Cactus Dunes. A Grant County Natural Area Inventory in 1976 mentions other private sand barrens in the area, such as Burt’s Cactus Area (heavily grazed former sand prairie) and Nellie Krause Dunes near Muscoda (Smith 1976:11).

Bill Tans and Dick Vogt from the WDNR spent time in the Blue River Cactus Dunes in 1970 in order to examine the area and the area’s wildlife more closely. At this

time, part of the Wisconsin river terrace consisted of blowouts, stabilized and unstabilized dunes, and sand barrens. The sand blows were still active. They found much evidence of turtle activity in the sand blows and sand road on the east and northeast edge of the area. They also found an abundant population of six-lined racerunners and declared it to be the best population that they had observed anywhere in the state. They mention other species that they saw or that they would expect to be in the area, but also emphasize the visible disturbances by motor bikes and dune buggies on the fields and on some of the dunes (Tans and Vogt 1970).

The use of motorized vehicles has been a continuous problem and threat to this sand barren since sometime before 1970. Tans and Vogt contended even in 1970 that, “something must be done to curb their use here, it being detrimental to the turtles and the overall aesthetics of the area” (Tans and Vogt 1970). This problem was once again reiterated in 2004 by Matt Zine, a WDNR field biologist, when he proclaimed that illegal ATV and off-road motorcycle use was causing significant damage to rare species at the BRSB (Preusser 2004). The WDNR has formally identified facility-related problems in the area to be illegal off-road vehicle use, littering, and vandalism (DNR Staff 1).

Another type of problem that has been identified is problem species which include black oak, black cherry, elm, lilac, and pine seedlings. The plant species that are of concern and that the WDNR is trying to protect in the BRSB are the prairie fame flower and poppy mallow. Animal species of concern include Blanding’s turtle, grasshopper sparrow, lark sparrow, bobolink, vesper sparrow, field sparrow, and western meadowlark. Current management of the area includes prescribed burnings and the removal of weedy

trees by hand cutting (DNR Staff 1).

## 2. Spring Green Preserve

The Spring Green Preserve (SGP) is located about 1.5 miles north of the town of Spring Green in Sauk County. It is divided between two pieces of land which together are just over 1,000 acres in area. Situated on the north edge of the Wisconsin River Valley, SGP features several limestone bluffs with steep south-facing slopes containing dry limy prairie. The south side of the bluffs level out into a sand prairie/barrens with several blowouts. This sand barrens area is roughly two miles from the Wisconsin River and is part of the once 13,000 acre especially dry prairie historically referred to as the “Wisconsin Desert” (Lange 1990). SGP is owned by The Nature Conservancy and was designated a SNA in 1972. The sand barrens here provide habitat for 3 lizard species (six-lined racerunner, five-lined skink, and glass lizard) and several species of snake. Also, box turtles (Wisconsin’s only terrestrial turtle) use the blowouts for nesting (Meyer 2003).

The original survey of this township was not completed until 1842. The plat map from this survey shows the SGP area as being in the north-east corner of a large prairie. The line signifying the border between prairie and forest runs north-south through the eastern part of the current SGP property. Just west of this line, close to where blowouts exist today, are three faint circles on the map. These marks are not found anywhere else on the map. We were not able to find out what they signify. It could be sand, or it could just represent a grove of trees that was drawn a little differently from other groves on the

plat. The field notes don't mention it, but they do say: "land south of bluff dry rolling sandy prairie 2<sup>nd</sup> rate."

An 1861 Sauk County atlas has a plat of the area showing buildings but not land ownership. There are no buildings in the SGP area, but several buildings elsewhere in what it calls the Spring Green Prairie. In its general description of the county it mentions that this area has poor, sandy soil but that this could be changed because of the availability of manure and because it is now "owned in small tracts". It also mentions the presence of green lizards, rattlesnakes, and blue racers (Canfield 1861). An 1877 plat shows the SGP property as part private and part County land at a time when the rest of the township is private. These plats suggests that the SGP corner of the prairie may have been less fertile than other parts of the prairie because it was settled much later. An 1878 plat mentions that the sandy soils of the county were already becoming "quickly exhausted" (Snyder, VanVechten and Co. 1878). This is probably why MacClintock (1922) states that "Considerable dune areas are found in the neighborhood of Lone Rock and Spring Green. In fact, the whole terrace is so sandy and so poor as farm land that it is called locally 'Barrens.'"

Similar to the Blue River Sand Barrens, The Bordner Survey in 1938 labels most of SGP as "permanent pasture," while the majority of the rest of the prairie is classified as "cleared crop land" and "poor land previously cropped." Like the Blue River site, this implies that the SGP site was always especially infertile. Also present on the Bordner plat are clumps of small diameter oak and jack pine. This is a change from earlier accounts of the prairie, which emphasize how open it was. This is no doubt due to

suppression of fire after settlement. The invasive most important to the SGP today is red cedar. Lange mentions that photos taken in the early 1900s show the south-facing bluffs to be open, whereas more recently red cedars began to encroach due to their tolerance for xeric conditions and fire exclusion (Lange 1990).

The species that have been identified as problem species in addition to red cedar include mainly sweet clovers but also black locust, Siberian elm, red pines, Norway spruce, quackgrass, bromes, and Kentucky bluegrass. The plant species of concern that should be protected are rough white lettuce, Hill's thistle, woody milkweed, prairie fame flower, pomme-de-prairie, poppy mallow, prairie dandelion, pale beardtongue, and Richardson's sedge. The animal species of concern include the ornate box turtle, grasshopper sparrow, lark sparrow, and bull snake (DNR Staff 2).

The management objectives of the WDNR are to preserve and protect the natural ecological values of the Spring Green Preserve by eliminating or severely reducing the populations of invasive exotic species. They are also reestablishing natural disturbance patterns to restore disturbed areas to native vegetation and want to limit uses of the area to those that are compatible with ecosystem preservation. As far as specific management practices, they are currently burning the area on a scheduled rotation, removing sweet clover by hand pulling, and cutting and burning large red cedars in winters with snow cover. They are also cutting down oak trees that are taller than 8 feet, but leaving 8 to 10 oak grubs per acre in critical ornate box turtle habitats like this one (DNR Staff 2).

### 3. Arena Pines and Sand Barrens

Arena Pines and Sand Barrens (APSB) provides a good example of sand barrens vegetated with jack pines. It is an 80 acre piece of land a mile north-west of the town of Arena and about 1,500 feet south of the main channel of the Wisconsin River. Like the other study sites, it is located on a dry sand terrace and shares many of the sand barrens species such as false heather, little blue-stem, and June grass. It is also the home to the only population of button-weed in the state. APSB was designated a SNA in 1991.

The original survey was done here in 1833. The field notes say: “land level and 2<sup>nd</sup> rate, thinly timbered with Black Oak.” The plat map does not show anything special except for the original location of the town of Arena before it was moved a mile to the south to be next to the new railroad. It is the only town we came across on these original plats. Incidentally, we discovered that the word Arena is Latin meaning “sandy place.”

Just as with the other study sites, the APSB appears to have been among the last properties to be bought in the area. On an 1870 plat of the township a ¼ section of it is the only piece of land without a name on it. Instead, it is just labeled as “x” (Wrigglesworth 1870). An 1878 county atlas mentions that Arena was the center of a large wheat country. It also mentions that land was considered abundant and labor was scarce so “good cultivation of the soil never thought of and land was planted successively to one crop” (Snyder, VanVechten and Co. 1878).

The Bordner Survey in 1938 shows the site as “cleared crop land,” with an area of 6-9 inch diameter jack pines in the middle. In the years since, this jack pine stand has slowly taken over the whole property, and adjoining properties were planted into pine plantations. An Iowa County Natural Area Inventory in 1976 mentions that, due to

unsuccessful agricultural attempts on the higher sand terraces, much of the land was planted with pine plantations as the Bordner Survey recommended. This Wisconsin DNR Inventory also mentions that irrigation was assuming an increasingly important role in the LWRV and that it posed a threat to the Pine Road Sand Blows (original name of APSB) and a couple other sand barrens that are still private (Jaunzems 1976:5).

According to an internal DNR Natural Area report from 1996, current management is focused on “reestablishing the barrens community functions.” This means cutting all red pine and red cedar, as well as thinning jack pines to 8-15 trees per acre. There were also recommendations to increase the size of the SNA to allow for burning, but this has not happened yet (DNR Staff 3).

#### 4. Gotham Jack Pine Barrens

Gotham Jack Pine Barrens (GJPB) is located on the north bank of the Wisconsin River, approximately three miles north-west of the town of Lone Rock. Its 353 acres contains a number of vegetation communities including: jack pine barrens, sand prairie, sand barrens, oak barrens, floodplain forest, oxbow lake, wet sand meadow, and pine plantation. The sand barrens make up between 10 and 20 acres and are roughly 1,500 feet from the rivers edge. GJPB was designated a SNA in 1994.

The original survey for this township was done in 1842. The plat shows most of the site within a small prairie surrounded by pine groves. The field notes for the section boundary nearest the site of the current sand barrens reads: “Land gently rolling, Sandy +

3<sup>rd</sup> rate, Pine + Bur Oak.” This is common for the whole area here between the river and the bluffs to the north. A few entries say “very sandy and poor.”

An 1874 plat shows the GJPB as State land, while nearly all of the rest of the township is private (Harrison and Warner 1874). An 1878 county atlas mentions that places in the valley here are “too sandy to be valuable.” Amusingly, it also states: “some diluvial soils and sands are known to produce malarial fevers” (Snyder, VanVechten and Co. 1878). By 1895 the entire township is private land and the GJPB property is part of Stout Wood Stock Farm (Hood 1895). This indicates that it was probably heavily grazed at that time. A 1903 plat is very similar to the 1895 one except for a 40 acre plot in the site that is covered with dots, possibly indicating sand but not labeled (Richland Rustic 1903). The study site on the Bordner Survey plat is a mosaic of classifications including: jack pine, open, cleared crop land, pasture, permanent pasture, and the only sand classifications we found on any of the plats (not counting river sand bars).

More recent documents provide information more specific to sand prairie/barrens. An inventory of the natural areas of Richland County from 1970 stated that the agriculturally useless sand flats between Lone Rock and Gotham account for most of the 150 acres (.2% of original) of sand prairie left in the county. It says that in addition to the scattered patches that have not been planted to pine, the rights of way along the railroad provide refuge for many sand prairie plants. Active sand dunes were more common in the area around the early 1900’s. But like the Arena and Blue River areas, most were stabilized since the 1930s by planting red or white pines, or through invasion by jack pine (Nee 1970:11). Now, however, DNR management objectives are

to reverse this by thinning and reestablishing regular fire in an effort to save the barrens community in GJPB (DNR Staff 4).

## 5. Woodman Lake Sand Prairie

Woodman Lake Sand Prairie (WLSP) has both deep marsh wetland on a lower terrace and sand barrens on a higher, dry terrace. The boundary between the two is extremely sudden. In some places the vegetation shifts from wetlands dominated by sedges to blowouts within a few feet. This shows the very different effects of just a few feet of elevation difference between the Wisconsin River sand terraces. This SNA is directly north of the town of Woodman and about four miles south-west of Boscobel. The edge of the sand barrens is approximately 2,000 feet south of the Wisconsin River. WLSP was designated a SNA in 1991.

We were not able to find as much information on this study site as the others. This may be because the upper terrace is very small in this part of the valley. The original survey in 1833 gives very little information because nearly the entire terrace lies within one section. It only refers to the wetlands as “bayou” and mentions some thinly scattered oak to the south. In a familiar trend, an 1868 plat has owner names on almost every piece of land, including the 40 acre plots next to the Wisconsin River in the WLSP property. However, the rest of the WLSP property is blank (Gray and Pattengill 1868). By 1903 this section is private to (Fennimore Times 1903). The 1938 Bordner Survey labels the upper terrace as “poor land previously cropped.” In 1976 a Grant County Natural Area Inventory mentions that this site and The Blue River Cactus Dunes (Blue

River Sand Barrens) are the best examples of sand prairies left in the county (Smith 1976).

The WDNR visited and made notes about this area three separate times over the years. In 1975, it was said to be a sand prairie with two large dunes and a few smaller ones. There were also two large sand blowouts. They also noted the dramatic difference as the wetland graded rapidly into a sand blowout all within a few feet. The area has not dramatically changed over the years. In 1984, the dominant ground cover was primarily species common to formerly disturbed sandy areas. Lichens and mosses were still abundant. They did note that some of the sand blowouts were being stabilized by false heather and rock spikemoss. The observations from 1992 do not provide much more information, though they do mention that the area had a large poppy mallow population (DNR Staff 5).

Management objectives these days are to preserve and protect the natural ecological values by preventing the establishment of invasive exotic species, reducing the impacts of vehicular use, and re-establishing pre-settlement processes. Problem species include red cedar and spruce, which are being found along the prairie periphery. These are to be cut and burned. The only species of concern is the poppy mallow, which is a change since 1992 when the DNR noted the large poppy mallow population. No specific management is required at this time for the poppy mallow. Specific management practices include conducting scheduled burns of the sand prairie (DNR Staff 6).

These historical records illustrate some similarities between our five study sites. The original field notes and plat maps of the Wisconsin Public Land Survey Records

show that these areas, with the exception of Woodman Lake Sand Prairie, were all considered sandy and infertile before European settlement. These records also show that tree cover was much thinner, yet more diverse, at that time. The ownership plats show that, for the most part, our study sites were some of the last lands to be settled. This indicates that these specific properties were especially infertile even before agriculture. More recent documents illustrate that most of our study sites are experiencing problems of encroaching invasive trees. The most popular method to deal with these invasive trees is burning.

### Aerial Photography

A main focus of our research was to examine how the sand barrens have changed over time. To do this, we looked at aerial photographs of four of the five sites from different time periods and observed many changes in their appearance. The key differences we saw were changes in overall size and plant cover. This is obvious in the Arena Pines site, which was comprised of many open sands in 1962 (Appendix B - image 4-c), but today is completely covered by vegetation (Appendix B - image 4-a).

From our research, we were able to make certain hypotheses as to why these barrens are changing over time. From the aerial photographs, we saw evidence that human interference has caused many of these changes. At the Gotham site, it appears that direct planting of trees has led to the disappearance of barrens there (Appendix B - images 3-a, 3-b, and 3-c), and at the Spring Green site it is evident that nearby farming/soil fertilization has had an impact on the size of barrens in the area (Appendix B - images 2-a, 2-b, and 2-c).

## Repeat Photography

In the late 1970s Ms. Virginia Kline, an ecologist at the University of Wisconsin, took a series of photos detailing the landscape and wildlife of the sand barrens in Southwestern Wisconsin. Her pictures clearly show the unique plants and animals that reside in the barrens. Photos include: prickly pear cactus, bull snakes, six striped runner lizards, and various types of fungus, lichen, and vegetation. In March 2009 we traveled to the Blue River Sand Barren and the Spring Green Preserve to see if we could replicate some of Kline's photos, and to see if there were any major visible changes to the landscape that we could document.

We found a very similar scene to the one portrayed in Kline's pictures (Appendix C - photos A, B and J, K). Every plant and fungus that she identified we were also able to find and identify. Including: the prickly pear cactus (Appendix C - photos H, I), British soldier lichen (Appendix C - photos D, E), and the earth star (Appendix C - photos A, B, C). The biggest difference that we found was simply a difference in seasons. Kline visited these areas in the early summer when everything was green and bright and we visited right at the beginning of spring so few things had started to grow. Also, we saw almost no wildlife because it had not yet emerged from its winter hibernation. Even without the replication of the wildlife shots we were able to prove that very little has changed in the landscape of these sand barrens since the time Virginia Kline took her photos.

## CONCLUSION

In examining these five sand barren sites, we were able to create a more comprehensive history and description of each of them than has been done before. We discovered that their creation had more to do with natural processes and less to do with extensive farming and grazing, which is contrary to what we initially thought. Even in the mid 1800s, there were already desert-oriented species present in some of the sand barrens areas, such as lizards. Over the years, humans have had a greater impact in decreasing the size of the sand barrens than they had on the creation of the sand barrens. With the use of excessive fertilizers and water in the surrounding areas, more plants have been able to grow and have started to encroach on the sand barrens. The use of ATVs and other motorized vehicles are also negatively affecting the sand barrens. While their sizes may be shrinking, they do still exist and have become a valued ecosystem in lower Wisconsin. The wildlife may vary slightly from site to site, but overall these five sites have a lot more similarities than differences.

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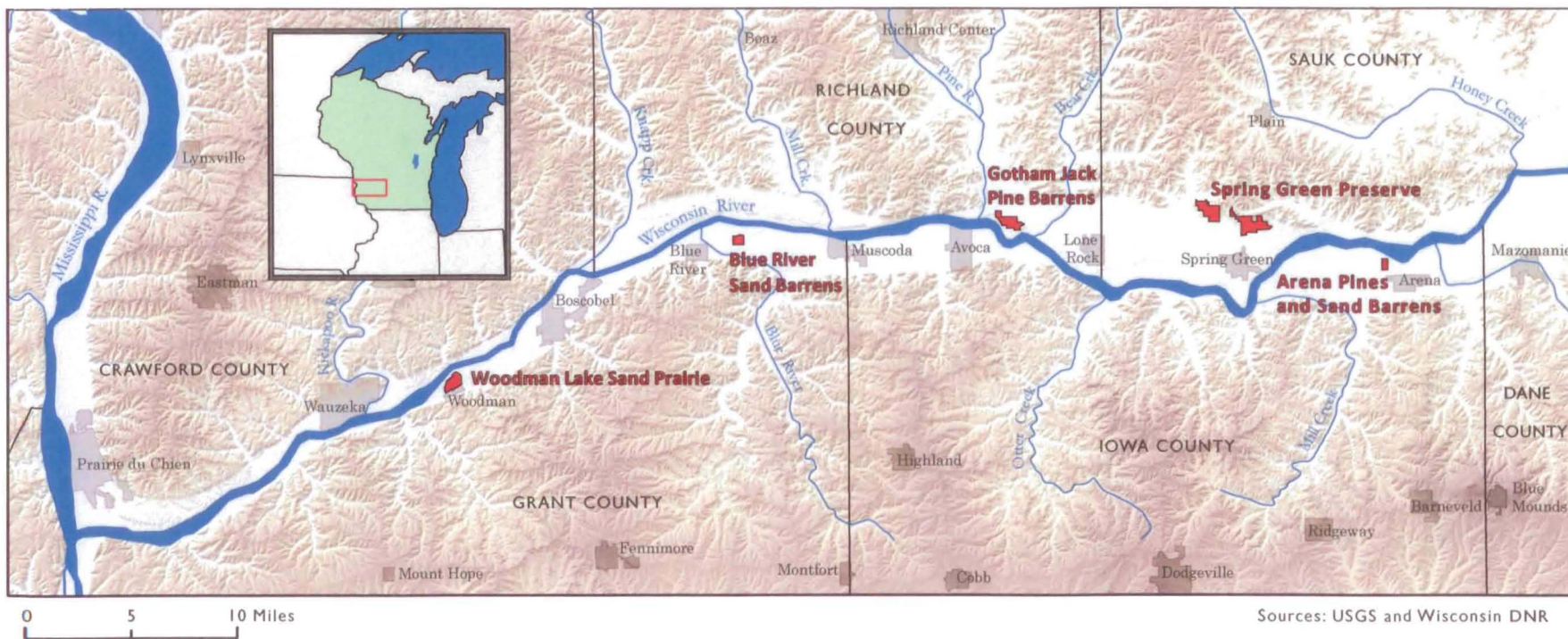
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## Sand Barrens Study Sites



Sources: USGS and Wisconsin DNR

# Blue River Sand Barrens



IMAGE 1-b



IMAGE 1-c



IMAGE 1-d



Blue River - In 1940, little plant growth and the existence of barrens outside of protected area evident. Gradually more vegetation cover throughout (especially outside highlighted area).

# Spring Green State Natural Area

IMAGE 2-a



IMAGE 2-b



Spring Green - Images show sand barrens shrinking in size since 1949. Barrens throughout area also show evidence of new plant cover.



IMAGE 2-c

Photos: Robinson Map Library, Madison, WI

# Gotham Jack Pine Barrens

IMAGE 3-a

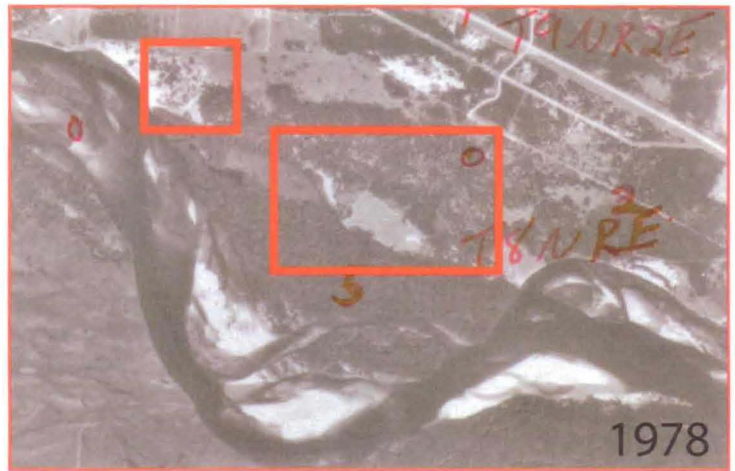


IMAGE 3-b

Gotham - Area with most change is in the north-west. Large amounts of open sands have been almost completely covered by tree growth.

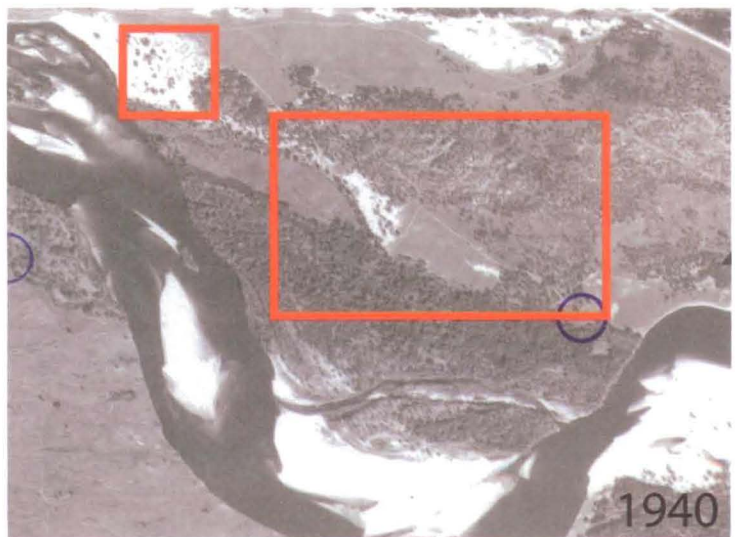


IMAGE 3-c

Photos: Robinson Map Library, Madison, WI

# Arena Pines and Sand Barrens

IMAGE 4-a



IMAGE 4-b



IMAGE 4-c



Arena Pines - In 1962, area had much less tree cover. Gradually more plant growth shown in 1976, and area almost completely covered by 2005.

## Appendix C

All pictures are from Lamb 2009 unless otherwise noted.

### Earth Star



A. Kline 1979



B.



C.

British Soldier Lichen with Five Lined Skink



D. Kline 1975



E.

Blue River Barrens, open sand and blowout.



F. Kline 1979



G.

Prickly Pear Cactus



H. Prickly Pear Cactus in Bloom, Kline 1960



I.

Active movement in the sand

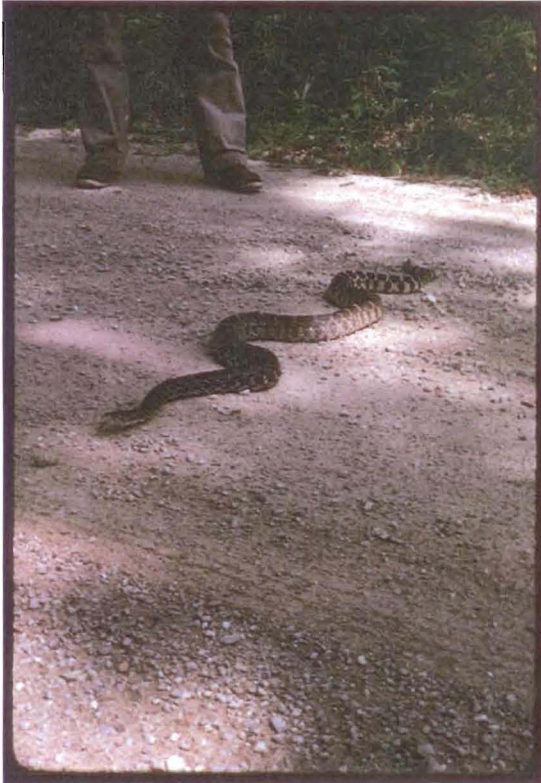


J. Kline 1979



K.

Animal Life



L. Bullsanke, Kline 1979



M. Blue Racer, Kline 1976



N. Orate Box Turtle, Kline 1974

Blue River Moving Duns



O.



P.

Spring Green Barrens



Q. Courtesy of Milwaukee Public Museum 1927



R.