Fig. 8. Survey point from 1845 in zone 17, 2012 aerial.

Another piece of evidence is the extra care that must be taken to prevent damage to trees with red-cockaded woodpecker nest cavities when applying prescribed fire. This woodpecker excavates nest cavities in living pines infected with a type of fungus that softens the heartwood. The tree responds by sealing the wound with sap, which protects the nest from climbing snakes. The sap can catch fire so inhabited trees are often mowed around to keep fire potential low. It is difficult to reconcile this bird's life history with the dense stands of pines we have today. It is much easier to understand these birds successfully breeding in the context of flatwoods with an open canopy and light understory consisting of a mix of grasses, forbs, herbaceous plants and woody shrubs, including palmetto.

The Future: An important aspect of land management for SPSP is restoration of the vegetation community that gave the park its name — open, grassy savanna-like flatwoods. This landscape was formed by frequent low-intensity lightning season fires; the use of prescribed fire is essential to restore and maintain the community type in its natural state. This fact is reflected in the "Goals and Objectives" section of the park's unit management plan: "*Implement prescribed burning as a tool to enhance fire-dependent native plant communities and to prevent damaging wildfires from occurring.*"[2] I would not argue the point that heavy tree mortality following the reintroduction of fire to a long unburned area can look shocking at first sight. However, it is important to see this as an important step in restoring the ecosystem to its more natural state, with lower pine density — a *savanna*. The plant species diversity of the understory will increase and the habitat will support more animals of all types.

Fig. 9. Scrubby flatwoods on Kennedy Space Center that illustrates the open canopy aspect of restored flatwoods.

Remember, in their natural condition — their greatest ecological value — flatwoods are not forests. They are grasslands with low densities of pines.[3]

Literature Cited/Suggested Reading:

1 Bridges, E. L. 2006. Landscape ecology of Florida dry prairie in the Kissimmee River region *in* R. Noss ed. *Land of fire and water: proceedings of the Florida Dry Prairie Conference. University of Central Florida, Painter, DeLeon Springs, Florida*, Pg. 14–42

2 Florida Division of Recreation and Parks. 2003. Savannas Preserve State Park: Unit Management Plan. Source: `http://rickinbham.tripod.com/TownOfSIRD/SavannasPreserveStatePark.pdf`

3 Noss, R. 2013. *Forgotten grasslands of the south: Natural history and conservation.* Island Press, Washington DC.

Florida Natural Areas Inventory. 2011. textitAtlas of Florida's natural heritage. FSU, Tallahassee, Fl.

The Reintroduction of Fire into Pine Flatwoods in Florida: Fewer Trees

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Introduction: Much of the peninsula of Florida comprises broad expanses of nearly level land inhabited by stands of pines with an understory principally composed of palmetto. These broad, level plant communities are called *pine flatwoods*. We must remember to insert a mental asterisk when we use the term pine flatwoods (hereafter "flatwoods") to describe this ecosystem today. Present flatwoods bear only a superficial resemblance to historic flatwoods. The differences between pre-settlement pine flatwoods and our current flatwoods, how we know about these differences, and the role of fire in restoring this ecosystem are the subject of this handout.

Pine Flatwoods Today: Unfortunately few "old growth" flatwoods remain in Florida; the stands of pines and palmettos you see along highways are not natural. Logging, invasive exotic species, and decades of fire suppression have changed which species we see, as well as the density and age distribution of trees. For the most part our flatwoods today are what ecologists refer to as an *even-aged stand*. This means the trees are all much the same age and height, which can be an artifact of planting or recruitment following clear-cutting. We know that there are too many trees in remaining flatwoods and the understory of palmetto is too dense.

Fig. 1. Typical pine flatwoods. Note unnaturally dense, uniform height (even-aged structure).

How We Know: If the majority of flatwoods that we see is not representative of this ecosystem in its pre-settlement form, how do we know what it should look like? One obvious source is historical literature, which paints a picture of flatwoods as open and savanna-like, with a grass/shrub understory. These accounts describe flatwoods as being so open that a wagon could follow a straight path and not have to go around too many trees. But this is a general description and we would like a way to look back at the specific area that is now the Savannas Preserve State Park (SPSP). We begin with historical aerial imagery.

The website `http://data.labins.org/` is a portal to a depository of land data, current and historical. Using geographic information system (GIS) software historical imagery can be *georeferenced* against newer imagery. In the image below I used 2012 imagery and drew a red line (called a polygon) around recently-burned SPSP zone 17. It is important to note that this polygon line is not simply drawn on a picture, it is *georeferenced*, meaning it is associated with a spatial location on earth's surface. We can use this line to extract the same area in older aerial imagery that has also been georeferenced.

Fig. 2. GIS map of SPSP burn zone 17. Imagery date: 2012.

I used the polygon to clip part of the 1944 image that will align properly with any georeferenced image of the zone (see Figure 3). It should be obvious that there were far fewer trees in zone 17 in 1944. But we would like a quantitative approach to comparing historical tree density to current conditions.

Fig. 3. GIS map of SPSP burn zone 17 from 1944.

One quantitative approach is to use GIS software to distribute 100 points randomly within the boundaries of the zone 17 polygon. For clarity in the handout the points are solid; in the GIS they are small open circles. I determined if the circles intersected a tree, which are easily seen by the shadows they cast.

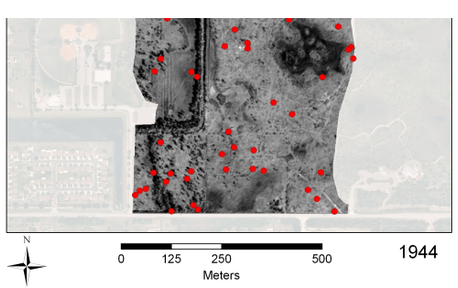

Fig. 4. Section of GIS map of SPSP burn zone 17 with sampling points on 1944 imagery.

The procedure was repeated for years 1944, 1958, 1970, 1999, and 2012. The resulting counts yield the percent cover for trees, presented in Table 1.

Table 1. Percent cover of trees for SPSP zone 17.

Year	1944	1958	1970	1999	2012
% Cover	21	20	35	48	40

A larger sample of points and a statistical accounting for uncertainty would be needed for publication, but this exercise serves to illustrate one way ecologists reconstruct past ecosystems. Of course, this does not tell us *why* there was approximately twice the coverage of trees in zone 17 in 2012 compared to 1944. To answer that question we need to understand the natural processes that shape pine flatwoods.

The prevalence of pines in the south-east U.S. is something of a paradox — pines are adapted to cold, dry climates. But pines are also adapted to low-intensity growing season wildfires that were historically sparked every few years by lightning. This natural disturbance selected for open pine stands with an understory of grasses, forbs, and woody shrubs. Development caused wildfires to be suppressed by man-made firebreaks such as roads and pastures. Fires in wildlands were put out. This began to change the species composition of flatwoods, allowing oaks and other hardwoods to invade in some areas, and increasing density of pines in others.

Could the area of zone 17 have been logged, and increasing pine density just recovery after clear-cutting? This is a valid question. Fortunately we have other evidence to turn to for an answer: The public land survey (1845).[1] Florida was surveyed by square *townships* 6 miles on each side. Townships are subdivided into 36 square *sections*. At each section and quarter section corner the surveyors were instructed to document the species, direction, and distance to the nearest tree, known as a *witness tree*. We have access to their field notes and can use them for rough estimates for pine densities.

These surveys were done in unfamiliar units of chains (66 ft.) and complicated statistics must be used to convert these data into pine density. The point is to illustrate a method used by ecologists to reconstruct pre-development ecosystems. Historical accounts, aerial imagery, and land surveys are all useful to give us an idea of the natural community structure for flatwoods.

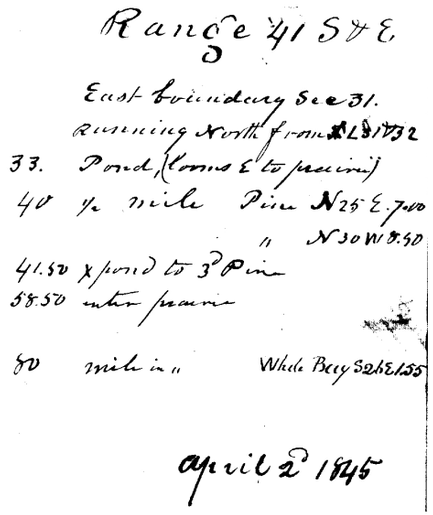

Fig. 5. Scan of field notes for zone 17, Florida land survey, 1845. Source: (`http://data.labins.org/2003/SurveyData/LandRecords/landrecords.cfm`)

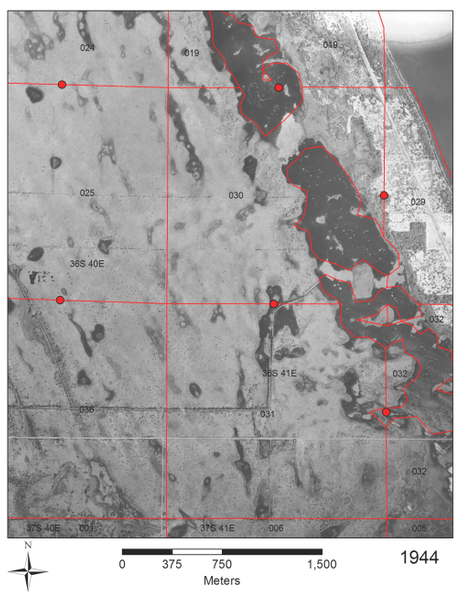

Fig. 6. Section of GIS map of SPSP burn zone 17 with zone layer inset from 1944 and sampling points.

In the figure above I used a GIS survey layer to place six points near zone 17 that correspond to surveyor field notes. I then averaged the distances to the nearest tree from each point, which is 292 ft. This is just a "ballpark" figure for illustrative purposes. Publishable data would require much more work, but the difference between 1845 and 2012 is so great that any measure of uncertainty in the estimation of tree density is dwarfed by the difference.

Next, using the GIS I drew a buffer circle with a radius of 292 ft. around a survey point in zone 17, which is shown in figure 8. If we were able to visit this spot in 1845 we would see one adult pine within this circle. This 1944 imagery shows a few pine shadows, perhaps three or four — no great change. The real shock comes from viewing figure 8 on the next page, which shows 75 to 100 pines in the same area in 2012.

There are ecological characteristics of the flatwoods community itself that also tell us what we have now is not natural. For example, much of the pine mortality resulting from prescribed fire is thought to be caused by the ignition of the *duff layer*, a buildup of organic matter on the ground surface. When the duff layer catches fire it tends to damage the roots, killing the trees. Historically frequent fires prevented this accumulation of flammable organic matter.

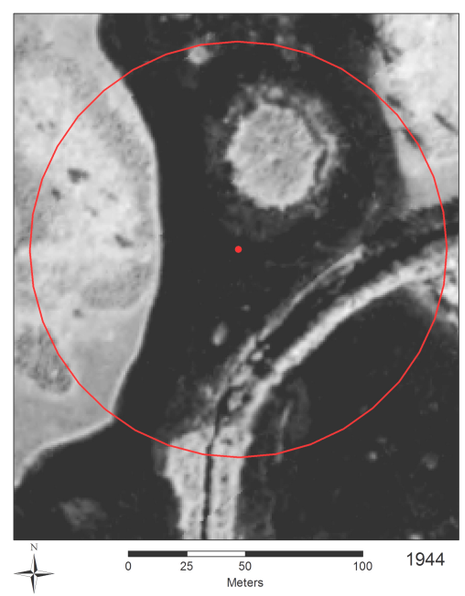

Fig. 7. Survey point from 1845 in zone 17, 1944 aerial.