China/US Fire Management Study Tour

(Summary Report)

Northeast United States

April 18th-26th 2009

Report prepared by Darren Johnson, The Nature Conservancy

Table of Contents

Table of Figures

Fire Management Study Tour Overview

Background

Fire is increasingly being used by natural resource managers as a tool for restoration and management of fire dependant pine/oak ecosystems in the northeastern United States. Fire dependant systems are ecosystems where fire is essential and the species have evolved adaptations to respond positively to fire and to facilitate fire's spread (vegetation that is fire prone and flammable). These systems are often referred to as fire-adapted or fire-maintained ecosystems. In the U.S., The Nature Conservancy (TNC) fire staff safely perform prescribed burns on about 100,000 acres per year, and support the planning and implementation of burns on hundreds of thousands of acres per year, in conjunction with partners. In the Northeast TNC and it's partners are applying fire in the form of prescribed burns to high conservation value pitch pine (*Pinus rigida*) and scrub oak (*Quercus ilicifolia*) ecosystems (pine barrens) of Maine, New Hampshire, Massachusetts and New York. Found only in scattered locations from New Jersey to Maine, pine barrens are characterized by sandy soils that are poor in nutrients and prone to drought. They have a long history of relatively frequent fire and harbor highly specialized plant and animal species, many of which are adapted to fire for their survival. In some areas pitch pine forms a dominant overstory that shades the ground, resulting in a fairly open understory. In other areas, dense thickets of scrub oak dominate and in others a mixture of pitch pine and scrub oak occurs.

Eight delegates from the China including representatives from the China State Forestry Administration (SFA) in Beijing, the Fire Prevention Office of Heilongjiang Province and TNC's China program travelled to the United States to take part in a week long study tour of TNC's northeastern fire management programs (Figure 1). Also joining the delegation from China were two representatives from the Food and Agriculture Organization of the United Nations (FAO) Forestry Department in Rome, Italy.

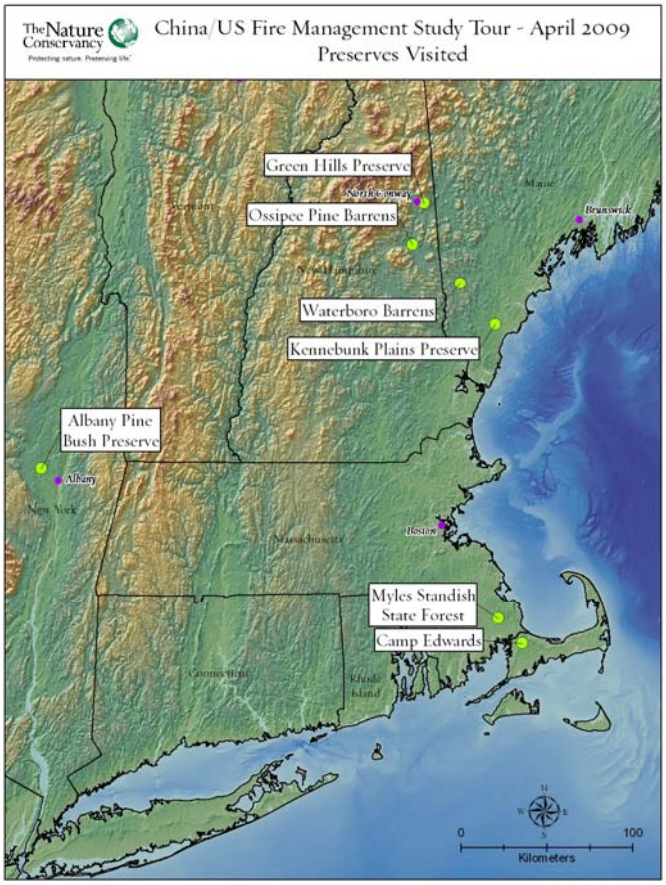

Figure 1: A map of the Northeast states including The Nature Conservancy preserves visited during the week long fire management study tour in Maine, Massachusetts, New Hampshire, and New York.

Objectives

The primary objectives of the study tour were as follows:

1. Provide on-the-ground examples of functional fire management programs on TNC preserves in New England to members of a delegation from China.

2. Provide examples of fire dependant vegetation that are not currently being managed with fire and discuss our assumptions about fire regimes in those systems.

3. Provide examples of programmatic challenges and successes in TNC's fire management programs, including community outreach and education.

4. Demonstrate the benefits of collaborative partnerships that include academia (fire ecology and fire regime), the private sector (funding and education), government

agencies (funding, training, implementation and policy) and other NGOs (training, education).

5. Provide opportunities for delegates to observe prescribed burns being conducted for the purposes of ecological restoration and maintenance.

6. Provide examples of burn units where post fire effects have met management/ecological objectives.

7. Discuss potential smoke management and fire effects monitoring approaches for use in China.

8. Demonstrate the use of 'high tech' fire planning tools such as GIS and fire behavior/smoke models.

Rationale

The Chinese have been using prescribed burning since the 1950's as a method to remove hazardous fuels. As such there exists considerable institutional knowledge and expertise in terms of 'putting fire on the ground'. However, with few exceptions prescribed fire is not used as a conservation management tool in China. Chinese fire management experts indicated an interest in learning more about the ecological role of fire in their forests and the potential for increasing the use of prescribed fire as a management tool. As a result a fire management study tour in the Northeast US was organized by TNC for several key fire management experts from China. The exchange of ideas and information resulting from visits to several of TNC's northeastern preserves where fire is being used as a conservation tool helped to: 1) facilitate enhanced cooperation between TNC and it's counterparts in China and; 2) lead to an improved understanding of the role of fire in conserving fire adapted ecosystems in the US and China.

Acknowledgements

The Nature Conservancy's Global Fire Team wishes to acknowledge the following organizations and individuals:

TNC China, TNC Maine Field Office, TNC Albany Pine Bush Preserve, TNC Massachusetts, TNC New Hampshire Field Office, The Food & Agriculture Organization of the United Nations (FAO), Lucy Guangzhi, Nancy Sferra, Parker Schuerman, Dan Grenier, Bob Bale, John Kelly, Kerry Crisely, Erik Martin, John Bailey, Mike Crawford, Mike Murphy, Paul Gregory, Jeff Lougee, Drew Barton, Craig Kostrzewski, Gabriel Chapin

Day 1 (April 20, 2009)

Myles Standish State Forest (14,000 acres):

Bob Bale – TNC Massachusetts Fire Manager
Paul Gregory – Massachusetts State Forester
Mike Crawford – TNC Burn Crew member

One of the Earth's two largest remaining pine barrens is found on and around the Myles Standish State Forest. This forest features a mosaic of pitch pine and scrub oak woodlands with embedded ponds that harbor rare species and help protect the quality fresh water resources critical in this rapidly developing area.

Fire History: (all fires were human caused)

- 1957 - 15,000 acre fire
- 1964 - 5,000 acre fire
- 1963 - 500 acre fire
- 1977 - 700 acre fire

The state of Massachusetts and The Nature Conservancy (TNC) are working in partnership to prevent another big wildfire in the state forest and surrounding area. The achievement of this objective is critical in that there currently exists a significant amount of Wildland Urban Interface (WUI) and an abundance of dead or decaying plant biomass available to burn. WUI is a term used to describe the area where structures and other human development meet or intermingle with undeveloped wildland. Two strategies are being employed to address these concerns: 1) thinning of overstory trees and; 2) prescribed burns designed to reduce hazardous fuel loads.

When planning for and implementing prescribed fire in the State Park TNC works closely with several key partners including the state and local municipality. The local fire chief in each municipality is responsible for issuing permits for prescribed burning in Massachusetts. In Massachusetts TNC will generally develop the prescribed burn plans, the state then approves the plan(s) and the local fire chief will then issue the appropriate permit.

Specific TNC conservation objectives when using fire in Miles Standish State Forest are: 1) to create and maintain habitat for a number of listed endangered species including 14 invertebrates, 1 plant and the Northern Red-Bellied Cooter (*Pseudemys rubriventris*) a native freshwater turtle; 2) maintain scrub oak understory in a shrub state (Figure 2). When scrub oak becomes too high it shades out the understory reducing species diversity. Scrub oak will grow to an average height of 15 ft if it is not burned periodically. Fire in such tall oaks can produce flame lengths of up to 60 ft. Mechanical treatment (lopping off the tops of the trees) is therefore necessary to reduce the tree heights and also fire intensity; 3) reduce fuel loadings and; 4) create canopy openings via thermal thinning of

overstory pine. To date 150 acres of the 14,000 State Forest has been treated using fire. There is a five year fire return interval on most of the pitch pine scrub oak sites.

Figure 2: Open canopy overstory of pitch pine (*Pinus rigida*) with an understory of shrub-like scrub oak (*Quercus ilicifolia*) in Myles Standish State Forest, Massachusetts. This habitat type is maintained by periodic burning.

Oak species present in the State Forest include white oak (*Quercus alba*), scarlet oak (*Quercus coccinea*), black oak (*Quercus velutina*), red oak (*Quercus rubra*) and scrub oak (*Quercus ilicifolia*). Pine species present are white (Pinus strobilus) and pitch (Pinus rigida). Pitch pine is considered a fire adapted species meaning that to a large extent it relies on the effects of fire to successfully regenerate and maintain it's niche. It has thick bark and dormant buds just beneath the bark on its stem which sprout producing epicormic branches after a fire allowing photosynthesis and cone production to continue (Figure 3). In addition pitch pine has serotinous cones which require extreme heat like that produced from fire to open. Serotiny of pitch pine is however variable depending on location or range. Some trees are completely serotinous while others exhibit mixed serotiny and some have cones that are not considered serotinous. It is thought that this is an adaptation to a variability in mean fire return interval within the range of this species. This species of pine is unusual in that it has the ability to re-sprout from its roots even if the tree is killed by fire. An additional benefit of fire is that leaves on scrub oaks re-sprouting after a fire event have an abundance of nutrients due to the ash deposits in the soil and are favored by a rare species of moth caterpillar.

Figure 3: Pitch pine (*Pinus rigida*) exhibiting sprouting from it's main stem. This is a response to fire allowing photosynthesis to continue even in the absence of the majority of canopy needles.

Mechanical treatment site at Myles Standish (38 acres):

Planted Norway spruce (*Picea abies*), Scotch pine (*Pinus sylvestris*) and red pine (*Pinus resinosa*) were removed from this site by mechanical harvesting. Excessively tall scrub oaks were also removed from the site using the same method. The harvested trees were chipped and sold as biofuel to a biomass facility located in New Hampshire. The objective was to restore the site to an open pitch pine scrub oak savannah and to then maintain that state using periodic prescribed fire.

Camp Edwards - Massachusetts Military Reservation (20,000 acres):

John Kelly – Natural Resource Manager

15,000 of the 20,000 acre military base are actively managed for ecological diversity. This includes coastal grasslands and the largest intact scrub oak barrens in the world (Figure 3).

Figure 4: Coastal grasslands on Camp Edwards military reservation, Massachusetts. The grasslands are maintained using prescribed fire at 3 to 5 year intervals.

Three principle reasons to use prescribed fire as a management tool:

- Public safety. There is quite a lot of urban development in the area resulting in significant WUI issues.
- The military requires a variety of vegetation structure and composition in order to conduct realistic training exercises.
- The preservation and maintenance of natural communities and creation of required habitat for endangered species such as the Whip-poor-will (*Caprimulgus vociferous*) a medium-sized (22–27 cm) nocturnal bird that requires an open mid-story in order to hunt for insects.

Camp Edwards has the largest diversity of endangered species in Massachusetts. Historically the use of munitions or explosive devices on the base created small fires resulting in a diversity of habitats critical for many species. Munitions are no longer used on the base and so a prescribed burning program was developed to mimic the disturbance regime created by the explosives and to maintain the ecological diversity on the site.

The military installation cooperates with federal, state and local government agencies as well as with TNC in the planning and execution of prescribed burning. State and Federal signatures are required on the Natural Resource Management plan. John Kelly a civilian and the Camp Edwards Natural Resource Manager is the point person for the base and coordinates management activities with various partners. There is a regional fire management co-operative agreement in place with all partners that allows for the sharing of resources between partners in the region when a prescribed burn is being planned or implemented.

There are 256 monitoring plots on the base each of which have a 10 year rotation. These plots are used to monitor ecosystem health, post fire effects and species populations.

Day 2 (April 21, 2009) - Albany Pine Bush Preserve (Albany, New York)

Craig Kostrzewski – TNC Fire Manager

The Albany Pine Bush is one of the best remaining examples of an inland pine barren environment in the world. It is home to a unique variety of rare plants and animals including the federally endangered Karner blue (*Lycaeides melissa samuelis*) butterfly. This particular habitat type burns regularly and as such many of the plants, insects and animals have specific adaptations that allow them to survive fires. Pitch Pine Scrub Oak barrens are the most volatile fuel type in the Northeast. Less than 10% of 25,000 acres remain in the state of New York. What does remain of this habitat type is degraded and fragmented. The Albany Pine Bush Preserve was established in 1988 to protect the habitat and is currently managed by TNC and other government partners.

Presentation #1 Fire Management in the Albany Pine Bush Preserve (Craig Kostrzewski):

The Albany Pine Bush Preserve is 3100 acres 100% WUI (the line or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetation). Burning here is very complex due to this interface issue (highways, shopping malls, residential development etc.) The Preserve is managed by the state's Albany Pine Bush Preserve Commission which includes 2 state government agencies (Parks and Recreation and the Department of Environmental Conservation), local government (county and town) and TNC. Lands are owned by members of the Commission and dedicated to the Preserve for management purposes.

Conservation objectives:

- Pine barren conservation
- Restoration of Karner blue butterfly habitat
- Restoration of 44 state and federal listed threatened species habitat

Fire is the primary restoration tool in achieving TNC's conservation objectives creating unique challenges in such densely populated urban area. A significant amount of development such as residential development and the construction of new highways has occurred since 1952. The Fire Management program started in 1991.

Additional overarching objectives for the fire program in the Pine Bush are fuel reduction/fuel management, hazard mitigation, ecological management (wildlife habitat (microclimates), control of competing species, and training (smoke management/fire behavior).

Fire history has been determined by historical records, local knowledge (folklore) and other examples from around the world. Historic fire regime is thought to be spring and fall (dormant season) and in July during extremely dry years. The vegetation typical of this habitat type was historically maintained via a combination of lightning and Native American burning. Highest risk months are April and May (after snow melt and prior to leaf flush). Dr. William Patterson, a fire ecologist from the University Massachusetts, suggests that during this period when the roots of the pine are still cold the tree is unable to provide adequate water to the needles. This results in a net loss of moisture via the needles into the atmosphere creating prime conditions for crown fire. For this and other reasons prescribed fire is usually implemented in the late spring, summer and fall. It was initially thought that dormant season fires would restore barrens habitat, reduce the stems/acre of scrub oak, reduce/eliminate litter and duff (ground fuels), restore lupine populations from seed bank and kill and remove black locust and aspen (native invasive species). Adaptive management techniques practiced by the Pine Bush fire staff has allowed for the timing of burns to be adjusted to best meet ecological objectives and public safety considerations.

From 1991-2002 the Pine Bush primarily conducted dormant season fires. The timing of these burns was based on historical data however fuel loads were too high resulting in excessive flame lengths and high intensity fire behavior. This type of fire usually top killed vegetation but left the root systems intact and alive resulting in an abundance of dead standing fuel in burn units.

In 2003 the Pine Bush adapted their approach and began mow and burn treatments in the spring using a hydro-ax which employs a mowing attachment on front (8' wide). The cut fuel (oak stems) was allowed to dry before being burned later in the summer (July, August and September). These months exhibit higher relative humidity resulting in reduced flame lengths but increased intensity. This modified approach achieved desired objectives of burning off organic litter and exposing mineral soil (sand) for improved pine regeneration. Post burning monitoring was conducted between 2004 and 2007 to determine if objectives are met using this particular treatment combination. The results indicate that the mow and burn treatment met most objectives except to kill the majority of the scrub oak.

In 2008 implemented mow and herbicide treatments to try to increase oak mortality. Herbicide is applied by hand to limited non-target impacts. The chemical used biodegrades when it comes in contact with the soil and therefore does not enter the ground water. The use of chemicals, however, still remains controversial. Monitoring is currently being conducted to assess effectiveness of this treatment.

To determine if overall management strategies are effective a comprehensive habitat viability assessment has been developed. The assessment measures the condition and health of pine barrens and the progress of management strategies. Indicators used are vegetative structure, habitat patch size, wildlife species (Karner blue, inland barrens buckmoth (*Hemileuca maia*)), and fire regime.

Presentation #2 Achieving Management Success (Craig Kostrzewski):

Between 1991 and 2008 approximately 1,141 acres have been burned on the Albany Pine Bush Preserve. The Pine Bush uses the national weather service website http://www.nws.noaa.gov/ to collect local weather information used to inform timing and location of their prescribed burns. In addition the Pine Bush has 1 on-site weather station which provides more localized data. Other specialized equipment used by the fire program includes tracked vehicles (200 gallon water tank), 6 wheelers with small water tanks and pickup trucks with small tanks and hand tools onboard.

Public outreach and education is considered to be a top priority. Pre-burn outreach to local community members includes the distribution of post cards (900-1500), phone calls to local residents and relevant officials on day of burn, signs posted at trailheads, emails, press releases and media coverage. This process fulfills a requirement of the New York state law.

The TNC fire program at Albany Pine Bush coordinates with 1 full time fire department and 8 volunteer fire departments. In New York fire departments adhere to what is known as 'home rule' where they have jurisdiction by law to put out fires (wildfires and structural). In some instances the fire department personnel assist TNC with prescribed burning by providing water and equipment. Members of the fire departments that participate directly have what is known as National Wildfire Coordinating Group (NWCG) training which is a federally developed standard required by law for anyone participating in a prescribed fire and participate directly. In addition to the fire departments. In addition to the fire departments a number of partners assist in the management of the Pine Bush including TNC, SCA, NYS DEC, NYS OPRHP, USFWS, USFS and NRCS.

Day 3 (April 22, 2009) – Albany Pine Bush Preserve

Site #1 Blueberry Hill (Region G):

This site was recently treated to create habitat suitable for Karner blue butterfly a federally listed endangered butterfly. The treatment included the removal by harvesting of all the black locust (*Robinia pseudoacacia*) trees and many of the pitch pines on the site. The stumps and root systems of the harvested trees were then buried deep enough to prevent re-sprouting and the organic or duff layer of the soil was removed leaving exposed mineral soil (Figure 4). The site will be manually seeded with native warm season grasses and wild lupine (*Lupinus perennis*) a wildflower whose preferred habitat is the dry soils of open pine and oak savanna and one that the Karner blue's lifecycle is dependant upon. Seeds are taken from local sources to ensure genetic suitability to the

area. The restored site will be maintained using a combination of prescribed fire and herbicide application.

Figure 5: Future Karner blue (*Lycaeides melissa samuelis*) habitat at the Albany Pine Bush preserve. Black locust (*Robinia pseudoacacia*), many of the pitch pines (*Pinus rigida*) and the organic soil layer were removed from the site in preparation for seeding of wild lupine (*Lupinus perennis*) and native warm season grasses.

Albany Pine Bush Site #2 Alley Cat:

This site received a combination of mowing followed by prescribed burning in 2006. A second application of mowing and burning occurred in 2008. The objective was to create Karner blue habitat that is dominated by low well spaced scrub oaks with a dominant ground cover of wild lupine and other native warm season grasses.

Ecosystems preferred by Karner blue butterflies in the Albany Pine Bush preserve have a mean fire return interval of approximately 5 years. The butterflies lay their eggs on grass stems in late spring making them vulnerable to fire. As a result prescribed burning in Karner blue units is conducted on a rotation basis to ensure that an adequate number of eggs survive to maintain butterfly populations across the landscape. This is one of the many challenges in trying to maintain a fire adapted ecosystem and not decimate the target species that depend on that particular habitat type.

There is a great deal of WUI in and around the Albany Pine Bush preserve as such a great deal of public outreach is conducted by the Albany Pine Bush TNC fire management staff prior to any restoration activities that involve the use of fire or herbicide. This includes distributing post cards to the homes of local residents containing detailed information about the planning and implementation of restoration activities. Due to its proximity to a residential neighborhood and main thorough fare a 75 ft (25 meter) buffer was used adjacent to the road to maximize safety and to also provide a visual barrier to the site.

Cooperating with and educating the public in this way has created a positive relationship allowing for continued conservation activities in this densely populated area.

Day 4 (April 23, 2009) - North Conway, New Hampshire

Jeff Lougee – TNC Fire Manager

Site #1 Green Hills Preserve (4,222 acres):

The original 2,822 acre Green Hills Preserve was purchased by TNC in 1992. In 1999 a donation of 1,400 adjacent acres was added to the original purchase to make up the present day Preserve. Today the majority of the Green Hills Preserve is owned by TNC with a small portion owned jointly by the state and the town of North Conway. Sustainable forest management on the preserve is conducted in compliance with the state Tree Farm certification system. The preserve's lower elevations are largely covered with hardwood forests in different stages of succession. Red maple (*Acer rubrum*), red oak (*Quercus rubra*), American beech (*Fagus grandifolia*) and paper birch (*Betula papyrifera*) dominate these forests. Most of these low elevation forest ecosystems in and around the preserve are not fire dependant meaning that fire plays a minimal role in these systems. There are however small scattered patches of forest where fire does play a role. These fire dependant patches are typically located in low flat sandy areas (pine barrens) and rocky mid elevation (2000 ft) sites dominated by red pine. Red pine rocky summit communities make up approximately 10% of the Green Hills Preserve (Figure 5). The majority of these red pine communities are maintained through lightning strike initiated fires. The last large fire event in the area occurred in 1918.

Figure 6: A red pine (Pinus resinosa) rocky summit at the top of Peaked Mountain (1700 ft) in the Green Hills preserve, North Conway, New Hampshire. Red pines are a fire adapted species with thick bark that helps protects the inner living tissue from fire.

Site #2 Ossipee Pine Barrens (2,800 acres):

The Ossipee Pine Barrens is New Hampshire's last intact example of a pitch pine/scrub oak woodland. It harbors a diversity of uncommon wildlife, including nearly two dozen threatened and endangered moths and butterflies, and several declining bird species. Many of these species are found nowhere else in New Hampshire. These pitch pine/scrub oak woodlands depend upon fire for their maintenance and regeneration. Historically, the Ossipee Pine Barrens are thought to have burned every 25 to 50 years. Plants and animals in the Ossipee Pine Barrens have adapted over thousands of years to live with fire.

The Ossipee Pine Barrens are located adjacent to several town forests. In 2007 with the assistance of a federal grant known as the Forest Legacy grant TNC was able to expand the barrens with the purchase of additional blocks of adjacent land. The total cost of the acquisition was USD$ 4 million. Of this USD$ 2.5 million was in the form of federal grants and the remaining USD$ 1.5 million was fundraised by TNC. The pine barrens have what is termed a secondary conservation easement tied to the land restricting development. This will ensure that in the event ownership of the barrens changes they will always be conserved.

Conservation objectives for the Ossipee Pine Barrens include:

- Protection of 17 rare species including insects and birds
- Restoration and conservation of pitch pine and scrub oak ecosystems.

TNC recognizes 3 major habitat types within the pitch pine scrub oak systems it is managing in New Hampshire:

- Forest >60% cover
- Woodland 30% – 60%
- Thicket (open) <30% cover

In 2007 after 4 years of planning and public outreach TNC conducted it's first prescribed burn in the Ossipee Pine Barrens. Due to the presence of residential homes adjacent to some of the proposed burn units a buffer was created between those homes and the perimeter of the units being burned. As part of the community outreach efforts TNC fire staff contact local residents are notified immediately prior to a planned prescribed fire. Smoke management is an issue in Ossipee owing to the number of developed residential neighborhoods in close proximity to the pine barrens. To mitigate smoke emissions a technique known as wet mop up is employed to completely extinguish prescribed fires. In addition burns are usually conducted when nighttime temperatures are expected to remain high to ensure continued smoke lift and adequate dispersal post burn. This means that most burns are conducted during the warm summer months in what is known as the growing season.

Treatments included a combination of mowing and prescribed burning. Mowing was used to reduce the height of the scrub oak prior to burning. In doing so fire behavior and

flame lengths were significantly reduced. Approximate cost is USD$ 550/acre for burning and USD$ 220/acre for mowing. All burn units are monitored to determine post fire effects on birds, moths and vegetation.

Day 5 (April 24, 2009) - TNC Maine Field Office (MEFO) (Brunswick, Maine)

Presentation #1 GIS in Fire Management (Eric Martin – TNC GIS analyst):

There are currently 4 habitat types in Maine where fire management is currently used (pine barrens or sand plains grassland systems)

Pre-burn planning includes:

- Safety (drop points, water sources, safe zones, and vehicle access)
- Modeling fuel types for the burn units and surrounding areas (assesses fuel types using established fuel models). Slope analyses help predict fire movement.
- Thinning and fire break design
- Identify hazards (developments and roads)
- Smoke modeling (highways, hospitals, airports etc and topography and areas prone to inversions)
- Contingency Planning (emergency access points and routes, communicate plans to community etc.)
- Post burn monitoring (calculate areas burned and track changes in species composition and structure)
- LANDFIRE (Mean fire return interval national map)
- ARCMAP demonstration

Presentation #2 Waterboro Barrens: How Monitoring Informs Action (Parker Schuerman – TNC Maine Fire Manager):

The primary objectives of the Waterboro Barrens fire program are as follows:

- Healthy forests
- Safe communities
- Partnerships and training
- Rare species
- Science and monitoring
- Habitat restoration

Fire managers need science to better inform management actions. 1990's baseline data established species lists of moths, butterflies, spiders, birds, amphibians and reptiles.

From these lists it can be determined whether a species is a 'fire increaser' or 'fire decreaser'. It can also be determined how man has affected the landscape over time. In this way fire managers can develop a fire history for an area (fire return intervals, ecological models etc.). Fire effects are based on timing and taxa. The fire program at Waterboro manages for multiple species within the landscape.

An adaptive management approach is used to effectively meet conservation objectives. The cyclical framework consists of the following 6 steps which are continually repeated:
1 Establish management goals
2 Identify and prioritize species or in-actions that interfere with management goals
3 Assess control or management techniques
4 Develop and implement management plan
5 Monitor and assess impacts of management actions
6 Review management goals control practice and control techniques

Fire science and fire planning:
It takes many years to develop clear objectives for newly acquired landscapes. For example the planning process for the Waterboro barrens took place between 2001 and 2004. A big question that arises during the planning process is 'what to monitor?'. In the early stages of the fire program managers knew that they could not safely apply fire when fuels were over abundant particularly in WUI areas due to risk of extreme fire behavior. A solution was to use mechanical treatments such as mowing and pruning to reduce fuels (ladder fuels etc) and thin stands. The added benefit of mechanical treatment is increased natural pitch pine regeneration due to soil disturbance. Another benefit is the sale of biomass resulting from these treatments for bio-fuel electricity plants. Between 2003 and 2005 a pitch pine recruitment study conducted to quantitatively capture the results of the mechanical treatments on pitch pine regeneration. Fire was first used by TNC and it's partners in Waterboro in 2004. Fire was used on a small scale in order to introduce the local community to the concept of prescribed fire and to be able to monitor results accurately. The TNC Maine fire program works with many partners including Maine Army National Guard, Maine State Forest Service and volunteer fire departments.

Monitoring fire effects:
First order fire effects include rate of spread and flame height during burn.
Second order fire effects include scorch height and duff removal (litter depth).
It is important to discuss the results of each burn, analyze the impacts and to then discuss next steps and adjust prescriptions. Local and state governments like to see fuel removal as an objective of these burns as it is a public safety issue. The TNC fire program in Maine is obtaining good data on diversity and plant structure resulting from fire using 'ecoplot' monitoring. In conducting prescribed burning operations over time more experience is gained and prescriptions can become broader allowing for variable fire effects/behavior that better meet ecological objectives.

Presentation #3 Fire Ecology Informing Conservation (Dr. Drew Barton University of Maine Farmington):

Fire ecology research can reveal at least r4 things about a landscape:
1 Natural fire regime of an area
2 Role of fire for species and forest types
3 Relationships of fire regimes with climate
4 Future scenarios

Two fire ecology data collection methods:
1 Fire scars which construct precise fie histories over decades to centuries (resolution is annual). Can be use to develop a prescribed fire management program
2 Fossil charcoal and pollen which examine fire and species occurrence over centuries to millennia (resolution is about 50 years). This technique can be used to identify past patterns and to predict the future.

Method 1: Fire scars: Each fire event will leave a scar on certain trees resulting in a record of fire occurrence. A cross section of the tree can reveal fire scars over time. Careful examination can even reveal at what age of the tree a particular fire occurred which can be translated into the year of the event. Using multiple trees with fire scars in an area a fire history of that area can be created.

Dendrochronology:
Arizona Madrean Pine-Oak Forests: Altered fire regimes, altered forest communities (Sierra Madre Mountains). Predominantly pine and oak forest (several species of each type). Fire is common due to a lack of rain. The dry season form April-June and the rainy season (monsoonal) extends between July and September. Lightning caused fire usually occurs at the end of the dry season and beginning of the wet season.

Fire History of Rhyolite Canyon:
Tom Swetman et al used data from 62 trees with fire scars. Results show many fires that burned the entire canyon also that successful fire suppression began in the late 1800's. Fire suppression has resulted in significant change in species composition and structure (forests are now more dense).

We can take the tree rings (measure thickness) and determine how wet or dry that year was. This can be done for every year going back 350 years. We can then see if fire years were wet or dry years and if the year preceding a fire was wet or dry. Data shows that it was usually wet preceding a fire creating more fine fuels (grasses etc.) and dry the year of the fire.

Pre-settlement fire regime is thought to be frequent, low severity surface fires that were driven by dry weather. Dr. Barton's research shows that pines can survive the fire but the oaks die and re-sprout. Frequent surface fires used to maintain a balance between pine and oaks but suppression has resulted in a dominance of oak and dense fuels increasing the likelihood of crown fires.

The National park at Rhyolite Canyon began a prescribed fire program about 15 years ago to try to recreate the historical balance between pine and oak. Conclusions to date from this fire program indicate that fire suppression causes species imbalance (less pine), and an increased chance of high severity fire. The use of prescribed fire can improve this situation.

Method 2: Fossil Charcoal and Pollen:
Smoke contains tiny bits of charcoal (particulate matter) that eventually falls out and collects in wetlands as sediment over thousands of years. Pollen also collects in the sediment over thousands of years. Pollen from each tree species is very unique so easy to identify. A core sample from wetland sediment containing charcoal and pollen can be sliced and examined under a microscope. The pollen can then be aged using radio-metric aging. We can then get a pollen profile that reveals evolution of vegetation over time in a specific location.

Pollen and charcoal records going back 8,800 years indicate that fire was a frequent event. Also shows that Pitch pine has been present on the landscape for thousands of years, specifically on the Pitch pine ridge tops located in the Basin Preserve, Maine. Charcoal and pollen samples also reveal that fires were common in the Basin over the past several thousand years and that pitch pine was a native to the Basin long before the arrival of Euro-Americans. Ambrosia is a weed that became more prevalent at the time of European settlement so its presence is used an indicator of European settlement in the area (mid 1700's). Pitch pine in most instances does not form fire scars. However some with fire scars have been found in the area (6 trees). The Scars from these 6 trees indicate a big fire occurred in 1926 or 1927. The best way to conduct fire research is using fossil pollen and charcoal, fire scars and documented evidence (newspapers etc.)

Presentation #4 Forest Fire Management in P.R. China (Jinhai Wang Forest Fire Management Office of SFA):

In China the top leaders of each government section are responsible for fire management. The Forest fire management agency is a combination of forestry and fire disciplines. There currently exist a variety of laws and regulations exist to help people manage fire and fire management is supported by a variety of government agencies. Continual improvement of fire suppression skills and of fire management teams in general is a key objective. The general public are included in fire management via the promotion of fire management knowledge (literature) designed to educate them in case of wild fire.

There are 3 main centers that focus on fire in China (fire protection centers in NE, SW and Central China). These are the Forest Force of CAPF Command Center, the Forest fire management headquarters in Beijing and the Forest fire management headquarters of Guangdong province. Cooperation exists between government agencies in fire management. Army troops are also responsible for fire suppression activities in China. The level of fire management is improved with the increased awareness of the dangers of wild fire and improved early warning systems. A Fire danger rating system (regionalized)

is used to identify fire risks nationally (2130 monitoring stations in China). Weather conditions are announced periodically. There are 5 grades of fire danger. Grade 1 is low risk and Grade 5 is extreme. When Grade 3 is reached at a weather station an alarm is sounded.

Monitoring includes:
1 Patrolling (boats, trucks, aerial and forest ranger (hiking)
2 The use of watch towers
3 Remote video monitoring (in areas of high fire risk)

In addition satellite monitoring networks are used nationally. There are currently 3 centers, Beijing, Kunming and NW China. Lightning monitoring centers exist in areas of China where lightning is prevalent. Use GIS to model 3D image of burned areas and to predict fire behavior and extent.

Fire breaks and isolation technology:
Large fire breaks are used on the border between China and Russia. Fire breaks are used beside some railway lines. About 1.19 million km of fire break have been created in China. Actual fire walls are also used that can be erected on site to contain fire. The use certain native fire resistant vegetation types (in strips) to create fire breaks is a common practice in China.

Prescribed fire is currently being used to reduce hazardous fuels. This has been done since the 1950's. Chinese fire management is in a transition period at the moment where prescribed fire may be used in achieving conservation objectives (ecological management) and not just fuel reduction. Each region of China has its own prescribed fire guidelines because of varying vegetation.

There are 8 different methodologies for fire suppression:
1 Facility tools
2 Blowers
3 Water
4 Bomb containing retardant
5 Suppression firing
6 Helijumper
7 Air attack
8 Artificial rain fall

Fire behavior modeling is used to determine if remote fires can be left to burn. i.e. if they are small and not threatening the forest resource , communities etc.

Since 2000 the Chinese government has implemented the 'land to forest' project. On slopes greater than 20 degrees the land must be converted to forest and not crops. Traditionally burning for land clearing, crop production etc is allowed only by government permission via permits. The government will often assist farmers in controlling agricultural burns to ensure minimal escapes.

Day 6 (April 25, 2009) – Southern Maine

Site #1 Kennebunk Plains Preserve (135 acres):

The Kennebunk Plains preserve located in southern Maine conserves a key parcel within a large expanse of coastal sandplain grassland. More than 2,000 acres surrounding the preserve are protected by the Maine Department of Inland Fisheries and Wildlife (MDIFW). The Nature Conservancy has an agreement with MDIFW to help with management of the rare species and natural communities here and conducts prescribed burns on the Department's behalf.

Six hundred acres of sandplain grassland are surrounded by pitch pine and scrub oak forest. Both of these habitat types are adapted to frequent wildfires that prevent fire intolerant trees and shrubs from dominating. The grasslands are home to several species of birds that are rare or endangered in Maine, including grasshopper sparrows (*Ammodramus savannarum*), upland sandpipers (*Bartramia longicauda*), vesper sparrows (*Pooecetes gramineus*) and horned larks (*Eremophila alpestris*). The northern blazing star (*Liatris borealis*), a rare plant which occurs nowhere else in Maine is also found in the preserve. The population of this plant at Kennebunk Plains is the largest in the world. Other common plants on the preserve include lowbush blueberries (*Vaccinium angustifolium*), poverty grass (*Danthonia spicata*) and little bluestem (*Schizachyrium scoparium*). One of only two known populations of black racer snakes (*Coluber constrictor)* in the state also makes the plains its home.

While visiting the preserve the delegation from China witnessed a demonstration prescribed burn conducted by the TNC Maine fire crew (Figure 6).

Figure 7: The TNC Southern Maine fire crew at Kennebunk plains after just completing a successful demonstration prescribed fire in fine fuels composed of grasses and blue berry (*Vaccinium* spp.)

Site #2 Waterboro Pine Barrens:

The Waterboro Pine Barrens preserve is home to Maine's best example of a boreal pine barrens. Up to 90 feet of nutrient-poor sandy soils filter water into groundwater aquifers and pristine ponds, streams and bogs. The pitch pine and scrub oak community is adapted to thrive after periodic fires, which keep fire-intolerant trees and woody shrubs from taking over the barrens. The preserve was established in the early 1990's when the Conservancy purchased the land from a developer who had planned a large recreational-residential complex.

As many as 11 species of rare butterflies and moths that feed on the barrens vegetation have been documented on the preserve, including the pine barrens buckmoth (*Hemileuca maia*). Whip-poor-will (*Caprimulgus vociferous*) and common nighthawk (*Chordeiles minor*), both ground-nesting birds in decline throughout their range, nest in open areas within the pine barrens.

The Nature Conservancy has recently initiated a prescribed burning program at Waterboro Barrens as a management and restoration tool. In addition, some areas have recently been thinned to reduce flammable fuels and provide firebreaks between the preserve and neighboring communities. The fire history of the Waterboro Pine Barrens was created using a combination of aerial photographs and newspaper records. There have been no significant fires since 1963 which is when the entire southern portion of the barrens burned.

Next Steps

A reciprocal fire management study tour is being considered to give TNC fire managers from the Northeast US an opportunity to learn about fire management approaches including suppression, prevention and the use of prescribed fire in China.

The delegation from China is considering integrating some what they learnt through this study tour into their work in China. A report developed by members of the delegation will be forthcoming that outlines possible next steps in fire management in China. At the same time, the TNC China program, is now considering promoting an integrated approach to fire management that includes the use of prescribed burning to meet conservation/ecological objectives in China. TNC China welcomes future cooperation with the TNC fire professionals from the Northeast and will look forward to receiving more fire related technical support in the future.

Appendix A: Agenda

China/US Fire Management Study Tour (April 18th – 26th)

Date	Itinerary	Meals/Hotel
Saturday April 18th	Chinese participants arrive in Boston	Dinner in Boston Four Points Sheraton at Boston Logan Airport
Sunday April 19th	Day to recover from the flight and sightsee; check out all those pre-Boston Marathon events. 4:00 pm - Leave for Plymouth, Massachusetts	Breakfast at Hotel Lunch at Boston area restaurant Dinner in Plymouth Area
Monday April 20th	**Cape Cod, Massachusetts:** Camp Edwards military base (progressive fire mgmt program) – Miles Standish (no current fire management) Cape Cod National Seashore (progressive fire mgmt program)	Breakfast at Hotel Lunch at Camp Edwards Mess Hall Dinner in Plymouth Area Hilton Hotel in Plymouth, Massachusetts
Tuesday April 21st	8:00 am – Leave for Albany, New York Presentation of Albany Pine Bush fire program at TNC office	Breakfast at Hotel Lunch en-route to Albany Dinner at Albany area restaurant Hotel in Albany Area
Wednesday April 22nd	8:00 am – 12:00 pm - Tour of Albany Pine Bush restoration sites 1:00 pm – Leave for Ossipee, New Hampshire area	Breakfast at Hotel Lunch Delivered to Albany Pine Bush Discovery Center Dinner in Ossipee NH area Hotel in Ossipee, NH area
Thursday April 23rd	8:00 am to 3:00 pm - Tour of Ossipee Pine Barrens Preserve	Breakfast at Hotel Box lunch in field

	3:00 – Depart for Brunswick, Maine	Dinner in Brunswick Hotel - Comfort Inn, Brunswick, Maine
Friday April 24th	**TNC Office, Brunswick, Maine:** 8:30 am – 4:15 pm: Fire presentations 4:30 – Depart for Portland, Maine	Breakfast in Brunswick restaurant Lunch at Frontier Dinner at Local 181 in Portland Maine Hotel – Eastland Park Hotel, Portland, Maine
Saturday April 25th	**Southern Maine Protected Areas:** 8:00 am – 4 pm - Tour of Waterboro Barrens Preserve, Kennebunk Plains, Wells Barrens Preserve 4:00 pm – Leave for Boston	Breakfast in Portland Box Lunch in Field Dinner in Boston Hotel – Four Points Sheraton at Boston Logan Airport
Sunday April 26th	**Boston all day**	Breakfast, lunch in Boston Farewell and thank you dinner in Boston's North End

Appendix B: Participant List

Apr. 18-26, 2009

Name		Gender	Organization	Position	Address	Phone (Office)
First Name	Last Name					
Ping	Zhang	F	Fire Prevention Office, Forest Police Bureau, State Forestry Administration	Deputy Director General	No.18 Hepingli East Street, Dongcheng District, Beijing, 100714, China	(86)-10-84239143
Jinhai	Wang	M	Forest Fire Warning and Monitoring Information Center, State Forestry Administration	Deputy Division Director	No.18 Hepingli East Street, Dongcheng District, Beijing, 100714, China	(86)-10-84239143
Jie	Li	M	Fire Prevention Office, Forest Police Bureau, State Forestry Administration	Principal Staff Member	No.18 Hepingli East Street, Dongcheng District, Beijing, 100714, China	(86)-10-84239143
Zhongming	Tang	M	Daxing'anling Fire Prevention Office of Heilongjiang Province	Office Director	6#, Galan North Road, Jinghong City, Xishuangbanna Autonomous Prefecture Yunnan Province, 666100 P. R. China	(86)-13988152990
Zhong	Li	M	Department of Wildlife Conservation and Nature Reserve Management, State Forestry Administration	Division Director	No.18 Hepingli East Street, Dongcheng District, Beijing, 100714, China	(86)-10-84238525
Nianjun	Sun	F	Multilateral Cooperation Division, International Forestry Cooperation Center, State Forestry Administration	Division Director	No.18 Hepingli East Street, Dongcheng District, Beijing, 100714, China	(86)-10-84238714
Aiming	Yang	F	Multilateral Cooperation Division, International Forestry Cooperation Center, State Forestry Administration	Chief Clerk	No.18 Hepingli East Street, Dongcheng District, Beijing, 100714, China	(86)-10-84238960
Guangzhi	Yu	F	China Program of The Nature Conservancy	Project Manager	B4-2 of Qijiayuan Diplomatic Compound, No. 9 Jianwai Street, Chaoyang District, Beijing, 100600, China	(86)-10-85319562
Petteri	Vuorinen	M	FAO Forestry Department Fire Management, FORM Forest Resources Division	UN-FAO Forest Officer	Forestry Department Room D-477 Viale delle Terme di Caracalla - 00100 Rome Italy	(39) 0657055508
Pieter	van Lierop	M	FAO Forestry Department Fire Management, FORM Forest Resources Division	UN-FAO Forest Officer	Forestry Department Room D-477 Viale delle Terme di Caracalla - 00100 Rome Italy	(39) 0657054392