Introduction

Effective forest fire detection is a critical component of our fire control program. Early fire detection, combined with rapid initial attack helps achieve the mission of protecting human life, property, and natural resources from wildfire. Our detection system has also long been an effective forest fire prevention and fire law-enforcement tool, locating illegal burning and bringing us face to face with our target audience.

Changing conditions such as the increased use of cell phones, changes in population density, the fire landscape or values at risk could influence what an effective detection system consists of. The following items were assessed in an effort to re-evaluate our detection system in light of these changing conditions:

- Aerial Detection Costs, Options and Effectiveness
- Traditional Tower Detection Costs, Options and Effectiveness
- Alternative Detection Systems Costs, Options and Effectiveness
- Detection by Citizen Reporting Costs and Effectiveness
- Effectiveness of systems as law enforcement tool
- Effectiveness of systems as prevention tool
- Effectiveness between systems

Charge

Provide alternatives and a recommendation to how forest fire detection can be provided (what methods and when). Explain how this can be provided given changes in what we can invest and at different levels of stratification.

Descriptions of Objectives

Analysis of our detection system is complicated. Each Dispatch Group has a different compliment of detection resources available and each uses them in different combinations. Area Forestry Leaders have crafted their detection methodology to meet the specific needs within their Dispatch Group. Recent budget limitations have forced Area Leaders to seek out ways to increase the efficiency of detection at the local level. The following objectives help to revaluate the effectiveness and efficiency of our detection system:

1) Prepare report which shows how fires are detected statewide and determine if there is a significant difference in how fires are detected across the State (across boundaries such as LOP's, Dispatch Groups, or Regions)
2) Determine how our existing detection options are used and the costs associated with that use.
3) Determine the number of acres and structures saved by our existing detection system.
4) Determine the effectiveness of each type of detection from a cost standpoint
5) Determine whether there is a significant difference in structures lost and fire size based on detection type in place.
6) Describe the strengths and weaknesses or limitations of each detection type

<u>Objective: 1</u> Determine how fires are detected statewide and identify significant differences across boundaries such as LOP's Dispatch groups or Regions.

<u>a)Statewide Detection</u> Table 1a displays how fires are detected throughout DNR intensive and extensive protection under the different detection scenarios recorded on fire reports. All fire reporters other than airplanes and fire towers were combined to form a 'Citizen Reporter' category that doesn't appear on the fire report.

Table 1a

		Detection Scenario at the Time of the Fire				
		Citizen Reporting Only	Aerial Detection	Aerial and Tower	Tower Detection	All Scenarios Combined
Fire Reporter	Airplane	0%	44%	6%	0%	2%
	Tower	0%	1%	40%	59%	9%
	Citizen *	99%	55%	54%	41%	89%
	Grand Total	100%	100%	100%	100%	100%

-from fire report data 2005 through 2008 excluding those with blanks in these fields

<u>b)Analysis of Citizen Reports</u> Table 1b breaks down the Citizen Reporter category found in Table 1a into the categories found on the fire report. It reveals that when organized detection is not in place, there is only a slight increase in the percentage of fire reported by the responsible party. It is local residents who report a much greater percentage of fires, followed by an increase in fires reported by transients.

Table 1b

		Detection Scenario at the Time of the Fire				
		Citizen Reporting Only	Aerial Detection	Aerial and Tower	Tower Detection	All Scenarios Combined
* Citizen Reporter	DNR employee	2%	3%	3%	3%	3%
	EFW	0%	0%	0%	0%	0%
	Local resident	47%	19%	18%	15%	40%
	Other	6%	4%	4%	2%	5%
	Party Responsible	29%	19%	23%	18%	27%
	Railroad	0%	0%	0%	0%	0%
	Transient	15%	10%	6%	3%	13%
	Citizen Total	99%	55%	54%	41%	89%

-from fire report data 2005 through 2008 excluding those with blanks in these fields

<u>c) Variation between Dispatch Groups</u> Table 1c displays how fire reporting varied between Dispatch Groups when organized detection was in place. These figures include only fires when either towers, air patrol or both were active at the time of the fire. Dodgeville does not have fire towers. Waupaca has minimal fire tower coverage. Map 1 of Appendix A shows detection coverage overlaying Dispatch Group Boundaries.

Table 1c

Dispatch Group	Citizen	Fire Tower	Air Patrol	Grand Total
Black River	28%	62%	11%	100%
Brule	48%	33%	19%	100%
Cumberland	42%	50%	8%	100%
Dodgeville	78%	0%	22%	100%
Park Falls	48%	46%	7%	100%
Peshtigo	60%	30%	11%	100%
Waupaca	50%	26%	24%	100%
Wisconsin Rapids	53%	39%	7%	100%
Woodruff	55%	40%	6%	100%
Average	50%	40%	10%	100%

-from fire report data 2005 through 2008 excluding those with blanks in these fields

d) Changes over time A previous detection study looked at fires that occurred from 1987 through 1995 during times and conditions when towers were likely to have been staffed and found that 62% of the fires were detected by citizens, 34% by towers and 4% by planes. Although cell phone use is now common and 911 has become standard since that earlier study, citizen reporting of forest fires has not increased. At the time of that study 95 towers were in use compared to 82 in this study.

Objective: 2 Determine how our existing detection options are used and the costs associated with that use.

a) Current Use Table 2a shows how each dispatch group used aerial and tower detection at different fire danger rating. The data set included three years from the Daily Fire Summary (2005 through 2007). The average days per year are displayed as the nearest whole number. The Daily Fire Summaries were not completed for each day. Discussions with dispatchers and a review of the data suggest that missing data is for Low or Moderate days during periods when there was no fire control staffing. Statistics such as days per year and percentage of time when detections was used would not be accurate for Low and Moderate adjective levels; it is therefore not displayed in the table.

The use of fire towers appears to be fairly consistent statewide both in terms of the conditions in which they are staffed and the number of hours that they are staffed. See Map 1 of Appendix A for fire tower and patrol route locations in relation to the Dispatch Group boundaries. The use of aircraft shows greater variation statewide. The hours flown includes detection routes, time spent in a suppression role and transit time. Flight hours spent on detection vs. suppression have not been tracked separately in recent years. The transit time is listed for each dispatch group so that the flight times can be compared more accurately. Transit time includes time to and from the route from the hanger.

Table 2a

Dispatch Group	Fire Danger	average days per year at adj level	days towers and plane were used	days plane alone was used	days towers alone were used	average tower hours per day used	average plane hours per day used	transit time Hrs
Dodgeville	Extreme	4	0%	55%	0%	0	4.6	0.4
	Very High	19	0%	24%	0%	0	3.4	
	High	95	0%	1%	0%	0	3.4	
Waupaca	Extreme	4	92%	0%	0%	6.8	4.8	0.3
	Very High	9	77%	8%	0%	6.2	4.1	
	High	39	42%	11%	5%	5.3	1.9	
Peshtigo	Extreme	3	100%	0%	0%	7.8	3.4	1.0
	Very High	8	100%	0%	0%	7.1	4.4	
	High	29	37%	26%	3%	6.2	3.3	
Black River	Extreme	1	100%	0%	0%	6.7	3.0	0.0
	Very High	12	91%	0%	6%	8.3	3.1	
	High	28	50%	31%	0%	6.0	1.8	
Wis Rapids	Extreme	2	100%	0%	0%	6.6	3.6	1.0
	Very High	10	93%	7%	0%	6.5	3.7	
	High	43	50%	28%	0%	5.8	2.8	
Brule	Extreme	1	100%	0%	0%	6.3	1.2	0.5
	Very High	17	94%	6%	0%	5.9	2.1	
	High	35	47%	17%	1%	5.4	1.6	
Cumberland	Extreme	1	100%	0%	0%	7.8	2.3	0.0
	Very High	13	87%	13%	0%	6.4	1.3	
	High	31	40%	48%	0%	5.8	1.1	
Park Falls	Extreme	1	100%	0%	0%	6.0	1.7	0.6
	Very High	11	69%	28%	0%	6.6	2.6	
	High	29	45%	39%	0%	5.9	1.8	
Woodruff	Extreme	1	100%	0%	0%	6.8	5.6	0.0
	Very High	9	78%	4%	19%	6.6	5.2	
	High	33	19%	15%	18%	6.6	3.2	

From Daily Fire Summary 2005 through 2007

b) Cost of Recent Tower Use Table 2b shows the average calculated cost of staffing towers as reported to the Daily Fire Summary over a three year period from 2005 through 2007. The table was calculated using an average tower wage of $9.20/hr. This table is calculated using the number of towers as staffed in recent years, not as identified for staffing in 2010. The two active towers in Menominee County (Sand Lake W and Kinepoway) were not included in this calculation since those towers report to MTE dispatch and are no longer funded by WI DNR.

Table 2b

Dispatch Group	Number Towers	Average Daily Tower Cost Moderate	High	Very High	Extreme	Average Annual Tower Cost Moderate	High	Very High	Extreme	Total
Dodgeville	0	NA	NA	NA	NA	NA	NA	NA	NA	NA
Waupaca	1	$40	$49	$57	$63	$92	$894	$380	$229	$1,596
Rapids	11	$557	$587	$658	$668	$2,412	$12,522	$5,920	$1,113	$21,967
Peshtigo	8	$412	$456	$523	$574	$2,610	$5,324	$4,006	$1,531	$13,471
Black River	11	$526	$607	$840	$678	$2,982	$8,501	$9,520	$678	$21,680
Park Falls	17	$829	$923	$1,032	$938	$3,316	$11,996	$7,570	$938	$23,820
Woodruff	12	$696	$729	$729	$751	$2,782	$8,987	$6,315	$1,001	$19,084
Brule	12	$585	$596	$651	$696	$2,145	$9,936	$10,205	$464	$22,750
Cumberland	10	$543	$534	$589	$718	$3,438	$6,581	$6,477	$478	$16,974
Total	82	$4,187	$4,480	$5,078	$5,085	$19,778	$64,740	$50,392	$6,433	$141,343
									Statewide Annual Tower Costs	$141,343
									Average Annual Cost Per Tower	$1,724

<u>c) Cost of Current Aircraft Use</u> Table 2c shows the average calculated aircraft cost for hours of use as reported to the Daily Fire Summary from 2005 through 2007 found in table 2a. The table includes aircraft suppression, detection and transits costs at the current rate of $125 per hour. Based on discussion with the Aeronautics Operations Team an estimated 25% of this expense can be attributed to detection.

Table 2c

	Average Daily Aircraft Cost Moderate	High	Very High	Extreme	Average Annual Aircraft Cost Moderate	High	Very High	Extreme	Total	Detection Estimate
Dodgeville	$363	$425	$425	$575	$121	$567	$1,983	$1,150	$3,821	$955
Waupaca	$88	$238	$513	$600	$583	$4,908	$3,758	$2,200	$11,450	$2,863
Rapids	$213	$350	$463	$450	$4,250	$11,667	$4,471	$750	$21,138	$5,284
Peshtigo	$313	$413	$550	$425	$3,125	$7,563	$4,217	$1,133	$16,038	$4,009
Black River	$150	$225	$388	$375	$3,250	$5,100	$4,133	$375	$12,858	$3,215
Park Falls	$188	$225	$325	$213	$2,125	$5,475	$3,358	$213	$11,171	$2,793
Woodruff	$338	$400	$650	$700	$1,125	$4,533	$4,767	$933	$11,358	$2,840
Brule	$200	$200	$263	$150	$2,333	$4,467	$4,375	$100	$11,275	$2,819
Cumberland	$138	$138	$163	$288	$4,675	$3,758	$2,58	$192	$10,683	$2,671
Total	$1,988	$2,613	$3,738	$3,775	$21,588	$48,038	$33,121	$7,046	$109,792	$27,448
									Total Annual Cost	$109,792
									Estimate of Cost Attributed to Detection	$27,448

Table 2d shows the estimated cost of flying the existing detection routes in their entirety without deviation to investigate smokes etc. The current flight rate of $125/ hr was used in these calculations. Map 1 of Appendix A displays the location of these routes.

Table 2d

	Transit Cost	Route Cost	Total Cost for 1 Route	2 Routes	3 Routes
Dodgeville	$48	$210	$258	$467	$677
Waupaca	$38	$138	$177	$315	$454
Rapids	$121	$136	$257	$392	$528
Peshtigo	$121	$171	$292	$463	$635
Black River	$0	$167	$167	$335	$502
Park Falls	$79	$226	$305	$531	$757
Woodruff	$0	$171	$171	$342	$513
Brule	$58	$115	$173	$288	$404
Cumberland	$0	$138	$138	$275	$413
Antigo*	$25	$165	$190	$356	$521
Total	$490	$1,638	$2,128	$3,765	$5,403

*The cost of the Antigo Route is shared by Woodruff, Wisconsin Rapids and Waupaca

Aircraft Cost

Aircraft Speed	130 mph
Cost per hour	$125.00
Cost per Mile	$0.96

Objective: 3 Determine the number of acres and structures saved by our existing detection system.

Table 3a shows the number of structures and acres saved that were attributed to early detection by either a fire tower or an airplane. These are fire report figures from 2000 through 2008. The high number of acres and structures saved in Brule can largely be attributed to a single fire in which an estimated 5000 acres and 250 homes were saved as a result of an early fire report by a tower.

Table 3a

Dispatch Group	Number of Fires	Acres Burned	Structures Burned	Acres Saved by Organized Detection	Structures Saved by Organized Detection
Black River	1173	4029	44	1367	89
Brule	797	3418	38	*6666	*333
Cumberland	1002	1490	34	250	45
Dodgeville	1510	9187	43	23	45
Park Falls	1172	1886	40	433	50
Peshtigo	1315	2380	33	160	38
Waupaca	1852	3811	89	356	61
Wisconsin Rapids	1884	6722	154	774	94
Woodruff	1612	1333	50	409	89
Grand Total	12317	34256	525	10438	844
Annual Ave	1369	3806	58	1160	94

-from fire report data 2000 through 2008

Objective: 4 Determine the effectiveness of each type of detection from a cost standpoint

The Detection Work Group was unable to accomplish this objective.

It is not possible to determine the cost effectiveness of tower and aerial detection in the manner it was calculated in the previous fire study. This is because similar Fire Report data is no longer collected or available regarding the value of structures and resources saved by tower or aerial detection.

An indirect estimate of suppression expenses saved can be made using an average cost per acre of suppression. From 2005 through 2008 the average cost per acre of suppression was $151 for all fires greater than one acre in size (See appendix E). Using that figure of $151 per acre and the average annual acres saved by organized detection in Table 3a, our detection system saved an average of $175,160 in suppression expenses annually from 2000 through 2008. The value of the structures and resources saved cannot be determined.

Recommendations:

A) If a more thorough analysis of the detection cost vs. property and resources savings is desired in the future then fire reports fields would need to be added to collect additional fire information. The fields would need to be similar to those from fire reports used in the last fire study, estimating the value of structures and resources saved by detection, and recording the time of the first citizen report following a report by either aircraft or fire tower.

B) Currently aircraft time for fire detection and fire suppression are not separated by pilots in their time reports or logs, or by dispatchers in the Daily Fire Summary. In the future it is recommended that aircraft time spent for detection versus suppression activities should be tracked separately to provide a more accurate estimate of aerial detection costs. That information could be tracked on the Daily Fire Summary by dispatchers, or it could be tracked by the pilots using different time codes.

Objective: 5

Determine if there is a significant difference in structures lost and fire size by detection type.

We cannot make a reasonable comparison of structures lost or fire size based on the detection in place. Detection is only commonly used during periods of high burning indices. Fires occurring on those days are fundamentally different than those that occur during periods of lower fire danger.

Objective: 6 Determine the strengths and weaknesses of our current detection system as well as other potential detection methods.

Wisconsin currently uses three methods of forest fire detection; aerial flights, fire towers and citizen reporting.

a) Aerial Flight Detection

Aircraft have been used for detection in the state since 1947. The following strengths and limitations associated with aerial detection are listed in no particular order.

Strengths:

Mobility – Pilots can easily alter routes and altitudes to meet changing sun and visibility conditions. Pilots can travel to the smoke enabling them to provide detailed information.

Information – Aerial detection can provide valuable intelligence including the source of a smoke, an exact location, access routes and resources at risk. WI DNR pilots receive fire suppression training which helps them make accurate and reliable assessments. That information helps dispatchers and initial attack resources prioritize smokes on busy fire days and also allows for a more metered response.

Efficiency – One pilot can provide detection for a large geographic area

Versatility – Aerial detection routes can be easily altered to accommodate special hazards or changing conditions. Aircraft can also be effectively used in conjunction with lightning strike data. Flights are available any time of the year and can be arranged on short notice.

Prevention –Illegal burning detected by aircraft helps improve fire control law enforcement and can prevent illegal burning operations from becoming forest fires.

Limitations:

Multiple Duties – The aircrafts serves two duties, the most important of which is to serve as a suppression resource functioning as a lookout and air attack. When the aircraft is performing in that roll it is no longer available for detection.

Coverage – Aircraft cannot provide continuous coverage over an entire dispatch group(s). Effective aircraft coverage is typically limited to a 10 mile radius for small to medium sized smokes.

Availability – Aircraft use may be limited during extreme weather conditions. An aircraft may also be grounded for mechanical problems.

b) Fire Tower Detection

Fire towers have been an integral part of fire control in Wisconsin since they were constructed around the 1930's. The following strengths and limitations associated with fire tower detection are listed in no particular order.

Strengths:

Coverage – Towers provide continuous detection coverage over that specific piece of ground they overlook. Fire towers can detect smoke in remote areas where citizen reporting is unlikely.

<u>Information –</u> Fire towers can provide updates on the smoke color, size and spread. This information can help dispatchers and responders set priorities when there are multiple smoke and fire reports. Towers can provide that information even when they were not the first to report the fire.

<u>Reliability –</u> Time has proven that towers are an effective detection method. Even with the increase in cell phone use, the percentage of fires that towers report has remained nearly the same (see table 1a and 1d).

<u>Accuracy –</u> Multiple tower shots can accurately pinpoint the location of a smoke for fire control staff.

<u>Prevention –</u> Illegal burning detected by fire towers helps improve fire control law enforcement and can prevent illegal burning operations from becoming forest fires.

Limitations:

<u>Staffing –</u> The tower is only as good as the tower person staffing it. Finding and retaining quality and reliable personnel to staff the towers is necessary.

<u>Single Shots –</u> If a tower cross cannot be obtained, locating the smoke on the ground can be difficult and time consuming.

<u>Weather –</u> On very windy days smoke will often lay low, proving more difficult to spot. During scattered stormy weather personnel may be put down for safety. Haze may reduce the distance that tower can normally see.

<u>False Alarms –</u> Non-reportables such as road dust, lime spreading, and chimney smoke can be called in, especially with inexperienced tower staff, requiring mileage and staff time to verify the source.

<u>Fixed Height and Location –</u> Topography can limit a tower's field of vision and hinder the accuracy of distance estimates.

<u>Maintenance –</u> Aging towers may prove to be an increasing cost to maintain. Quincy tower was recently replaced at a cost of just over $110,000. There is also an increasing need for additional security at tower sites to prevent vandalism and public endangerment. Recent vandalism to Norway and Knapp towers destroyed the cabs. Cab replacement costs were of $60,000 and $76,200.

<u>c) Citizen Reporting</u>

Although citizen reporting is not an organized detection method, citizens do report a majority of the fire that occur in the state (see table 1a). The following strengths and limitations associated with citizen reporting are listed in no particular order.

Strengths:

Coverage – Citizen reporting can provide detection 24 hours a day, 7 days a week utilizing the 911 system. Most fires in Wisconsin are caused by human activity and are therefore likely to be in a location where there is opportunity for citizen reporting.

Location – A caller may be able to provide an address or good directions to a fire. Enhanced 911 systems can provide a GPS location.

Cost – There is no cost to the state.

Limitations:

Size-Up – Typically a public reporter does not have the experience to determine the severity of a fire; this can result in an over-response by fire control, increasing costs.

Remote Locations – In remote areas there are fewer citizens to detect and report fires.

Availability – People are typically at work during the peak of our fire day possibly limiting the number of people available to report smoke or a fire

False Alarms - People report false alarms, such as legal burning permits.

New Technology

There are many new technologies available for detecting forest fires. The following are some of those technologies with a brief description. See Appendix C for sources of additional information about these technologies.

d) Satellite

Satellite sensors record the intensity of electromagnetic radiation from the Earth in various spectral wavelengths or channels. Fire and other sources of heat are detected if a sensor includes a channel near the 4μm range – hotter than 200ºC. There are two main types of satellite sensors in use; polar orbiting sensors, which provide only several passes over an area per day; and geostationary satellites, which provide coverage every 15-30 minutes. The information on fire position should be used as a general guidance. Tactical decisions, such as the activation of a response to fight these fires, should not be made without other information to corroborate the fire's existence and location. The following strengths and limitations are listed in no particular order.

Strengths:

Coverage – One method could provide detection for the entire state equally, and at all times of the year. No differences across areas or regions.

Limitations:

Time Delay – Geostationary satellites can provide coverage every 15 to 30 minutes, however there is additional lag time to transmit the data.

Adverse Conditions – Effectiveness may be limited by cloud cover, fires that are small or burning with low intensity, vegetation canopy and steep slopes.

Accuracy – The geolocation of the fire can be inaccurate by up to 6 miles. Very warm and dry ground can also show up as a fire (ag land).

Cost – Undetermined what the cost would be to implement.

e) Video Cameras

There are manual camera systems that rely on an operator to monitor the screen for smoke as it scans the landscape. We do not recommend using this type of camera system.

Most video camera systems are semi-automated, meaning they scan the landscape and use motion and scene-change detection algorithms to detect smoke and then alert an operator. How many operators and monitors needed per camera varies by system. Most systems also include some type of filter for non-smoke motion, but false alarms still happen and require an operator to confirm the alarm. Most systems also incorporate some type of GIS mapping capabilities to show the smoke location on a map with landscape features such as rivers and roads, known smoke locations, and will display the smoke coordinates allowing for quick smoke location.

Data transmission for the camera control and image broadcast can be done by satellite, microwave, or land line. Microwave data transmission requires a direct line of sight, or it needs to be repeated. Live video via satellite transmission is costly and only feasible using compressed images. Compatibility with our existing radios and computers needs to be evaluated. Power supply and backup during outages would be a factor at many of our tower sites; solar power was an option with some. Lightning striking towers/equipment and causing damage may be another concern to address. The following strengths and limitations are listed in no particular order.

Strengths:

Coverage – These cameras could be mounted on existing fire towers and even radio and cell towers expanding coverage across the state, and could provide detection throughout the year.

Consistent Capabilities – Unlike our current fire towers which we have stated rely on the quality of the individual staffing that tower; camera capability would be the same at all locations.

Better Sight – Cameras can be adjusted to see things beyond what human sight is capable of. Many camera systems claim 24 hr detection using night vision and other enhanced color and brightness features allowing them to see more than a person would.

Limitations:

Capital Investment & Costs – Cost to purchase cameras and supporting software could be significant. Component life span could be an issue as well as one estimated only 5 years. Data transmission from the camera to the monitors can become very costly as well, especially if it needs to be done by satellite.

Not Fully Automated – Even though the system will scan and alert when there is something to observe, you still need a dedicated person to view the images and confirm the smoke. This person also needs to be familiar with the landscape to know what they are viewing in the series of photo images.

Learning Curve – As with all new technologies staff would need to be trained and it would take time to become familiar with the new system.

Reliability– The reliability of this technology has not been tested in this area.

Camera Position – If not located at the top of the tower the camera will have obstructions in its view because of the tower structure itself; some have solved this with 2 cameras per tower each scanning half of the scene. Also the capability for detection will deteriorate if the camera is not stable and has too much shake.

f) Unmanned Aerial Vehicles (UAV)

Using drone type aircraft to fly above with many different sensors on them; thermal imagers, cameras, or other satellite like sensors. There are many different types and companies available. Costs for drone aircraft and supporting software could be significant.

g) Thermal Imagers

Thermal infrared scanners flown on board aircraft are often used to map hotspots and fire intensity over individual fires or small areas. This allows managers to target fire suppression efforts by air tankers and ground crews. This would not be an effective forest fire detection method for the State of Wisconsin.

h) Range Finders

There have been suggestions from the field to use rangefinders in our fire towers to provide more accurate distance estimates. The typical rangefinder has a maximum range of 1000-2400 yards which only gets you about 1 mile of coverage. There are some long distance range finders that can provide 20,000-25,000 meter coverage which translates to about 12-15 miles. These rangefinders cost $11,000-$25,000 each.

i) Fire Plotters

This method uses tilt scopes placed in existing fire towers to help obtain accurate distance estimates. Information is entered into a computer and a software system using topographic information of the area maps the fire location using the pitch angle and the azimuth reading. Appendix C contains additional information about this technology.

Change in Investment

Reduction in Resources
If reductions in detection are required, we first recommend reducing the use of organized detection on Moderate days across all Fire Landscapes (Alternative 1). If further cuts were required we recommend eliminating organized detection in the lowest ranked Fire Landscapes (Alternative 2). Next we would eliminate the use of aerial detection while fire towers are staffed (Alternative 3). After that we would reduce the number of towers based on analysis of Fire Risk in the viewing area of each tower (Alternative 4). Our least preferred methods were to replace tower detection with aerial detection (Alternative 5) and to reduce towers based upon an individual towers past statistics (Alternative 6).

Alternatives Considered
Each of the following alternatives identifies reductions beyond the towers identified for closure in the spring of 2010. Estimated cost savings were calculated using the average staffing cost per tower of $1,724 determined in table b and aerial detection cost identified in table c of objective 2. The annual detection cost in 2010 using those figures would be $146,379.

Reduction Alternative 1 Reduce the number of days that we use our existing detection system

This method of reduction would simply raise the minimum fire danger at which we begin to implement our detection system. Based on past staffing patterns found in Table b of Objective 2, about $16,613 will be spent towering at Moderate conditions using the number of fire towers approved for use in 2010. Table c of Objective 2 estimates that $21,588 will be spent for aircraft on Moderate days, of that an estimated 25% or $5,397 is for detection purposes. Total savings if nothing was spent for detection on Moderate days would be $22,010 (15% reduction).

Advantages of this alternative:

- Would retain detection everywhere that it is currently available at high and above adjective levels.
- The effects of delayed reporting that results from this reduction will occur under Moderate conditions

Disadvantages of this alternative

- Would lose the flexibility to use detection on Moderate days to look for lighting strikes.
- It will be difficult to retain tower people if we further reduce their total hours.
- Would lose the flexibility to staff towers on a moderate days to train and gain proficiency prior to reaching more critical indices.
- Tower people are typically advised of the next day’s staffing at the end of their shift. A predicted High day could turn out to be a Moderate day. A weather forecast may indicate the possibility of changing conditions, justifying having detection in place to be prepared for that possible weather event.
- Implementing detection on Moderate days may be very effective for law enforcement and prevention reasons prior to reaching more critical conditions for the season.

<u>Reduction Alternative 2</u> Eliminate detection in certain Fire Landscapes

This method would involve eliminating detection by Fire Landscape starting with the landscapes that have the lowest overall ranking and continuing until the desired level of reduction is achieved. Table a shows the estimated cost reduction associated with this method starting with Fire Landscape #10 and continuing in order through Landscape #15. Fire Landscapes 1,2, and 12 are primarily Coop and already rely solely upon citizen detection.

Towers near the edge of a Fire Landscape were associated with the highest ranked Fire Landscape that comprised a significant portion of their viewing area. Map 2 in Appendix A shows the location of fire towers within the Fire Landscapes. Map 3 displays tower names

Tower wages saved were calculated using the statewide average cost per tower. Aircraft cost savings were calculated using the average annual aerial detection cost by dispatch group as displayed in table c of objective 2. Tables b and c that follow, show cost reductions that would result by eliminating only towers or only aerial detection by Fire landscape, although that is not the proposal here.

Table a – Towers and Aerial Detection by Fire Landscape

Fire Landscape Number	Towers Closed	Annual Tower Wages Saved	Aerial Detection Routes Reduced	Annual Aircraft Costs Saved	Tower + Aircraft Savings	Cumulative Savings	Cumulative Percentage of Detection Costs
10	Rib River, North Mound	$3,448	1/2 of Antigo	$710	$4,158	$4,158	2.8%
6	none	$0	1/4 of Peshtigo	$1,002	$1,002	$5,160	3.5%
11	Cheteck	$1,724	none	$0	$1,724	$6,884	4.7%
3	none	$0	Dodgeville	$955	$955	$7,839	5.4%
16	Washburn, Flanigan	$3,448	none	$0	$3,448	$11,287	7.7%
14	Timberland, Shelton	$3,448	negligible	$0	$3,448	$14,735	10.1%
5	Mosinee, Quarry	$3,448	none	$0	$3,448	$18,183	12.4%
8	Kolpack, Perkinstown Wolf River, Lawrence Park Falls, Ladysmith Ogema, Swayne Worcester, Pattison Park Falls, Harmony Mellen, Marengo	$24,136	1/2 of Antigo, Cornell, 3/4 Park Falls, 1/4 Brule	$4,311	$28,447	$46,630	31.9%

13	Blue Hills, Sand Lake P Pipestone	$5,172	1/4 of Park Falls	$698	$5,870	$52,500	35.9%
9	Zenith, Lookout Jack Pine, Hodag Squirrel Hill, Indian Lake Muskellunge, Monahan	$13,792	Woodruff	$1,420	$15,212	$67,712	46.3%
4	Seymore, Wilson Twin Mound, Bruce Mound Saddle Mound, Knapp Oak Ridge, Norway WI Dells, Camp Douglas Quincy Bluff, Friendship Necedah, Dyracuse Cranberry Rock, Nursery	$27,584	3/4 of Black River Falls, WI Rapids, Waupaca	$10,558	$38,142	$105,854	72.3%
7	Bagley, Beaver Thunder Mt, Cedarville Dunbar, Buckeye	$10,344	3/4 Peshtigo	$3,007	$13,351	$119,205	81.4%
15	Sterling, Grantsburg Siren, Danbury McKenzie, Five Mile Lampson, Hayward Gordon, Highland Bennett, Brule Iron River	$22,412	Cumberland, 3/4 Brule	$4,785	$27,197	$146,402	100.0%
Totals		$118,956		$27,446	$146,402	$146,402	100.0%

* 1/2 of the Woodruff cost was attributed to the Antigo Route
* 1/4 of the Black River cost was attributed to the Cornel Route
* this table estimates cost reduction beyond the towers identified for closure in 2010.

Table b – Towers by Fire Landscape

Fire Landscape Number	Towers Closed	Number of Towers Closed	Annual Tower Wages Saved	Cumulative Savings	Cumulative Percentage of Detection Costs
10	Rib River, North Mound	2	$3,448	$3,448	2.4%
6	none		$0	$3,448	2.4%
11	Cheteck	1	$1,724	$5,172	3.5%
3	none		$0	$5,172	3.5%
16	Washburn, Flanigan	2	$3,448	$8,620	5.9%
14	Timberland, Shelton	2	$3,448	$12,068	8.2%
5	Mosinee, Quarry	2	$3,448	$15,516	10.6%
8	Kolpack, Perkinstown Wolf River, Lawrence Park Falls, Ladysmith Ogema, Swayne Worcester, Pattison Park Falls, Harmony Mellen, Marengo	14	$24,136	$39,652	27.1%
13	Blue Hills, Sand Lake P Pipestone	3	$5,172	$44,824	30.6%
9	Zenith, Lookout Jack Pine, Hodag Squirrel Hill, Indian Lake Muskellunge, Monahan	8	$13,792	$58,616	40.0%
4	Seymore, Wilson Twin Mound, Bruce Mound Saddle Mound, Knapp Oak Ridge, Norway WI Dells, Camp Douglas Quincy Bluff, Friendship Necedah, Dyracuse Cranberry Rock, Nursery	16	$27,584	$86,200	58.9%
7	Bagley, Beaver Thunder Mt, Cedarville Dunbar, Buckeye	6	$10,344	$96,544	66.0%
15	Sterling, Grantsburg Siren, Danbury McKenzie, Five Mile Lampson, Hayward Gordon, Highland Bennett, Brule Iron River	13	$22,412	$118,956	81.3%
totals		69	$118,956	$118,956	81.3%

* This table estimates cost reduction beyond the towers identified for closure in 2010.

Table c – Aerial Detection by Fire Landscape

Fire Landscape Number	Aerial Detection Routes Reduced	Annual Aircraft Costs Saved	Cumulative Savings	Cumulative Percentage of Detection Costs
10	1/2 of Antigo	$710	$710	0.5%
6	1/4 of Peshtigo	$1,002	$1,712	1.2%
11	none	$0	$1,712	1.2%
3	Dodgeville	$955	$2,667	1.8%
16	none	$0	$2,667	1.8%
14	negligible	$0	$2,667	1.8%
5	none	$0	$2,667	1.8%
8	1/2 of Antigo Cornell 3/4 Park Falls 1/4 Brule	$4,311	$6,978	4.8%
13	1/4 of Park Falls	$698	$7,676	5.2%
9	1/*2 Woodruff	$1,420	$9,096	6.2%
4	3/4 Black River WI Rapids Waupaca	$10,558	$19,654	13.4%
7	3/4 Peshtigo	$3,007	$22,661	15.5%
15	Cumberland 3/4 Brule	$4,785	$27,446	18.7%
totals		$27,446	$27,446	18.7%

* 1/2 of the Woodruff cost was attributed to the Antigo Route
* 1/4 of the Black River cost was attributed to the Cornell Route

<u>Advantages of this alternative</u>:

- It prioritizes detection in Fire Landscapes where delayed response is likely to have the greatest consequence.
- Avoids eliminating scattered individual towers across the state making the residual towers less effective due to a reduction in crossing towers. This could result in an increased use of aerial detection to compensate.
- This method acknowledges that detection efficiency within individual Dispatch Groups has been largely achieved through past tower reduction efforts and tight local budgets.

<u>Disadvantages of this alternative</u>:

- Although fires in the lower risk landscapes may not have the same potential as the higher risk landscapes, if they are areas protected by the DNR it is still in our interest to detect fires early and efficiently suppress them, minimizing suppression costs as well as property and resource damage.

- The areas that would lose organized detection first will typically be the areas with the fewest DNR resources and longer response times.

- The detection currently provided in the lower ranked landscapes has saved property, resources and suppression expenses in the past. The detection efforts are not necessarily ineffective.

<u>Reduction Alternative 3</u> Eliminate the use of aerial detection when fire towers are staffed.

This option would eliminate aerial detection flights while fire towers are staffed. While both aerial detection and towers are in use, towers locate 40% of the fires and planes 6%. We cannot quantify how frequently detection routes are flown while towers are staffed. An informal survey of Area Leaders indicates that it is not uncommon to do so once the adjective level begins to approach very high but there was some variation across the state. The survey answers indicated that efforts to reduce costs at the area level have already reduced the practice of using towers and detection flights simultaneously.

<u>Advantages of this alternative</u>:

- Maintains detection in any landscape where it currently exists.
- Does not required the closure of additional towers

<u>Disadvantages of this alternative:</u>

- Limits an Area Leader's options

- Having both detection methods in place may be desirable during very windy conditions when smokes are the most difficult for towers to pick up and delayed response will have greater impacts.

- Aerial detection may be needed to fill in gaps in tower coverage created by past tower closings or by tower vacancies.

- Aerial detection may be needed to supplement tower detection in specific areas with high occurrence of arson or high hazards such as blown down timber.

- By having the plane in the air during the peak burning periods of very high and extreme days it may have a quicker response time to a reported fire for use as a suppression resource.

Reduction Alternative 4 Reduce the number of towers used based on Fire Risk within the towers viewing area.

Appendix B Table 6 ranks towers by the average Fire Risk within a 12 mile buffer around the tower. Each tower that might be decommissioned would reduce annual detection costs by an average of $1,724 or about 1.2%. Decommissioning the lowest ranked 10% of active towers would reduce detection costs by $12,068 or about 8.2%. The following towers that fall into that category: Lawrence, Matson (N), Ladysmith, Rib River, Cheteck, Seymore, Perkinstown, and Mosinee.

Advantages of this alternative:

- Ensures that towers that see the lowest mean fire risk are reduced first

Disadvantages of this alternative:

- Picking scattered individual towers could reduce the ability of the remaining towers to get crosses.
- Leaving scattered holes in tower coverage may increase the use of aerial detection to provide coverage for those gaps.
- There may be local factors that make individual towers important, that may not be reflected in this method of ranking. (topography, history of high fire occurrence, etc.)

Reduction Alternative 5 Replace tower detection with aerial detection.

The following table attempts to compares the cost of tower detection in a dispatch group to the cost of equivalent aerial detection. The characteristics and quality of detection provided by these two different methods make them difficult to compare.

The towers costs were calculated based on towers staffing as reported to the Daily Fire Summary over a three year period from 2005 through 2007. The following table was calculated using an average tower wage of $9.20/hr and only included the towers approved for staffing in 2010. Aerial Detection Costs include 2 routes for each day at Moderate and High on days when towers were staffed and three routes at Very High and Extreme on days when towers were staffed. The cost for the Antigo Route was divided among Woodruff, Waupaca and WI Rapids. The Brule route that was used includes coverage for the east side of the dispatch group. The cost used for that route is $585 for 2 routes and $848 for three routes. The cost of the other individual routes can be found in table d of objective 2. Costs reflect a minimum to fly the route without deviation or delay.

Dispatch Group	2010 Tower Numbers	Annual Tower Cost	Cost of Aerial Coverage	Predicted Budget Change
Dodgeville	0	$0	$0	$0
Waupaca	1	$1,596	$2,548	$952
Rapids	10	$19,970	$16,974	-$2,996
Peshtigo	6	$10,103	$14,900	$4,797
Black River	9	$17,739	$12,771	-$4,967
Park Falls	14	$19,616	$15,329	-$4,287
Woodruff	10	$15,904	$19,642	$3,738
Brule	10	$18,958	$25,739	$6,781
Cumberland	9	$15,277	$9,946	-$5,331
Total	69	$119,163	$117,849	-$1,314

Advantages of this alternative:

- Eliminated the hiring process and supervision of tower staff.
- Could reduce the number of non-reportable runs
- Easier to schedule than fire towers
- Eliminated the need to maintain fire tower infrastructure

Disadvantages of this alternative:

- Replaces continuous coverage with periodic flights.
- When the aircraft is assigned to suppression roll detection is lost.
- There are no backup aircraft right now. There are 10 primary routes and 10 planes.
- To ensure continuous aerial detection an aircraft dedicated solely to detection would be required. See Appendix D for details on the cost of contracted aerial detection used by the USFS in Wisconsin.

Reduction Alternative 6 Identify additional individual fire towers for elimination based on past effectiveness.

This method considers eliminating the towers that have saved the fewest structures and acres and that have spotted the fewest fires in recent years. It follows the methodology used in the last fire towers study to identify fire towers for closure. Simply put, the towers that have recorded the least savings should be the first towers eliminated. Appendix B contains tower rankings by structures saved, acres saved and first sightings.

From 2000 through 2008 there were 6 towers that had less than 1 first sighting per year, 0 structures saved, and less than 1 acre saved per year. Three of those 6 have already been identified for closure starting in 2010. Closing the other three (Mellen, Worcester and Timberland) would save about $5,172 annually (3.5%)

Eliminating additional towers that saved 0 structures and less than 1 acre per year regardless of how many fires they detected would include three additional towers (Cedarville, Perkinstown and Marengo) saving another $5,172 annually bringing the total to $10,344 (7.1%)

Five additional towers saved 0 structures and less than 5 acres per year. Two of those have been identified for closure in 2010 already. Closing the other three (Iron River, Ladysmith and Pipestone) would save an additional $5,172 bringing the total to $15,516 (10.6%).

Advantages of this alternative:

- None of the towers identified for closure have been attributed with a saved structure in the 9 year period studied.

Disadvantages of this alternative:

- This method does not take into consideration the fire risk in the area of the tower.
- This method of reductions could result in patchy residual tower coverage potentially eliminating important crosses for the remaining towers.
- Doesn't consider the value of supplemental information provided by towers.
- The statistics for an individual tower reflect upon the past performance of the individuals who staffed the tower as well the location of the tower. A very well placed tower could have poor statistics as a result of a poor quality tower person. The quality of the tower personnel that we are able to hire and retain is a separate issue.
- Past performance may not always be a reliable indication of a tower's value. In 1997 the last fire tower study determined that Sand Lake Tower in the Waupaca Dispatch Group 'does not appear to warrant continued staffing – but was identified for transfer to the Menominee Tribe' In the 9 year period evaluated for this study, that tower was the first reporter for 28 fires, saving 11 structures and 22 acres.

Change in Investment

Increase in Resources

If additional resources were available to improve detection we would first recommend building new towers in high risk Fire Landscapes were they currently do not exist (Alternative 1). Next we would recommend increasing aerial detection where towers do not exist (Alternative 2).Following that we would seek to improve the pool of tower person candidates by increasing wages (Alternative 3). Our final alternative would be to staff decommissioned towers (Alternative 4)

Alternatives Considered

Each of the following alternatives identifies increases beyond the towers approved for staffing in the spring of 2010. Estimated costs were calculated using the average cost per tower of $1,724 determined in tables 2b and aerial detection cost identified in table 2c of objective 2. The annual detection cost in 2010 using those figures would be $146,379.

Increase Alternative 1 Build new towers in high risk Fire Landscapes were they currently do not exist.

This alternative seeks to fill gaps in tower coverage in the higher risk Fire Landscapes by adding to the fire tower infrastructure in those locations. The areas of highest fire risk in the Waupaca Dispatch group (Fire Landscape #4) lack any tower coverage. There are no other areas of the state with such a large area of high fire risk that do not have fire towers. Other towers located in Fire Landscape #4 have been successful at detecting fires and saving values at risk. From 2000 through 2008 the active towers in FL#4 have averaged 1 structure saved, 8 acres saved and 2.6 initial fire reports per tower each year. Another consideration is the importance of the supplemental benefits and information that towers provide in these critical fire landscapes.

The addition of 3 towers, depending on their placement, could cover the majority of this high risk area at a staffing cost of about $5,172 per year (a 3.5% increase). It would of course require the construction of 3 towers at an estimated cost of $110,000 per tower for a total of $330,000.

If placement of the towers was less optimal, 4 towers may be required to cover the area of concern. In that case the staffing cost would increase to $6,896 per year (a 4.7% increase) and would increase the construction cost to around $440,000.

Advantages of this alternative:

- This would provide for continuous detection in that area of high risk while the aircraft is being used for suppression purposes.
- The use of aerial detection routes would likely decrease as a result of having tower coverage in the higher risk portions of the Dispatch Group.

Disadvantages of this alternative

- Cost of the new towers
- Additional infrastructure to maintain

Increase Alternative 2 Increase aerial detection where towers do not exist.

This proposal is to increase the aerial detection in Dodgeville and Waupaca bringing the level of detection closer to that which is provided by fire towers in other dispatch groups. This would be done by flying the Dodgeville route twice daily on half of the days at High and each day at Very high or Extreme. The Waupaca route would be flown twice daily on half of the days at High and three times daily at Very High and Extreme. The number of days at each adjective level used to calculate cost was gathered from the Daily Fire Summary (2005 through 2007). The increase is as follows:

	Cost of Proposed Aerial Coverage	Estimated Current Cost	Added Cost of Proposal	Increase in Detection Costs
Waupaca	$12,045	$2,863	$9,182	6.3%
Dodgeville	$25,704	$955	$24,749	16.9%
total	$37,748	$3,818	$33,930	23.2%

Advantages of this alternative:

- This would allow for more continuous detection in these areas without fire towers. Other dispatch groups currently have that continuous detection in the form of fire towers.

- Provides for increased detection without adding to the fire tower infrastructure.

Disadvantages of this alternative

- There is no detection when the plane is being used for suppression purposes.

Increase Alternative 3 Improve effectiveness of existing towers by increasing the candidate pool for fire tower jobs.

Increasing tower person wages could help to recruit and retain competent and reliable tower people. Many comments from the field have stated that the quality of the tower person is directly related to the success of the tower. Raising tower person wages across the board would result in the following cost increases:

	Tower Wage	Average Tower Cost	Detection Cost Increase	Percent Increase
(current)	$9.20	$1,724.00	0	0%
	$10.00	$1,873.00	$12,290.00	8%
	$11.00	$2,061.00	$27,654.00	19%
	$12.00	$2,248.00	$43,017.00	29%
	$13.00	$2,435.00	$58,380.00	40%

Advantages of this alternative:

- Helps us maximize the effectiveness of one component of our existing detection system.
- Easy to implement
- Better tower people detect fires earlier, reduce mileage and response time with more accurate tower shots, and improve prevention through early detection of non-reportables.

Disadvantages of this alternative

- Even with better pay there are other hurdles including the unpredictable schedule and limited number of total hours per season.

Increase Alternative 4 Staff more existing towers

This alternative seeks to utilize more of our existing fire tower infrastructure. Prioritization of those towers to be activated could be done in several different ways. See Appendix A Map 4 showing inactive tower buffers by Fire Landscape and displays Fire Risk.

a) Reactivate in order of the overall risk rating of the Fire Landscapes that the tower supports. This method would activate towers in the following priority
:

Fire Landscape Number	Towers Closed	Number of Towers	Annual Tower Wages	Cumulative Cost	Cumulative Increase of Detection Costs
15	Clevedon, Frederic	2	$3,448	$3,448	2.4%
7	Middle Inlet, Goodman	2	$3,448	$6,896	4.7%
4	Greenfield	1	$1,724	$8,620	5.9%
9	Springstead, Pine Lake	2	$3,448	$12,068	8.2%
8	Matson, Kent Rindt, Gilman Ruby, Flambeau Stang, Meteor Connor's Lake, Lugerville Glidden, Dairyland	12	$20,688	$32,756	22.4%
10	Vilas	1	$1,724	$34,480	23.6%
totals		20	$34,480	$34,480	23.6%

b) Reactivate towers based on the level of risk which that towers sees.

Visual analysis of the level of risk in a 12 mile buffer around each tower placed the towers in 4 groups. The first group includes towers that saw high risk landscape in half or more of their viewing area. The second group saw high risk landscapes but less than the first category. The third saw mostly moderate risk landscape. The fourth group saw primarily lower risk landscapes. Appendix B Table 6 ranks fire towers based on the average fire risk within a 12 mile viewing area.

Risk Groups	Towers Activated	# towers	Annual Tower Wages	Cumulative Cost	Cumulative Increase of Detection Costs
1	Goodman, Springstead Meteor, Clevedon	4	$6,896	$6,896	4.7%
2	Greenfield, Middle Inlet	2	$3,448	$10,344	7.1%
3	Pine Lake, Frederic Connors Lk, Lugerville Rindt	5	$8,620	$18,964	13.0%
4	Dairyland, Glilman Stang, Glidden Vilas, Kent Flambeau, Matson Ruby	9	$15,516	$34,480	23.6%
totals		20	$34,480	$34,480	23.6%

* this table estimates cost increases beyond the towers approved for use in 2010.