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An Evaluation of Two-Stage Burn Bans in Washington

Report to the Legislature

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- Air quality forecasters at Washington's local air quality agencies, Department of Natural Resources, EPA, and tribal lands
- Public outreach and communication staff and field inspectors of the above agencies

Executive Summary

Report purpose

In 2008, the Washington State Legislature revised Washington law related to temporary bans on woodstove and fireplace use during periods of high air pollution. RCW 70.94.473 states:

The department (Ecology) and local air pollution control authorities shall evaluate the effectiveness of the burn ban programs contained in this section in avoiding fine particulate levels to exceed thirty-five micrograms per cubic meter, measured on a twenty-four hour average, and provide a joint report of the results to the legislature by September 1, 2011.

This report evaluates the effectiveness of the revised law in preventing exceedances of the federal fine particle pollution (PM_{2.5}) standard.

PM_{2.5} pollution and burn bans

PM_{2.5} pollution is made up of tiny particles that are smaller than 2.5 microns in size (about 30 times smaller than the width of a human hair). PM_{2.5} is a health concern because the particles are so small that they can easily penetrate lung tissue and cause or worsen heart and lung diseases, heart attacks, strokes, asthma, and pneumonia. EPA and delegated states, including Washington, regulate PM_{2.5} pollution under the federal Clean Air Act and state statute. Burn bans restricting the use of woodstoves have historically been a tool for reducing PM_{2.5} pollution. Air quality agencies call burn bans when pollution in an area reaches unsafe levels. PM_{2.5} pollution can reach unhealthy levels in Washington communities during wintertime when many people burn wood to heat their homes. The vast majority of burn bans are called during the heating season which Ecology and local air agencies define as the period beginning on October 1st of a given year and ending on March 31st of the following year.

In December 2006, EPA toughened the federal PM_{2.5} standard from 65 micrograms per cubic meter of air ($\mu\text{g}/\text{m}^3$) to 35 $\mu\text{g}/\text{m}^3$ to better protect health. The 2008 Washington State Legislature passed Senate Bill 6753 which updated the burn ban program to address this more stringent standard. The former program, which was designed to prevent exceedances of the previous standard, allowed pollution to build up to levels well above the revised standard before a burn ban could be called.

How the program was evaluated

There were less than two complete heating seasons under the 2006 PM_{2.5} standard with which to compare against the three complete heating seasons following changes to the burn ban statute. In addition, there can be large variations in the number, location, scope and severity of stagnant air events from year to year. These factors prevented robust statistical comparisons between the pre and post burn ban statute revision periods under the 2006 standard. Rather than rely on these

statistically limited comparisons, we analyzed individual burn bans that occurred following the changes to the statute.

Ecology and local air quality agencies recorded air quality and burn ban data during the 2008-2010 heating seasons. Ecology then combined meteorological data with air quality information in areas where burn bans were called. We analyzed this information to see how pollution levels were affected. We also looked at bans by type (Stage 1 and 2) to determine whether one was more effective than the other, and we determined how long it took following the implementation of a ban for reductions in pollution levels to start to occur.

Results

Many factors influence a burn ban's effectiveness, including weather, topography, and human behavior. The combination and varying degree of influence of these factors make it difficult to isolate and quantify how effective the updated burn ban program has been at reducing PM_{2.5} levels and preventing exceedances of the standard. Despite these challenges, it was possible to draw some conclusions from our analysis.

While exceedances of the standard did occur following implementation of the revised burn ban program, our evaluation of the available air quality and burn ban data, along with the experiences of burn ban program forecasters and outreach and enforcement professionals, lead to the following findings:

- Stage 1 burn bans did not noticeably reduce PM_{2.5} pollution levels.
- Stage 2 burn bans help limit PM_{2.5} pollution during some wintertime air stagnation events but reductions did not occur until at least the second day of the bans.
- Public understanding of and compliance with burn bans varies widely.
- Insufficient tools and resources limit the effectiveness of compliance and outreach efforts related to burn bans.

Options

Based on the conclusions above, the following components of the burn ban program could be improved and may increase its effectiveness at reducing PM_{2.5} levels, preventing exceedances of federal standards, and better protect public health. The extent of any such improvements would be limited by the availability of resources and budget constraints.

- More effective application of burn bans such as calling burn bans earlier, well before conditions cause pollution to build up or basing all burn calls on forecasted weather and air quality conditions. This may require statutory change to RCW 70.94.473. Legislation has been introduced in the 2012 session that proposes improvements consistent with this approach.
- Improve communication approaches and invest more in outreach for burn bans so the public receives more timely information and better understands their responsibilities. Ecology and local air agencies have begun working on a collaborative effort to better

organize and leverage existing resources from interested government agencies, industry, and community groups. Work continues in wood smoke affected communities to help media better understand and communicate information on burn bans.

- Improve compliance tools and increase staffing during burn bans to ensure proper woodstove operation and use. Using no visible smoke as the indicator for proper operation may simplify both communication and compliance during burn bans. Ecology and local air agencies are discussing approaches, sharing techniques, and beginning to pilot new methods to aid compliance.

Introduction

Report purpose

RCW 70.94.473 requires Ecology and local air quality agencies to submit a report to the legislature by September 1, 2011. The report must evaluate the effectiveness of Washington's revised two-stage burn ban law in preventing exceedances of the federal daily fine particle pollution (PM_{2.5}) standard.

PM_{2.5} pollution in Washington

Wood smoke is one of the main sources of air pollution in Washington. Woodstoves, fireplaces, and other solid fuel burning devices emit much more air pollution than other sources of heat such as natural gas or electricity.

One of the main pollutants of concern from wood smoke is PM_{2.5}. On cold, clear, and calm winter days, heavy woodstove use is the main cause of unhealthy levels of PM_{2.5}. PM_{2.5} pollution can cause or worsen health problems including:

- Heart disease, heart attacks, and strokes
- Lung diseases
- Asthma
- Pneumonia

The Washington State Department of Ecology (Ecology) estimates that fine particle pollution kills over 1,100 Washington residents and costs the state about \$200 million every single year. (See the Department of Ecology's report "Health Effects and Economic Impacts of Fine Particle Pollution in Washington" at <http://www.ecy.wa.gov/pubs/0902021.pdf>).

Currently, a large portion of Pierce County does not meet the federal PM_{2.5} standard. Several other areas are at risk of violating the standard including Yakima, Darrington, Marysville, Wenatchee, and Vancouver. In all of these areas, wood smoke is the largest contributor to PM_{2.5}.

In addition to affecting human health, violations of air quality standards have economic consequences for affected communities. These may include tighter regulations on businesses and growth, loss of community reputation, and loss of federal highway dollars.

Washington's burn ban program

Historically, burn bans that restrict the use of woodstoves have been one tool for reducing PM_{2.5} pollution. Washington State law allows Ecology or a local air quality agency to call a burn ban when PM_{2.5} in an area reaches unsafe levels (EPA and tribes administer burn ban programs on reservations).

Burn bans may be called in two stages:

- Stage 1: The use of all uncertified wood heating devices is banned when pollution approaches unhealthful levels.
- Stage 2: All wood heating is banned when pollution reaches an even higher level.

Burn bans do not apply to homes with no other source of adequate heat. All outdoor burning is also banned during burn bans.

Bans are typically called across a whole county, with the exception of the upper and lower Yakima Valley and the Spokane Metropolitan area. This is mainly to make public communication easier.

Changes to the burn ban program

The 2008 Washington State Legislature passed Senate Bill 6753 which updated the burn ban in RCW 70.94.473 to address EPA's updated PM_{2.5} standard. In 2006, EPA toughened its PM_{2.5} standard from 65 micrograms per cubic meter of air ($\mu\text{g}/\text{m}^3$) to $35\mu\text{g}/\text{m}^3$ to better protect health. Because the standard is now much lower, the former two-stage burn ban program was not sufficient to keep PM_{2.5} pollution below the standard during the home heating season. The home heating season is the period beginning on October 1st of a given year and ending March 31st of the following year. For the purposes of this report, heating seasons are denoted by the year on which the season begins. For example, the 2008 heating season is the season that began on October 1, 2008 and ended on March 31, 2009.

Like the original law, the 2008 revision allows Ecology or an air quality agency to call a Stage 1 ban and, if air quality worsens, then call a Stage 2 ban. However, when meteorological and air quality conditions are worsening rapidly, the revised law allows agencies to call a Stage 2 burn ban without first calling a Stage 1 (i.e., Direct-to-Stage 2 ban).

Overview of Washington's Burn Ban Program

How burn bans are called

Stage 1

Air quality agencies call **Stage 1** burn bans when:

- Based on meteorological observations and forecast model guidance, trained and experienced air quality staff predicts that high PM_{2.5} conditions will continue and will probably not disperse for at least 24 hours;
- PM_{2.5} levels are forecast to exceed 35 micrograms per cubic meter (35 µg/m³), calculated as a 24-hour running average, within 48 hours; and
- Air quality agency staff determines that smoke from home heating is likely to be a significant contributor to PM_{2.5} levels, and that reducing indoor burning is reasonably expected to reduce PM_{2.5} health effects.

Stage 2

Agencies call **Stage 2** burn bans when:

1. A Stage 1 burn ban *has* been issued and all of the following conditions are met:
 - The 24-hour PM_{2.5} running average has reached or exceeded 25 µg/m³.
 - Based on meteorological observations and forecast model guidance, air quality agency staff predicts that high PM_{2.5} conditions will continue and will probably not fall below 25 µg/m³ for at least 24 hours.
 - Air quality agency staff determines that smoke from home heating is likely to be a significant contributor to the PM_{2.5} levels and that reducing burning from home heating is reasonably expected to reduce the impact of particulate matter on public health.
2. A Stage 1 burn ban *has not* been issued and all of the following conditions are met:
 - The 24-hour PM_{2.5} running average has reached or exceeded 25 µg/m³.
 - Meteorological conditions have caused PM_{2.5} levels to rise rapidly.
 - PM_{2.5} levels are forecast to exceed 35 µg/m³, calculated as a 24-hour running average, within 24 hours.
 - Based on meteorological observations and forecast model guidance, air quality agency staff predict that high PM_{2.5} conditions will continue and will probably not fall below 25 µg/m³ for at least 24 hours.
 - Air quality agency staff has determined that smoke from home heating is likely to be a significant contributor to the PM_{2.5} levels and reducing burning from home heating is reasonably expected to reduce the impact of particulate matter on public health.

Evaluation method

Ecology and local air quality agency forecasters, outreach experts, and enforcement professionals evaluated their experiences implementing the updated burn ban program. They also reviewed meteorological, air quality, and burn ban data for areas where burn bans were called during the 2008-2010 home heating seasons. Data included:

- County in which the ban was called
- Start and end time of the ban
- Stage of the ban
- PM_{2.5} trends during the ban
- Forecast meteorology and other factors considered when issuing the ban
- Any enforcement actions taken or penalties issued

Ecology combined this data with PM_{2.5} and meteorological data recorded in areas where burn bans were called over the past three heating seasons.

Ecology attempted several data analysis techniques to determine the effectiveness of two-stage burn bans, including:

- Statistical modeling to account for variations in meteorology
- Cluster analysis to identify days with similar meteorology
- Trend analysis during stagnation episodes
- Other exploratory data analyses

Overall effectiveness of bans

How well a burn ban works at ending or avoiding an exceedance of the federal PM_{2.5} standard depends on a number of factors. There are three general elements:

- Accurate implementation of burn bans (calling burn bans at the appropriate times)
- Timely/effective communication to the public that a burn ban is in effect
- Actual levels of compliance with burn bans.

Burn bans were mostly called during periods of poor air circulation. During the period covered by this report, some conditions merited the rapid movement from a Stage 1 to a Stage 2 ban, or the use of the Direct-to-Stage 2 process outlined in the RCW. But forecasters and communicators also try to avoid “media saturation.” Saturation is thought to occur when burn bans are called on and off frequently, running the risk of the public paying little to no attention to future bans.

The effectiveness of bans depends on the accuracy of forecasts and human behavior. For example, in a few instances, winds blew slightly stronger than predicted immediately after a burn ban was called, lowering PM_{2.5} levels and making the ban appear to be effective. At other times, a forecasted increase in wind that an agency hoped would help ventilate an area and avoid the

need for a ban, turned out to be insufficient to clear out the pollution. Heavier-than-anticipated use of woodstoves, even those that are certified, especially on weekends, holidays, or particularly cold nights, can overwhelm the airshed in spite of a burn ban. These factors, plus statewide differences in public communication methods and compliance levels, can reduce a burn ban's effectiveness.

Compliance

Compliance with burn bans varies geographically and with the frequency of burning activity. Some local air quality agency field inspector reports cite widespread non-compliance with burn bans. In 2010, the Washington members of the Northwest Air Quality Communicators (a group of communications professionals from air quality agencies in Washington, Oregon, Idaho, and British Columbia) conducted a statewide survey of Washington residents who frequently burn wood as a source of heat. According to the survey, 68% of respondents described themselves as complying with burn bans either "all the time" (56%) or "most times" (12%). However, a subgroup of survey respondents from around the state that participated in three follow-up focus groups unanimously agreed they would choose to ignore burn bans in order to stay warm, even if they had access to an adequate alternative source of heat.

Ecology and local air agencies announce burn bans through radio, TV, print media, the internet, and social media (Twitter, Facebook). The use of such media varies by agency and jurisdiction. Compliance with burn bans is affected by a variety of challenges posed in communicating a ban in addition to how well the public understands that a ban, including the type of ban, is in place. Factors that may limit compliance include the following:

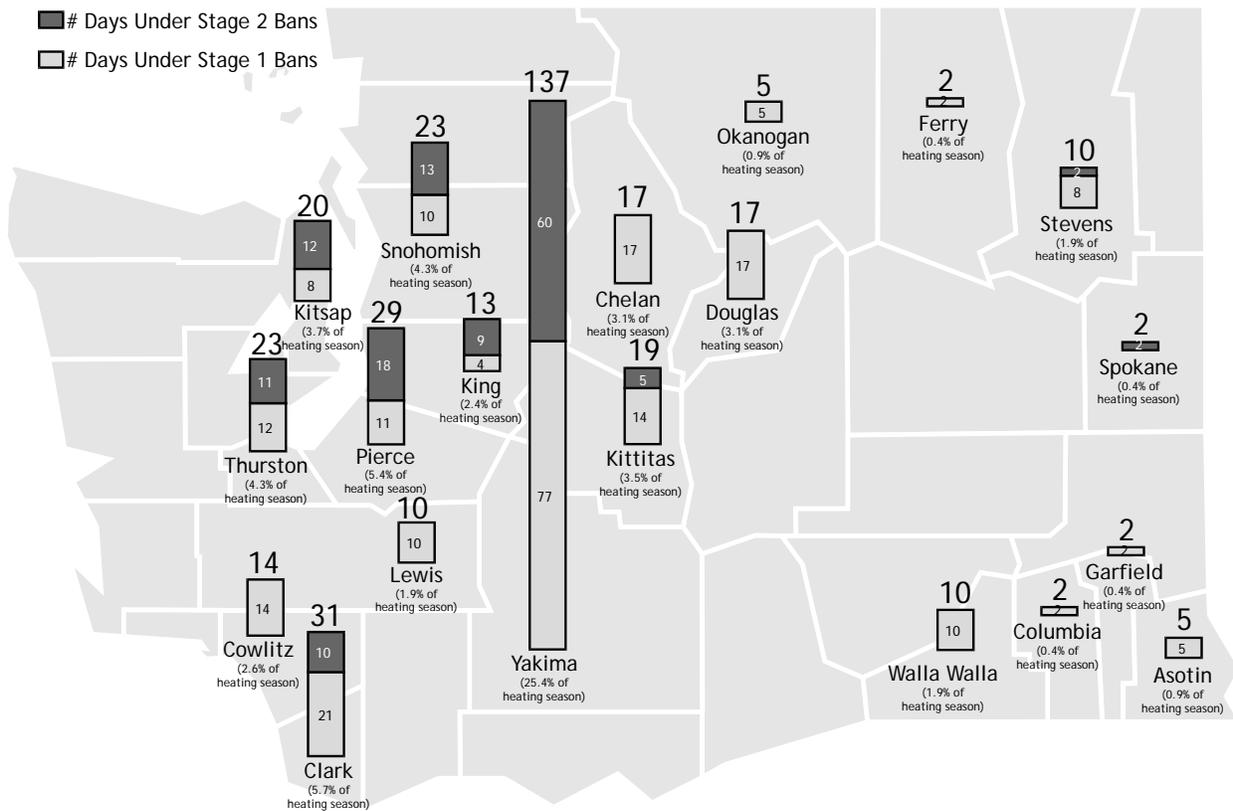
- Coverage by local TV news stations is spotty and varies by jurisdiction. Urban counties typically receive more coverage than rural areas.
- The National Weather Service (NWS) does not routinely include burn ban information in its air stagnation advisories that are shared with the media. At the time of this writing, these air stagnation advisories make only general generic references to local burn bans. We are working with the NWS to help them provide more consistent and specific burn ban messaging in its advisories.
- Demographics vary from region to region and are likely to affect how and when people hear of a burn ban.
- Some areas of the state may be best served by translation services. These services may not always be available.
- Air quality may deteriorate rapidly enough that there is limited time in which to communicate to the public that a burn ban is in place, making it less likely that they have sufficient time to switch to an alternative source of heat. The consensus among forecasters and communicators was that without a lead time of at least one day, it is unlikely that burn ban messages can be effectively communicated to the public.
- People don't always operate their woodstove or other device properly. Operating these devices according to the manufacturer's manual will maximize efficiency (heat output) and minimize smoke.
- Some people may continue to burn during a Stage 1 ban because they are unaware that their stove is uncertified.

- Some people may continue to burn during burn bans because they consider it their only source of adequate heat or only affordable source of heat.

Due to the variables discussed above and the fact that there were only a few years of data to analyze, it is difficult to be certain of the effectiveness of burn bans across the state. Overall, the data show that some Stage 2 bans worked in some areas, while others made little difference.

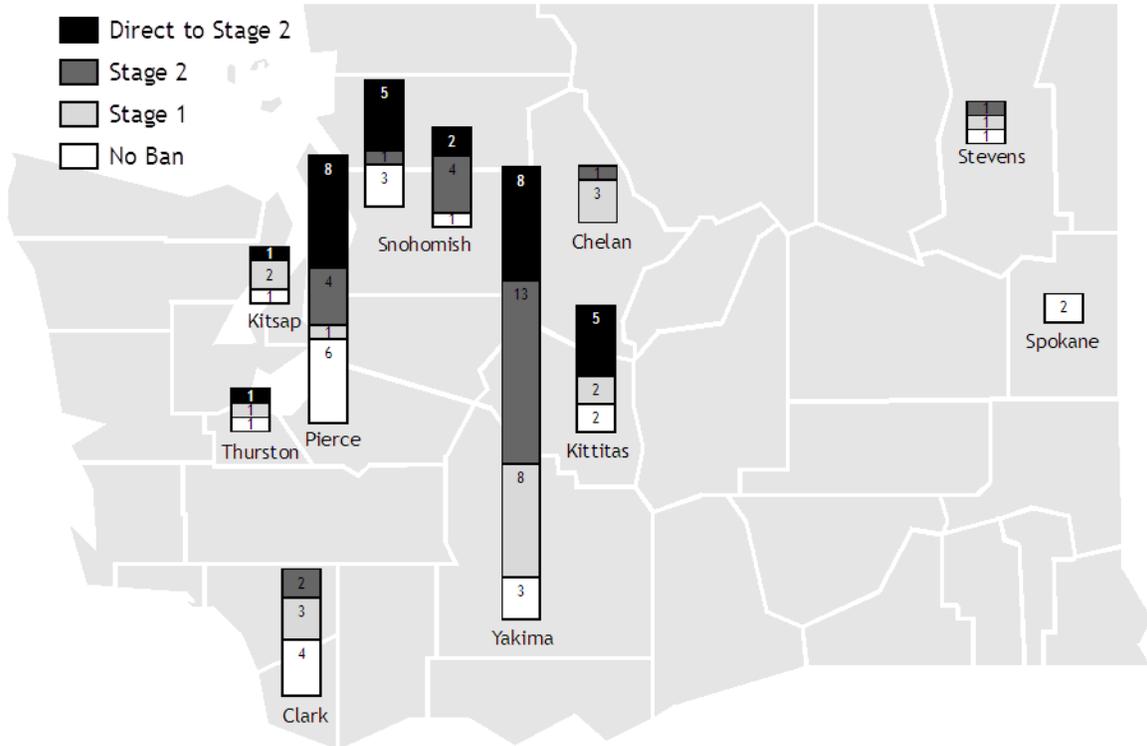
Figure 1 (below) shows the number of days that counties were under a burn ban during the three home heating seasons that were evaluated for this report. Statistics for counties in which no burn ban was called during the period are not shown. As the figure shows, Yakima County spent more days under burn bans more often than other counties. During the home heating seasons we evaluated, Yakima frequently experienced relatively higher PM_{2.5} pollution levels than other counties.

Figure 1: Number of days under burn bans by county over 3 home heating seasons (2008-2010 seasons)



Based on the limited data we have, it appears that some Stage 2 burn bans reduced PM_{2.5} levels some of the time at some locations. However, it is not clear if these bans reduced the number of times a given location exceeded the PM_{2.5} standard. As figure 2 (below) shows, exceedances of the standard still occurred, even when burn bans were in place. Statistics for counties in which no exceedances occurred during the evaluation period are not shown.

Figure 2: Burn bans in Washington counties on days exceeding the federal daily PM_{2.5} standard (2008-2010 heating seasons)



Results and Options for Improving the Burn Ban Program

Results

Many factors influence a burn ban's effectiveness, including weather, topography, and human behavior. The combination and varying degree of influence of these factors make it difficult to isolate and quantify how effective the updated burn ban program has been at reducing PM_{2.5} levels and preventing exceedances of the standard. Despite these challenges, it was possible to draw some conclusions from our analysis.

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