Ragweed Pollen Season

Identification

1. Indicator Description

This indicator describes trends in the annual length of pollen season for ragweed (*Ambrosia* species) at 11 North American sites from 1995 to 2015. In general, by leading to more frost-free days and warmer seasonal air temperatures, climate change can contribute to shifts in flowering time and pollen initiation from allergenic plant species, and increased carbon dioxide concentrations alone can elevate the production of plant-based allergens (Melillo et al., 2014). In the case of ragweed, the pollen season begins with the shift to shorter daylight after the summer solstice, and it ends in response to cold weather in the fall (i.e., first frost). These constraints suggest that the length of ragweed pollen season is sensitive to climate change by way of changes to fall temperatures. Because allergies are a major public health concern, observed changes in the length of the ragweed pollen season over time provide insight into ways in which climate change may affect human well-being.

2. Revision History

December 2012:	Indicator published.
May 2014:	Updated indicator with data through 2013.
August 2016:	Updated indicator with data through 2015.

Data Sources

3. Data Sources

Data for this indicator come from the National Allergy Bureau. As a part of the American Academy of Allergy, Asthma, and Immunology's (AAAAI's) Aeroallergen Network, the National Allergy Bureau collects pollen data from dozens of stations around the United States. Canadian pollen data originate from Aerobiology Research Laboratories. The data were compiled and analyzed for this indicator by a team of researchers who published a more detailed version of this analysis in 2011, based on data through 2009 (Ziska et al., 2011).

4. Data Availability

EPA acquired data for this indicator from Dr. Lewis Ziska of the U.S. Department of Agriculture, Agricultural Research Service. Dr. Ziska was the lead author of the original analysis published in 2011 (Ziska et al., 2011). He provided an updated version for EPA's indicator, with data through 2015.

Users can access daily ragweed pollen records for each individual U.S. pollen station on the National Allergy Bureau's website at: www.aaaai.org/global/nab-pollen-counts. *Ambrosia* spp. is classified as a "weed" by the National Allergy Bureau and appears in its records accordingly. Canadian pollen data are not publicly available, but can be purchased from Aerobiology Research Laboratories at: www.aerobiology.ca/products/historical-data.

Methodology

5. Data Collection

This indicator is based on daily pollen counts from 11 long-term sampling stations in central North America. Nine sites were in the United States; two sites were in Canada. Sites were selected based on availability of pollen data and nearby weather data (as part of a broader analysis of causal factors) and to represent a variety of latitudes along a roughly north-south transect. Sites were also selected for consistency of elevation and other locational variables that might influence pollen counts.

Table TD-1 identifies the station locations and the years of data available from each station.

Table TD-1. Stations Reporting Ragweed Data for this Indicator

Station (ordered from north to south)	Start year	End year	Notes
Saskatoon, Saskatchewan (Canada)	1994	2015	
Winnipeg, Manitoba (Canada)	1994	2015	
Fargo, North Dakota	1995	2012	Stopped collecting data after 2012
Minneapolis, Minnesota	1991	2015	
La Crosse, Wisconsin	1988	2015	
Madison, Wisconsin	1973	2015	
Papillion/Bellevue, Nebraska	1989	2015	Station was in Papillion until 2012, then moved a few miles away to Bellevue
Kansas City, Missouri	1997	2015	
Rogers, Arkansas	1996	2012	Temporarily stopped collecting data after 2012; newer data not available
Oklahoma City, Oklahoma	1991	2015	No data available for 2013
Georgetown, Texas	1979	2015	Near Austin, Texas

Each station relies on trained individuals to collect air samples. Samples were collected using one of three methods at each counting station:

1. Slide gathering: Blank slides with an adhesive are left exposed to outdoor air to collect airborne samples.
2. Rotation impaction aeroallergen sampler: An automated, motorized device that spins air of a known volume such that airborne particles adhere to a surrounding collection surface.
3. Automated spore sampler from Burkard Scientific: A device that couples a vacuum pump and a sealed rolling tumbler of adhesive paper in a way that records spore samples over time.

Despite differences in sample collection, all sites rely on the human eye to identify and count spores on microscope slides. All of these measurement methods follow standard peer-reviewed protocols. The resulting data sets from AAAAI and Aerobiology Research Laboratories have supported a variety of peer-reviewed studies. Although the sample collection methodologies do not allow for a comparison of total pollen counts across stations that used different methods, the methods are equally sensitive to the appearance of a particular pollen species.

6. Indicator Derivation

By reviewing daily ragweed pollen counts over an entire season, analysts established start and end dates for each location as follows:

- The start date is the point at which 1 percent of the cumulative pollen count for the season has been observed, meaning 99 percent of all ragweed pollen appears after this day.
- The end date is the point at which 99 percent of the cumulative pollen count for the season has been observed.

The duration of pollen season is simply the length of time between the start date and end date.

Two environmental parameters constrain the data used in calculating the length of ragweed season. As a short-day plant, ragweed will not flower before the summer solstice. Furthermore, ragweed is sensitive to frost and will not continue flowering once temperatures dip below freezing (Deen et al., 1998). Because of these two biological constraints, ragweed pollen identified before June 21 or after the first fall frost (based on local weather data) was not included in the analysis.

Once the start date, end date, and total length of the pollen season were determined for each year and location, best-fit regression lines were calculated from all years of available data at each location. Thus, the longer the data record, the more observations that were available to feed into the trend calculation. Next, the regression coefficients were used to define the length of the pollen season at each station in 1995 and 2015. Figure 1 shows the difference between the 2015 season length and the 1995 season length that were calculated using this method.

Ziska et al. (2011) present these analytical methods and describe them in greater detail.

7. Quality Assurance and Quality Control

Pollen counts are determined by trained individuals who follow standard protocols, including procedures for quality assurance and quality control (QA/QC). To be certified as a pollen counter, one must meet various quality standards for sampling and counting proficiency.

Analysis

8. Comparability Over Time and Space

Different stations use different sampling methods, so absolute pollen counts are not comparable across stations. Because all of the methods are consistent in how they identify the start and end of the pollen season, however, the season’s length data are considered comparable over time and from station to station.

9. Data Limitations

Factors that may impact the confidence, application, or conclusions drawn from this indicator are as follows:

1. This indicator focuses on only 11 stations in the central part of North America. Although dozens of other stations across the country collect pollen data, they use a variety of methods, and their data are not all readily available; stations are run by a wide variety of organizations, and only some of them report their data to the National Allergy Bureau. Thus, the scientists who developed the analysis for this indicator chose to make it a focused study, using a subset of stations near one longitudinal transect. The impacts of climate change on ragweed growth and pollen production could vary in other regions, such as coastal or mountainous areas.

2. This indicator does not describe the extent to which the intensity of ragweed pollen season (i.e., pollen counts) may also be changing.

3. The indicator is sensitive to other factors aside from weather, including the distribution of plant species as well as pests or diseases that impact ragweed or competing species.

4. Although some stations have pollen data dating back to the 1970s, this indicator characterizes trends only from 1995 to 2015, based on data availability for the majority of the stations in the analysis.

10. Sources of Uncertainty

Error bars for the calculated start and end dates for the pollen season at each site were included in the data set that was provided to EPA for the original version of this indicator, which EPA published in 2012. Identification of the ragweed pollen season start and end dates may be affected by a number of factors, both human and environmental. For stations using optical identification of ragweed samples, the technicians evaluating the slide samples are subject to human error. Further discussion of error and uncertainty can be found in Ziska et al. (2011).

11. Sources of Variability

Wind and rain may impact the apparent ragweed season length. Consistently windy conditions could keep pollen particles airborne for longer periods of time, thereby extending the apparent season length. Strong winds could also carry ragweed pollen long distances from environments with more favorable growing conditions. In contrast, rainy conditions have a tendency to draw pollen out of the air. Extended periods of rain late in the season could prevent what would otherwise be airborne pollen from being identified and recorded.

12. Statistical/Trend Analysis

The indicator relies on a best-fit regression line for each sampling station to determine the change in ragweed pollen season. Trends in season length over the full period of record were deemed to be statistically significant to a 95-percent level ($p < 0.05$) at seven of the 11 stations, based on ordinary least-squares regression: Saskatoon, Saskatchewan; Winnipeg, Manitoba; Minneapolis, Minnesota; La

Crosse, Wisconsin; Madison, Wisconsin; Papillion/Bellevue, Nebraska; and Kansas City, Missouri. For further discussion and previous significance analysis, see Ziska et al. (2011).

References

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