Ragweed Pollen Season

Identification

1. Indicator Description

This indicator describes trends in the annual length of pollen season for ragweed (*Ambrosia* species) at ten North American sites from 1995 to 2011. Ragweed 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.

2. Revision History

December 2011: Indicator developed
May 2012: Indicator updated with data through 2011

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 2011.

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.aspx. *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/data.php.

Methodology

5. Data Collection

This indicator is based on daily pollen counts from 10 long-term sampling stations in central North America. Eight 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 altitude and other locational variables that might influence pollen counts.

Data were available from 1995 to 2011 at all sites except for two: Georgetown, Texas (near Austin) had data from 1998 to 2011, and Rogers, Arkansas, had data from 1996 to 2011.

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 length of the pollen season was determined for each year and location, a best-fit regression line was calculated for the period from 1995 to 2011. The change in ragweed pollen season (days) from 1995 to 2011 is derived from the slope of this trendline.

Ziska et al. (2011) describe analytical methods 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. However, because all of the methods are consistent in how they identify the start and end of the pollen season, the season's length data are considered comparable over time and from station to station.

9. Sources of Uncertainty

Error bars for the calculated start and end dates for the pollen season at each site were included in the dataset that was provided to EPA. 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).

10. 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.

11. Statistical/Trend Analysis

The indicator relies on a best-fit regression line for each sampling station to determine the change in ragweed pollen season. The 95 percent confidence limits for start and end dates of the pollen season were calculated using Sigmaplot, using the observed data as a basis for the analysis. Changes in season length at six of the 10 stations were deemed to be statistically significant, based on these 95 percent confidence intervals: Saskatoon, Saskatchewan; Winnipeg, Manitoba; Fargo, North Dakota; Minneapolis, Minnesota; LaCrosse, Wisconsin; and Madison, Wisconsin. For further discussion and an earlier version of this significance analysis, see Ziska et al. (2011).

12. Data Limitations

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

1. This indicator only focuses on 10 stations in the central part of North America. 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 1973, this indicator only examines trends from 1995 to 2011, based on data availability for the majority of the stations in the analysis.

References

Deen, W., L.A. Hunt, and C.J. Swanton. 1998. Photothermal time describes common ragweed (*Ambrosia artemisiifolia L.*) phenological development and growth. Weed Sci. 46:561–568.

Ziska, L., K. Knowlton, C. Rogers, D. Dalan, N. Tierney, M. Elder, W. Filley, J. Shropshire, L.B. Ford, C. Hedberg, P. Fleetwood, K.T. Hovanky, T. Kavanaugh, G. Fulford, R.F. Vrtis, J.A. Patz, J. Portnoy, F. Coates, L. Bielory, and D. Frenz. 2011. Recent warming by latitude associated with increased length of ragweed pollen season in central North America. PNAS 108:4248–4251.