Production Gone Sour: Pesticide Exposure and Cranberry Bogs in Plymouth County, MA

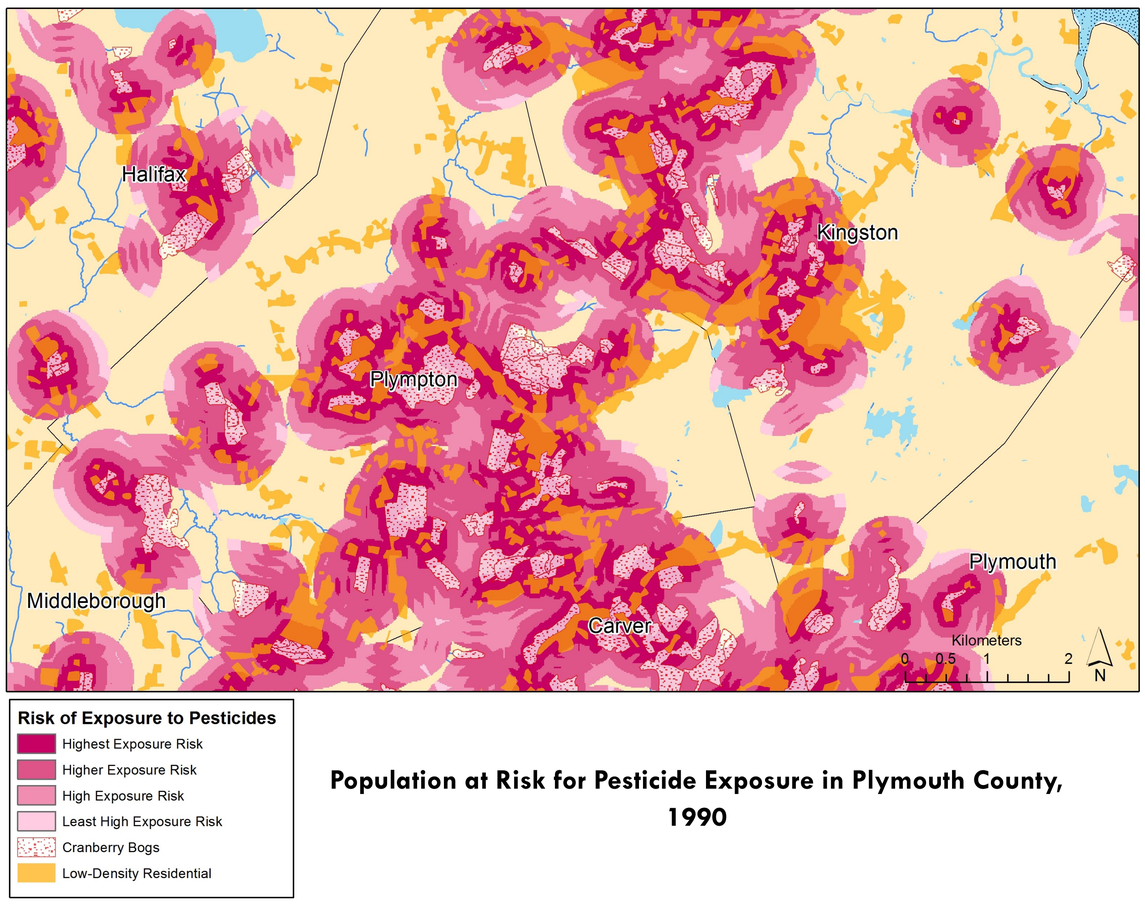
Overview

Plymouth County, MA is home to a high proportion of the state's cranberry bogs and the subject of this analysis. Cranberry bogs are both aquatic and terrestrial in nature and thus subject to high levels of unwanted pests and plant diseases. For that reason, the seasonal application of pesticides, herbicides, and fungicides is common on cranberry bogs. There are several pesticides commonly utilized on cranberry bogs, the most common of which is Chlorothalonil. This fungicide travels mostly through soil and has been categorized as a likely human carcinogen. According to studies conducted by the USGS, application of Chlorothalonil in Plymouth County has increased from 158.8 kg in 1990 to 336.7 kg in 2005. Perhaps in ignorance of this fact, Plymouth County residents continue to settle in close proximity to cranberry bogs.

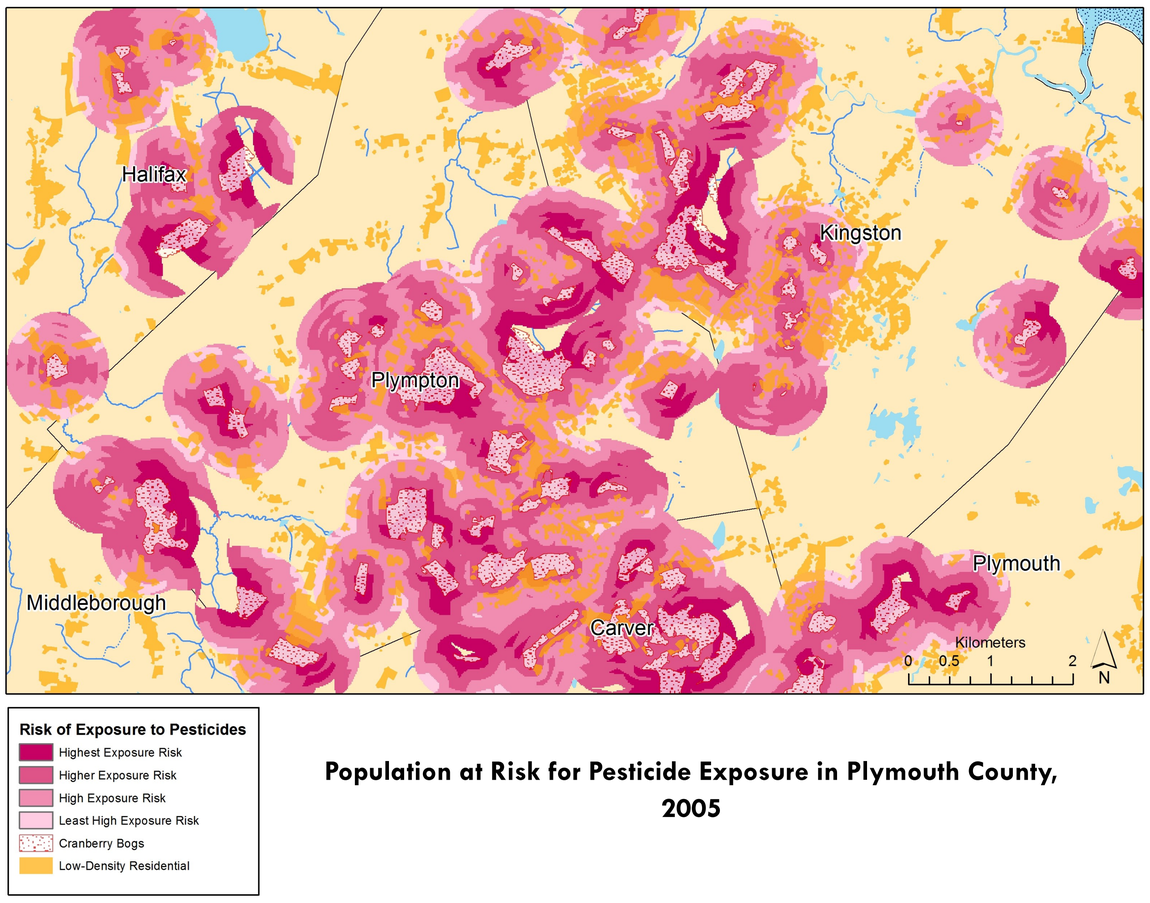
Cranberry Bogs and Rural Residential Settlement

Methods

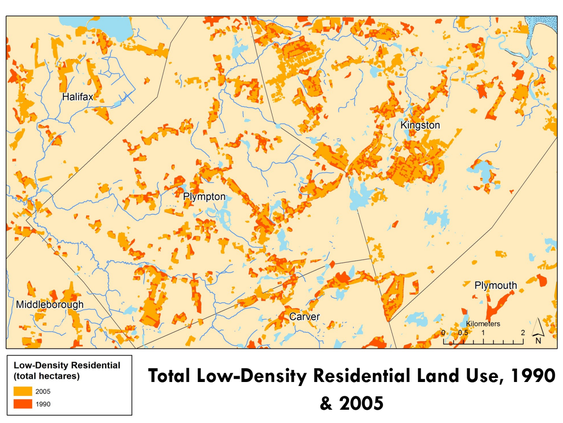
The purpose of this model is to analyze the relationship between cranberry bogs and subsequent pesticide exposure of surrounding populations. Was the increased application of Chlorothalonil in response to land use changes occurring over the same time period? Which portions of the population were most susceptible to these increases in pesticide use? First, an analysis was performed to determine changes in cranberry bog and residential settlement area between 1990 and 2005. Plymouth County is rural and thus low in population density, so "Low-Density Residential/ housing on ½ - 1 acre plots" was chosen to represent population settlement in the region of interest. Second, a raster algebra analysis was performed to determine locations in the area of interest with highest risk of exposure to pesticides from cranberry bogs. Prior to this step, a Euclidean distance of 500m was performed on both cranberry and low-density residential land uses for 1990 and 2005. Areas categorized as "highest risk" have both the highest number low-density residences and are located closest to cranberry bog locations.



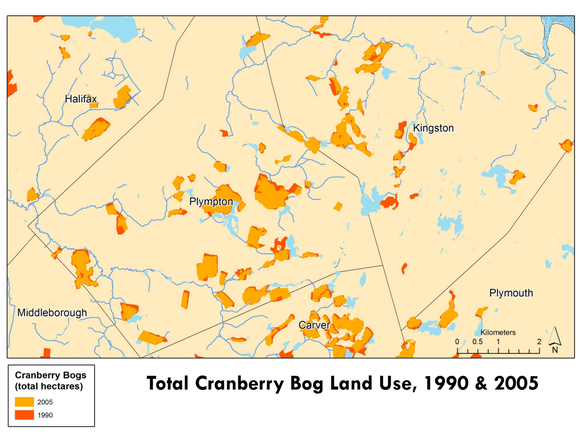
Population at Risk for Pesticide Exposure in Plymouth County, 1990



Population at Risk for Pesticide Exposure in Plymouth County, 2005

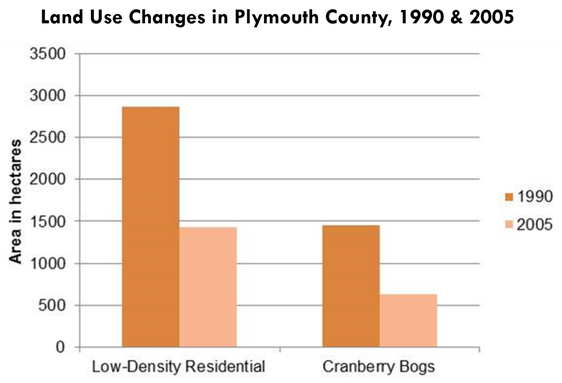


Total Low-Density Residential Land Use, 1990 & 2005

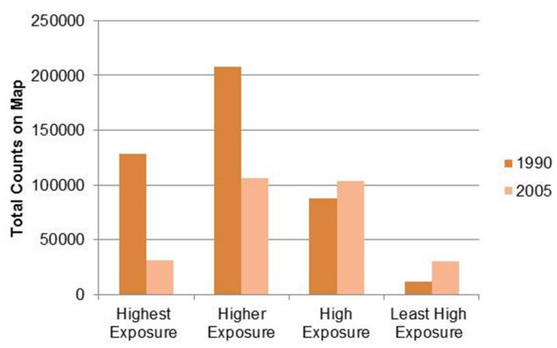


Total Cranberry Bog Land Use, 1990 & 2005

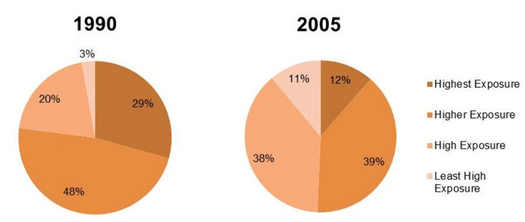
Land Use Changes in Plymouth County, 1990 & 2005



Population at Risk of Pesticide Exposure, 1990 & 2005



Percentage of At-Risk Population at Specific Risk Levels, 1990 & 2005



Findings

In terms of land use, both "Low-Density Residential" and "Cranberry Bogs" appear to have decreased in hectares between 1990 and 2005. In terms of pesticide exposure, the number of residences within "Highest" and "Higher" exposure appear to have decreased between 1990 and 2005, whereas the number of residences in "High" and "Least High" appear to have increased. Keep in mind that use of Chlorothalonil increased over this same time period. The decreasing hectares categorized as low-density residential could imply that Plymouth County residents are relocating away from this area of high cranberry production. Or, as implied by the decreasing number of residences within "Highest" and "Higher" exposure, residents could be moving further away from the cranberry bogs but still within the region of interest to areas of "High" and "Least High" exposure. Whether this observed movement is related to increasing use of pesticides such as Chlorothalonil is not determined in this analysis.

Discussion

Admittedly, this model presents a highly simplistic version of the spread of pesticides. This model assumes exposure risk based solely on proximity to cranberry bog and ignores the many ecological forces that contribute the spread of pesticides. Although much of the research on Chlorothalonil claims that it does not travel well in air and water, it is inevitable that some pesticide is diffused in that matter. This would significantly increase the range of exposure, and thus the number of Plymouth County residents exposed to cranberry-bog related pesticides and fungicides. Also, there is uncertainty in the land use data for 1990 and 2005. Land use for both years was determined from aerial photographs, an oft inaccurate technique. For a variety of environmental and financial reasons, cranberry bogs are often left abandoned or fallow for extended periods of time. Fallow fields could imply no pesticide use. From this dataset, there is no way to determine which bogs are in use and which are not. Also, the dramatic decrease in "Low-Density Residential" land use is questionable, considering the seemingly small decrease in area pictured below. Perhaps the aerial data collected in 1990 overestimated the number of low-density residences, making the change between 1990 and 2005 appear more dramatic than reality. Finally, this model assumes that all cranberry bogs use the same types of pesticides in the same volume – and that all cranberry bogs even utilize pesticides.

Works Cited

Massachusetts State Plane Projection

Town Boundaries: MassGIS, February 2014

Hydrography: MassGIS, March 2010

Land Use (1990): MassGIS, Massachusetts Executive Office of Environmental Affairs, January 2002

Land Use (2005): MassGIS, June 2009

Pesticide Usage: USGS Pesticide National Synthesis Project, 1991 & 2006

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