

Understanding the Impact of COVID-19 Policy Change in the Greater Seattle Area using Mobility Data

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Results as of March 29, 2020 8 p.m.; covid@idmod.org

This report focuses on mobility only. We have prepared a [follow-up study](#) exploring the relationship between mobility and COVID-19 transmission in King County, WA. Results of this study should be interpreted with respect to the stated assumptions and limitations.

Executive Summary

To stem the spread of COVID-19, Washington State instituted increasing levels of separation policies between March 11 and 24, 2020, including closing schools and prohibiting large groups. These policy changes were supported by [computational modeling](#), which explored social distancing at 25%, 50%, and 75% reduction in person-to-person contact. Due to the long period between first exposure to COVID-19 and the onset of symptoms (~5 days), delays to seeking a test (1+ days), and time required to process tests (1+ days), **it takes about a week for any policy changes to have an impact on case counts**, and even longer to see an impact on COVID-19 mortality.

Real-time data give us insight into trends before they appear in epidemiological data. Aggregated data from [Facebook Data for Good](#) allow us to measure coarse changes in where people spend their time and how much they move around the greater Seattle area; data are aggregated in space and time, and individual users cannot be identified. **Since March 2, we've observed a persistent decline in mobility**, with movement from other regions into Seattle and Eastside dropping by about 90% as of March 28 relative to baseline movement as observed in January and February. Also, we see strong evidence that people have been staying at home, as daytime population occupancy counts in residentially zoned areas of Seattle have increased by 27% on average compared to a baseline (pre-social distancing) period, while the daytime population occupancy in mixed-use areas (primarily comprising downtown Seattle) decreased 43% on average.

While Facebook mobility data gives us insight into changes in mobility patterns, it is not a direct measure of social distancing, and it cannot tell us about COVID-19 transmission on its own. That being said, the data is encouraging, particularly since similar interruptions in mobility have been shown to reduce disease transmission in our area, as we saw during '[snowpocalypse](#)' last year. In a [follow-up to this study](#), we use a transmission model-based approach to connect the mobility data to daily COVID-19 test results provided by the Washington Department of Health to more definitively address this issue. For the purposes of this report we have not yet linked mobility data to epidemiological trends, **though while the data are encouraging, we also see some evidence of fluctuating adherence to social distancing policies, emphasizing that we remain in a precarious position.** For social distancing to be effective in restricting COVID-19 transmission, **widespread adherence over the coming weeks is critical.**

Background

The novel coronavirus SARS-CoV-2 emerged in Wuhan, China, in [late November or early December 2019](#). As of March 26, 2020, it is responsible for 462,684 confirmed cases and 20,834 deaths of the disease COVID-19 ([WHO](#)). After initial emergence in China, travel associated cases started to appear in other parts of the world with strong travel connections to Wuhan (<http://rocs.hu-berlin.de/corona/>). The first confirmed case in the US was a travel-associated case in Snohomish County, WA, screened on January 19, 2020. In the six weeks following late February, a [second presumptive case](#) was identified roughly 10 miles away from where the first case was treated. As of the evening of March 19, [Washington State reports 1,376 confirmed cases and 74 confirmed deaths associated with COVID-19](#) with the majority from King and Snohomish counties.

Washington State has instituted several policies to slow the spread of the virus. On March 4, Public Health Seattle & King County (PHSKC) [announced](#) recommendations that workplaces should enact measures to allow people who can work from home to do so. Employers such as Microsoft, Amazon, Google, Facebook, and others subsequently [announced](#) work from home policy starting March 5. Then, on March 11, Governor Jay Inslee [banned](#) gatherings of more than 250 people in King, Pierce and Snohomish counties, including weddings. The following day, all schools in King, Pierce and Snohomish counties were [closed](#) through April 24, and on March 13, school closures were [extended](#) to all Washington schools. Two days later, Governor Inslee [announced](#) closures of gyms, entertainment and recreational facilities, as well as bars and restaurants (take-out/delivery remain available), and gatherings of more than 50 people were prohibited. Finally, on March 23rd, Governor Inslee [announced](#) the “Stay home, stay healthy” policy - a two week shelter-in-place order for all but essential services.

These policy measures were supported by COVID-19-specific [computational modeling](#) of the potential impact of social distancing policies. The computer simulations compared “business as usual” to three levels of social distancing--25%, 50%, and 75%. A key finding was that only the 75% level resulted in reductions in the number of active cases over time.

Findings from Facebook Disaster Maps Data

We used data from the [Facebook Data for Good Project - Disaster Maps](#) to track changes in population and mobility between regions over time. **These data are collected from mobile users with location services enabled and are aggregated to coarse geographic levels as anonymous counts of users; individual users cannot be identified.** On a typical day, data are captured from around 230,000 people across the Puget Sound region. Using these data, we make comparisons over a time period between February 26 through March 28, and a baseline period 45 to 90 days before that (i.e., for movement measures: mid-January to end-February, and for population occupancy measures: most of December through February). Unless otherwise noted, all results are presented as a percent change in either mobility or number of Facebook users at a location, relative to the same time, day of week, and location during the entire baseline period. **We emphasize we are not measuring reductions in social contact, but rather changes in mobility and the places where people are spending their days.** Though as populations spend more time in residential areas and away from shared public and work spaces, it is

likely they are coming in contact with fewer people. These datasets are described in detail [here](#), and a broader discussion of the utility of these data for COVID-19 research [here](#).

Data confirms that mobility patterns have shifted tremendously in the greater Seattle area over the past four weeks. We observe reduced overall movement across the city and region coupled with increasing population concentrating in residential areas and away from commercial areas. These trends began around March 2, the Monday after the first COVID-19 death was reported in King County, and have steadily increased over time, during a period of increased policy intervention as well as COVID-19 awareness.

Movement during daytime (9 a.m. to 5 p.m.) from other regions to Seattle and to the Eastside had declined from about 40% below baseline on March 5 after Public Health Seattle and King County recommended a work from home policy, to over 60% on March 12 when Gov. Inslee banned gatherings of over 250 people and closed K-12 schools through April 27th, to about 90% on March 28, the last day for which we have data.

Decreases in movement into Seattle at nighttime (1 a.m. to 9 a.m.) have been less pronounced and had taken longer to achieve until March 16, when Gov. Inslee announced the closure of all entertainment and recreational facilities, including gyms, bars, and restaurants. As of March 28, the decrease is close to 90%.

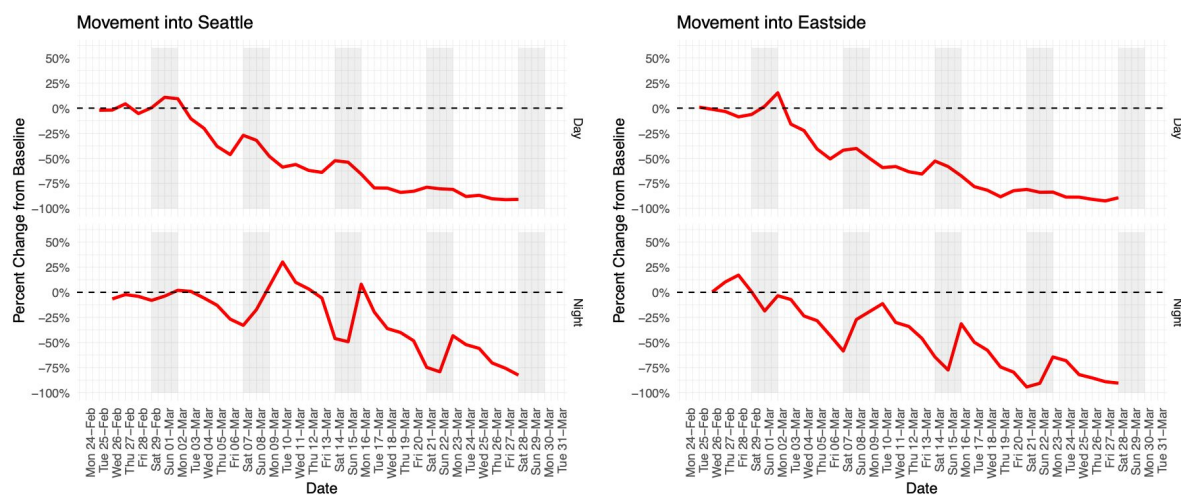


Figure 1. Percent change in mobility from other regions into Seattle (left) and the Eastside (right). Top and bottom panels of each figure represent daytime and nighttime trends. The dashed horizontal line is baseline level, and negative percent changes indicate reductions in mobility.

Table 1. Cumulative changes in mobility relative to baseline. Positive numbers indicate reductions.

Date	Event	Day into Seattle	Day into Eastside	Night into Seattle	Night into Eastside
29-Feb	First announced death	-0.4%	6%	8%	-0.6%
05-Mar	On 04-Mar PHSKC recommended workplaces should enact measures to allow people who can work from home to do so. Multiple employers announced work from home policy.	38%	41%	13%	28%
12-Mar	Gov Inslee banned gatherings of more than 250 people (11-Mar) and ordered closure of all schools in King, Pierce and Snohomish counties (12-Mar)	62%	63%	-3%	34%
16-Mar	Gov. Inslee announced on the evening of 15-Mar that all entertainment and recreational facilities, including gyms as well as bars and restaurants will close; however, restaurants will be allowed to do take out and delivery.	66%	68%	-8%	31%
28-Mar	Stay home, stay healthy in place since 23-Mar. Last day of available data.	91%	89%	82%	90%

In addition to declines in mobility around the region, Figure 2 (below) shows that many more people are staying away from commercial areas and remaining in residential areas of Seattle. By March 24, we observed an average 28% and 26% increase in daytime population occupancy in multi-family and single-family zoned areas of Seattle over the baseline period. The same day, daytime occupancy at the University of Washington Seattle campus had declined 55%, mixed-use zoned areas (primarily comprising downtown) declined 42% percent, and commercially zoned areas (primarily SoDo, Harbor Island, and Fishermen's Terminal) declined by 31%. During weekends, the trends revert to some extent toward parity with baseline, as, for example, more people typically stay home during the weekend.

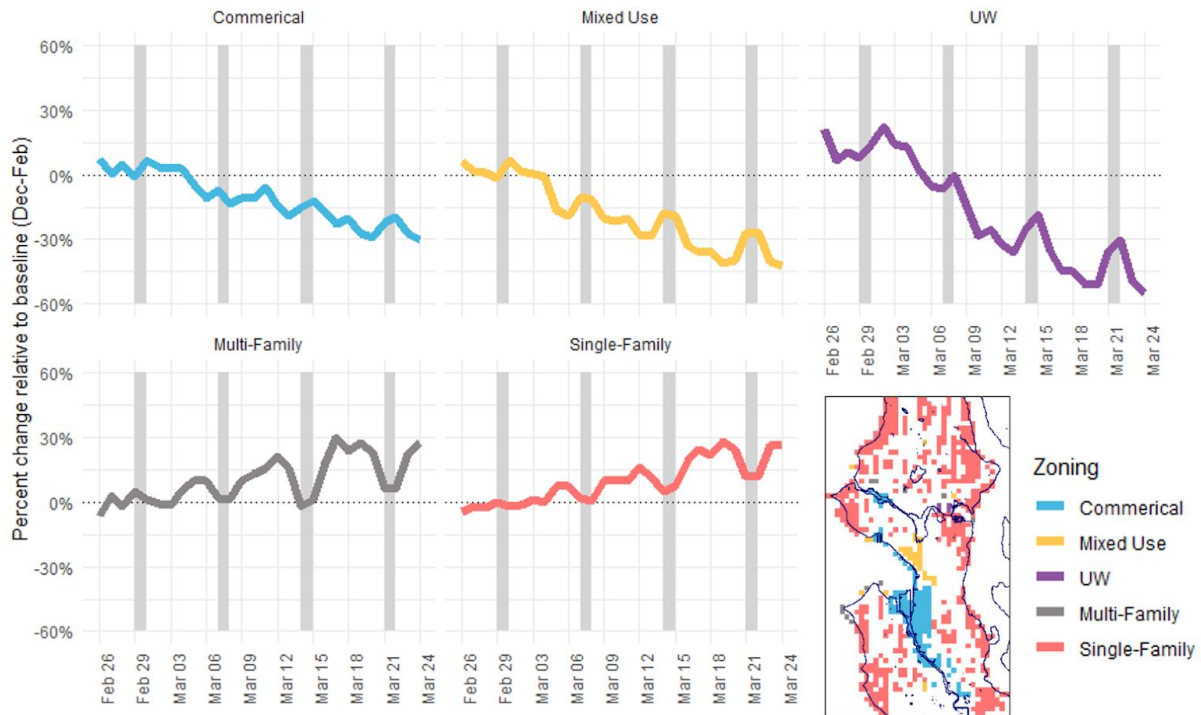


Figure 2. Lines show the average change in daytime population occupancy relative to the baseline period (January and February) across zoned areas of Seattle. Reduction in commercial, mixed-use, and UW areas are in stark contrast to increases in single- and multi-family zones. Grey vertical bars indicate weekends. Facebook population tile layers were overlaid with a [city parcel map](#) containing zoning information on over 178 thousand city parcels. Only tiles for which all contained parcels were of the same zone were kept, these remaining tiles are mapped in the legend of the plot.

These trends extend beyond Seattle and the Eastside. The maps in Figure 3 below show the increasing concentration of people into residential areas across the Puget Sound region. These patterns become increasingly evident over time, both in terms of intensity and consistency across the entire region.

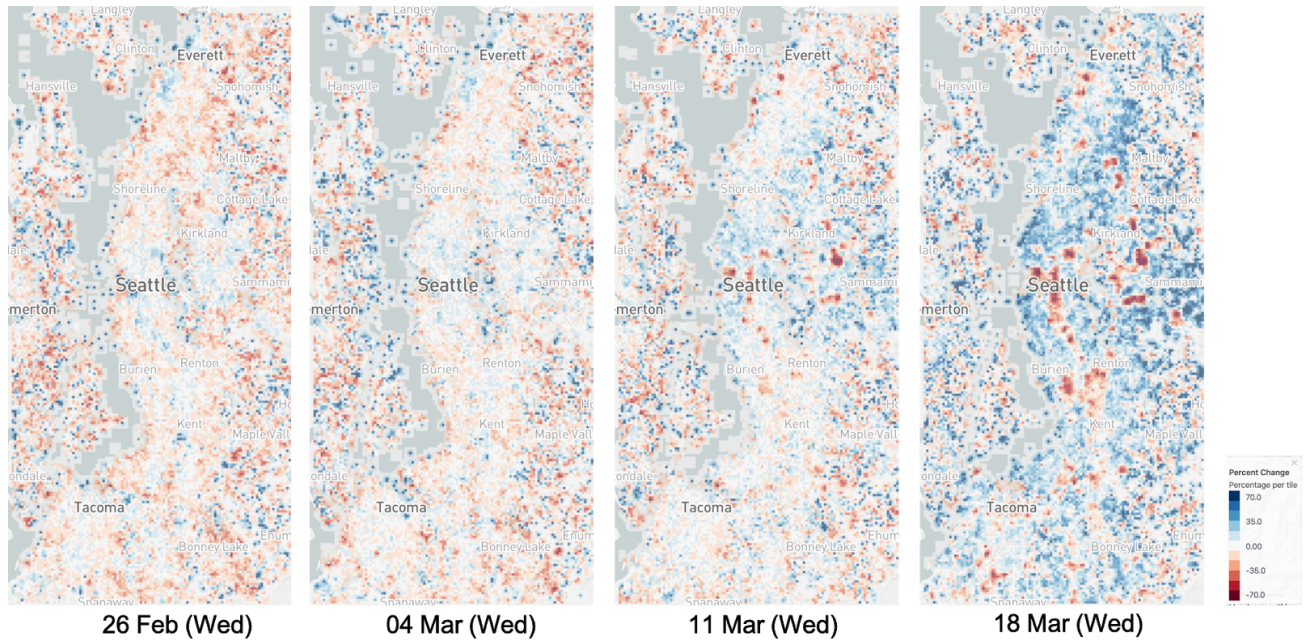


Figure 3. Changes in population occupancy in the greater Seattle region from February 26 to March 18 relative to the 90 day period before Feb 26. Blue indicates increases, whereas red indicates decreases. The figure shows people are spending less time in urban areas, such as downtown Seattle and Tacoma, and the Microsoft campus.

Additionally, we can observe change in population movement during the course of a day. By comparing population occupancy at night to the same location during the day, we captured the extent to which people tend to stay put over the course of a day, without relying on a baseline period for comparison. Figure 4 (below) again indicates a general reduction in mobility, in concordance with the other measures. We saw a brief increase in mobility during the weekend of March 21 and 22, when there was a [noted](#) increase in outdoor gatherings corresponding to nice weather. The following Monday, Governor Jay Inslee announced the “Stay home, stay healthy” policy. The following weekend there was another increase in mobility the following Saturday, March 28th. It is difficult to determine from these data if this increased mobility activity corresponds to non-compliance with the “Stay home, stay healthy” policy. For example, this could be capturing, in part, increased weekend grocery shopping or outdoor exercise. As more epidemiological data are available, we will be able to better understand what impact these changes have on transmission and what measures best capture transmission-relevant social distancing behavior.

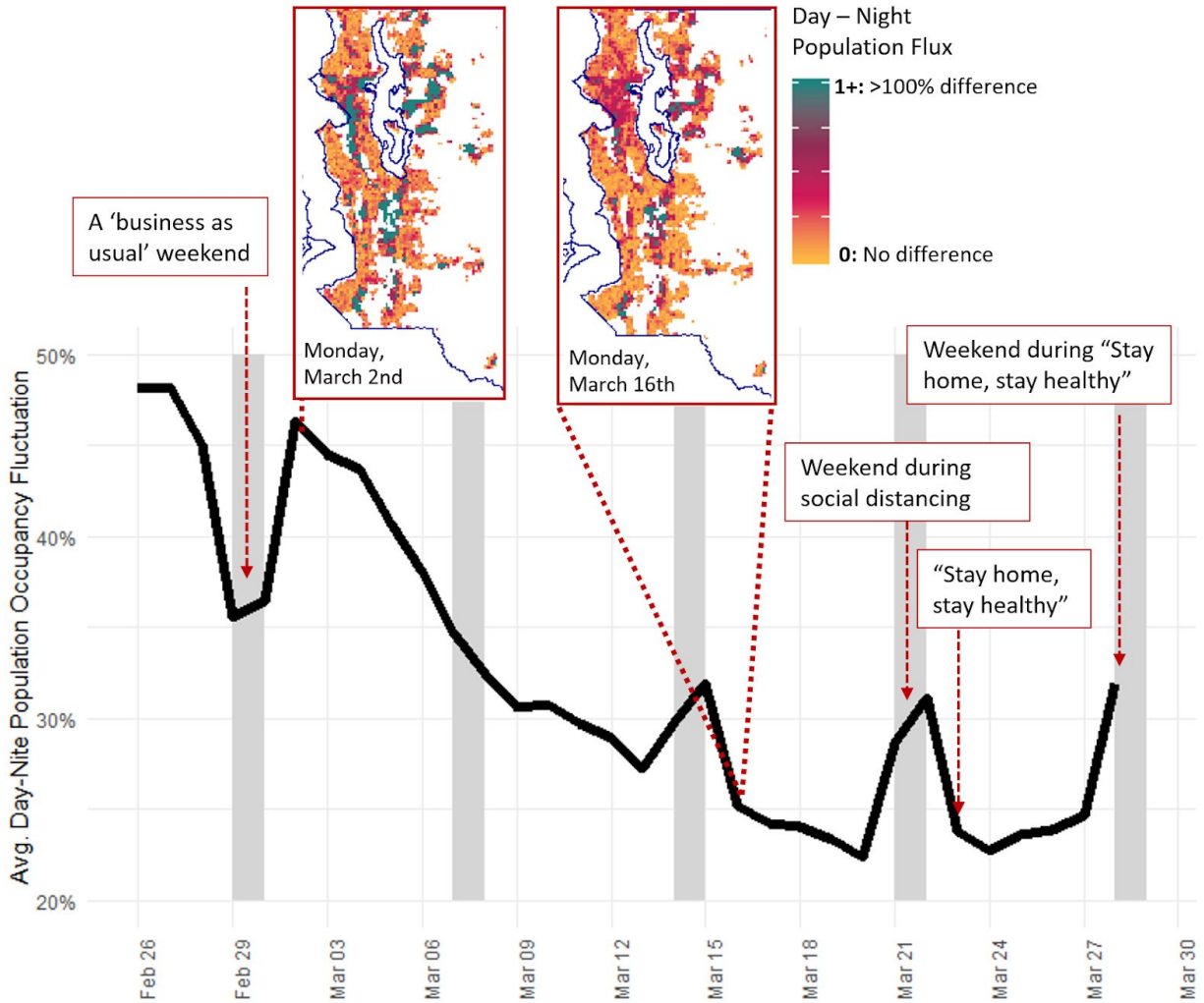


Figure 4: Relative fluctuations in daytime to nighttime population over time in King County. We notice an inversion in weekend mobility behavior. During the social distancing period (after March 2nd) there is more day-night fluctuation on weekends than during the work week, compared to the ‘business as usual’ period before that, where more people tended to stay home on the weekends. Now as more people are working from home, the more mobility occurs during weekends. Day-night fluctuations were measured as the absolute value of the relative difference between day and night population in each tile. The black line indicates the average relative day-night movement across populated tiles in King County. Tiles with Facebook population occupancy <10 are masked from researchers due to privacy concerns.

Data derived from social media users is not without its limitations. For example, there is some concern that the population of Facebook users does not represent the general population. To explore this, we compared Facebook estimates from Eastside to Seattle commutes with [WS-DOT](#) toll data from SR 520 measuring reduced volume relative to the same day of the week in February. There was very high agreement between these two measures with $R^2 = 0.94$, see Figure 5.

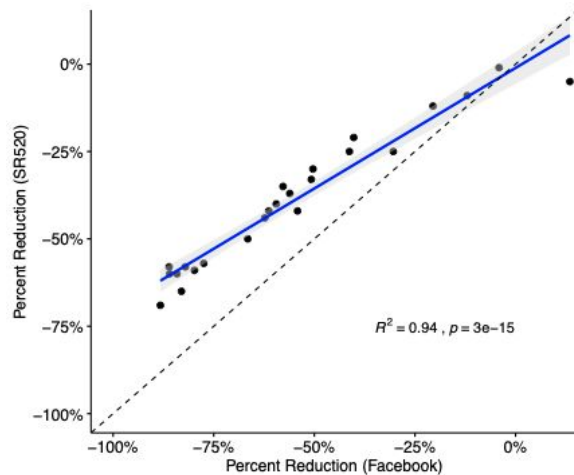


Figure 5: Verifying Facebook mobility data with other mobility signals. We compared a measure of mobility from Eastside to Seattle with traffic volume data from the SR-520 toll. The reduction of mobility detected in Facebook data is highly correlated with the traffic reduction detected through tolls, the reduction in Facebook mobility data (in number of people) is higher than WS-DOT tolls (in number of cars).

Epidemiological Implications of Mobility Findings

Facebook data indicates mobility in the greater Seattle area has reduced significantly from March 2 to today, showing dramatic change in response to COVID-19. Still, **mobility increases over the past three weekends highlight a potential difficulty in maintaining widespread adherence to social-distancing policies.** In a [follow-up report](#), we model diagnosis data, allowing us to start to understand how mobility decreases can be connected to decreases in COVID-19 transmission. However, the link between mobility and disease transmission is not one-to-one; even with zero mobility, we know some transmission will continue within homes and other tight personal circles.

Conclusions to Date

Washington State has rapidly instituted policy measures to slow COVID-19. Modeling indicates generic “social distancing” can overcome the spread of COVID-19, but only if high levels (i.e., 75% reduction in person-to-person contact) are achieved. Delays in how COVID-19 spreads and further delays in testing render us unable to measure the impact of policy on new cases for a few more days, and the impact on deaths for another few weeks after policy implementation.

Based on the aggregated Facebook data, we can say with confidence **mobility behavior in the greater Seattle area has reduced dramatically since early March**, when it first became clear community transmission of COVID-19 was occurring in the area. **Significantly fewer people are commuting to work, and many more people are spending their days at home.** However, we see evidence of inconsistency, particularly during weekends. Mobility is not a direct measure of social distancing; while these data indicate people are spending much more time at home and away from shared spaces (which has been [shown to reduce disease transmission](#) before), we cannot use it to determine the percent reduction in social contact. See the [follow-up report](#) to learn how these changes in mobility relate to reductions in COVID-19 transmission.