ATLAS

How prepared was the US Hospital System for the volume of Covid 19 cases requiring hospitalization during the month of March 2020, and how can we use this data to better equip hospitals so they have the capacity to successfully navigate the next wave of Covid 19?

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GEOG 381 Atlas Project

INTRODUCTION

Background

The Covid 19 crisis has been an ongoing strain on medical professionals and front line workers since as early as March of 2020. It is currently December of 2020 and while the vaccine rollout is in motion, it will likely not be available to the general public until the spring. In the earlier stages of the pandemic, the CDC and most state authorities strongly encouraged social distancing methods for the foreseeable future. This was suggested in an effort to minimize the burden on hospitals around the country. However, it appears that a sizable portion of the public is choosing to ignore these guidelines, especially with Covid fatigue playing a role. This will likely progress and cases will continue spiking, potentially very drastically, as the holiday season approaches. According to sources at Get Us PPE, we are at the same position currently that we were in March regarding PPE shortage. This lack of sufficient PPE is very telling and indicative of hospitals having to cope with a higher volume of patients than they may be prepared for. I wanted to investigate data from March, which was the height of the earlier stages of the pandemic, to examine how well our hospitals were prepared and what the outcome looked like then. I believe this will be useful information to extrapolate from and help us prepare for another peak of cases that appear to be mirroring our circumstance in March. It may give us direction in improving our social distancing efforts and incentivize us to increase hospital capacity and ensure that they have the necessary resources.

Aim

This project aims to a) inspect hospital capacity and Covid 19 treatment capability during March 2020, b) use that information as a guide in preparing our hospitals so they are able to properly navigate the next wave of Covid 19, and c) make recommendations regarding any adjustments to ensure that hospitals are equipped with the appropriate level of resources.

Approach, Results and Conclusion

I created and consulted five different maps to assist me with my investigation. I wanted a map that was more high level to inform me of hospital capacity in a pre Covid 19 environment. This is available in Map #3, which specifically shows hospital bed capacity per county per capita in March. I also wanted a map that displayed Covid 19 cases in the month of March, and another map that displayed Covid 19 deaths in March. This was Map #1 and Map #2. These were key components in understanding the number of active cases spreading through the country at a rapid level, and the number of these cases that resulted in death. Because hospitalization data isn't as readily accessible, the assumption I made here is that the majority of those death cases were at some point engaging with a medical professional and receiving treatment. This allowed me to understand and convey the severity of the disease and put into perspective how many deaths resulted from contracting Covid 19. The next two maps I used, Map #4 and Map #5, were more focused, informing me what a mild and aggressive approach would look like in terms of hospital beds for Covid 19 patients, as defined by the US hospital system.

The comparison between these two interventions is valuable, and I also noted that even with a minimal impact to our capacity in the mild intervention, it is not the best intervention. I would expect that in the event of a mild capacity, nearby regions would at least have a high enough threshold to support nearby hospitals that are beginning to reach capacity or already capped, and this is not the case. This analysis using Map #4 and Map #5 is also relevant because based on the number of cases and deaths that appear in Map #1 and #2, the US hospital system was operating on what they deemed their most aggressive intervention level, as shown in Map #5. This means that there were times where we were completely at capacity as a country. Even when falling back to our most extreme level of intervention, which was our last resort plan, we were not equipping hospitals with a sufficient number of hospital beds. Allowing our hospitals to reach that level of capacity means that we are putting hospitals in a place where they are forced to turn away additional patients who need treatment. This was the case in several states around the country in March.

This leads me to believe that our numeric estimate regarding the most aggressive intervention was flawed. At the aggressive intervention, hospitals are completely capped and this is not fair to our healthcare workers, as this creates a burden that falls entirely on them. There should still be a certain amount of hospital beds available to treat patients at that intervention, even if any excess is minimal at that stage.

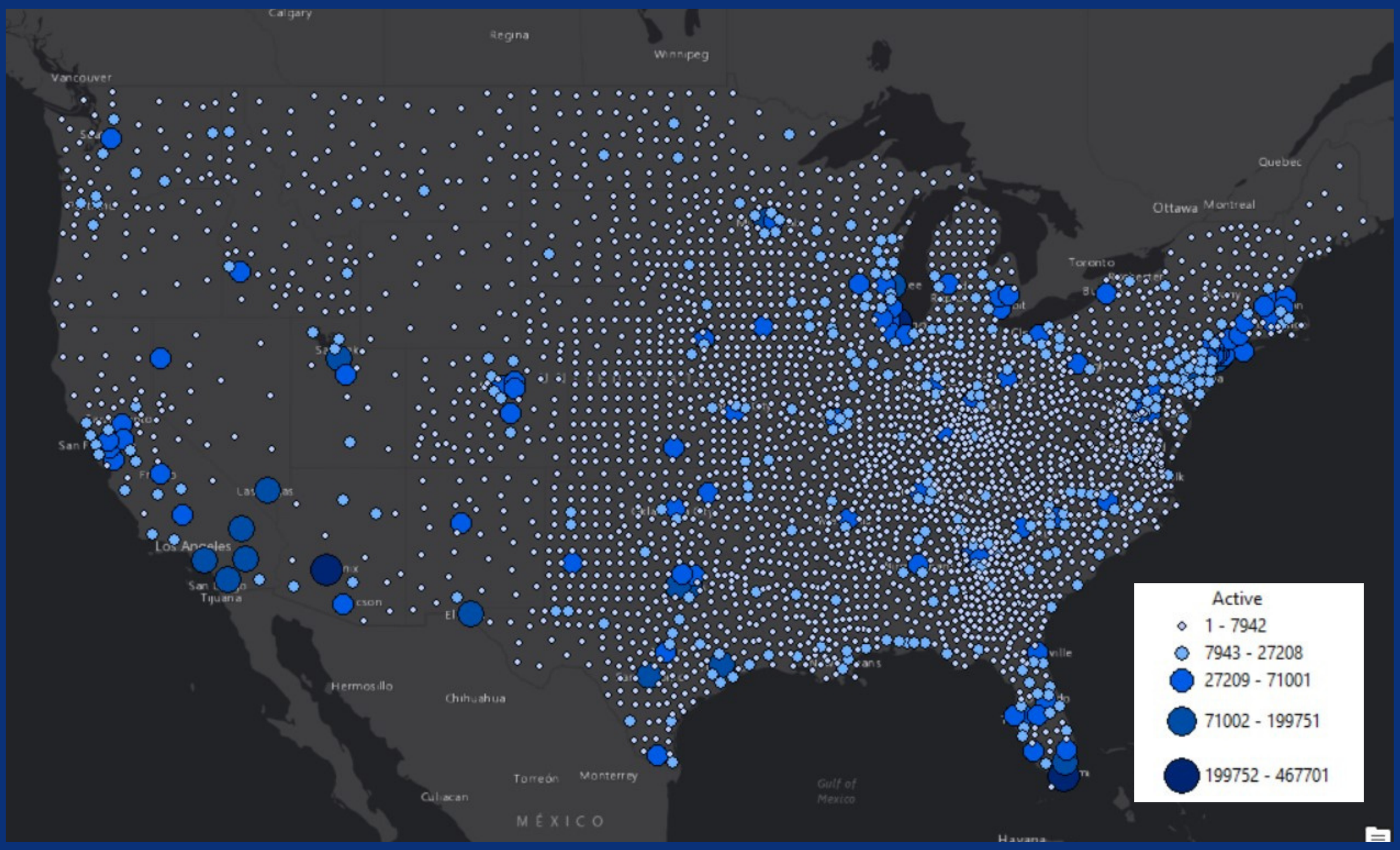
Examining Map #3, Map #4 and map #5 allows us to analyze how we segmented different levels of hospital capacity and how that fit into the number of hospitals we have per county and per capita. My most significant comparisons were between Map #1, Map #2, Map #3 and Map #5, as this helped me piece together the hospital bed capacity in our country, the overflow of Covid 19 cases and the large portion of those which would become severe and require medical attention, and the effect of implementing an aggressive intervention on hospital bed capacity. The last map I created was a snapshot of our current situation regarding Covid 19 transmission. This ties into the idea that the more cases there are, the more potential there is for more Covid 19 deaths, which is established by Map #1 and Map #2. Back to Map #6, it is central to this argument because it communicates the idea that almost every single state in the US is at the highest risk level, which was calculated based on how many new cases there were per 100K cases. This ties back into the parallel I discussed between March and December, and how if we were at capacity and had overflowing cases then, the same is true now.

Used in conjunction, these maps create a bigger picture that shows us how many hospital beds we had available in the country to treat Covid 19 cases, what we considered the different levels of intervention regarding hospital bed usage and what it looks like to employ an aggressive intervention level, the number of cases and deaths we recorded in March, and how our data in December so far shows that we are transitioning into this cycle once again, maybe even in a worse context because our hospitals have been strained for longer than they had been in March.

Another important takeaway here is that we need to establish aggressive interventions where hospitals have an abundance of resources and hospital beds to continue treating Covid 19 cases that need to be hospitalized. In our most extreme intervention, we need to have open space for patients. It would likely be in our best interest to avoid finding ourselves so close to the line of capacity, and instead give ourselves more of a margin. We also need to consider the alarming burden we are putting on hospitals again, just as we did in March, and course correct this by alleviating the stress we are placing on hospitals. This can be done in two parts, by increasing our funding in hospital resources so they can continue increasing their capacity and capability to treat patients, and flattening the curve and being mindful about our exposure, limiting breaking quarantine for work and essential activities, washing our hands frequently and wearing masks, and socializing in the safest possible ways.

MARCH COVID CASES

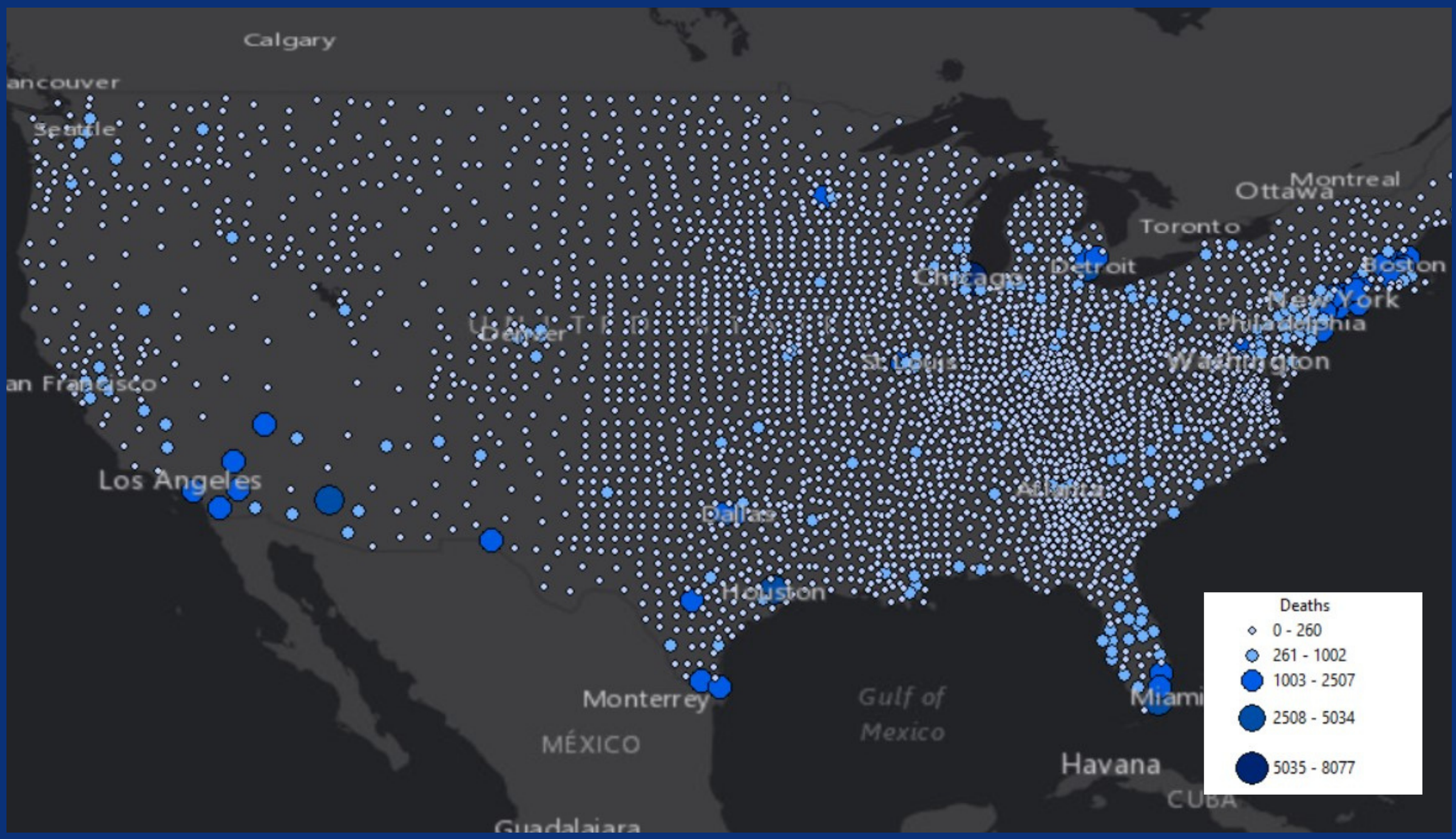
Map #1: Covid 19 Active Cases in the U.S. During the Month of March, 2020



This is a Dot Distribution map that displays the active Covid 19 cases in the US, it is taken from a snapshot that was captured in March. It is intended to provide context regarding the active cases during March, 2020 and draw attention to the sheer magnitude of cases that were spreading throughout the country. It is apparent that the majority of the country was struggling with an obscenely high volume of cases. The coasts and any regions on a border were seemingly in the worst position, and the eastern part of the country appeared to be in slightly worse shape, although this can likely be attributed to a difference in population and density. This map plays a role in my research because it illustrates the point that the Covid 19 case volume was increasing tremendously at the time, and a large portion of those cases likely required either hospitalization or medical care. It is important to note that the lower the case count is at any point in time, the more we can reduce Covid 19 transmission and therefore decrease the number of people who contract it. A lower Covid 19 contraction rate in turn directly lowers the number of people who require medical attention. This attempt to reduce the influx of patients that healthcare workers have to treat would also greatly reduce the burden we are placing on hospitals.

This map was created using ArcMap, using the data from the Johns Hopkins *Center for Systems Science and Engineering (CSSE)*

Map #2: Covid 19 Death Cases in the U.S. During the Month of March, 2020

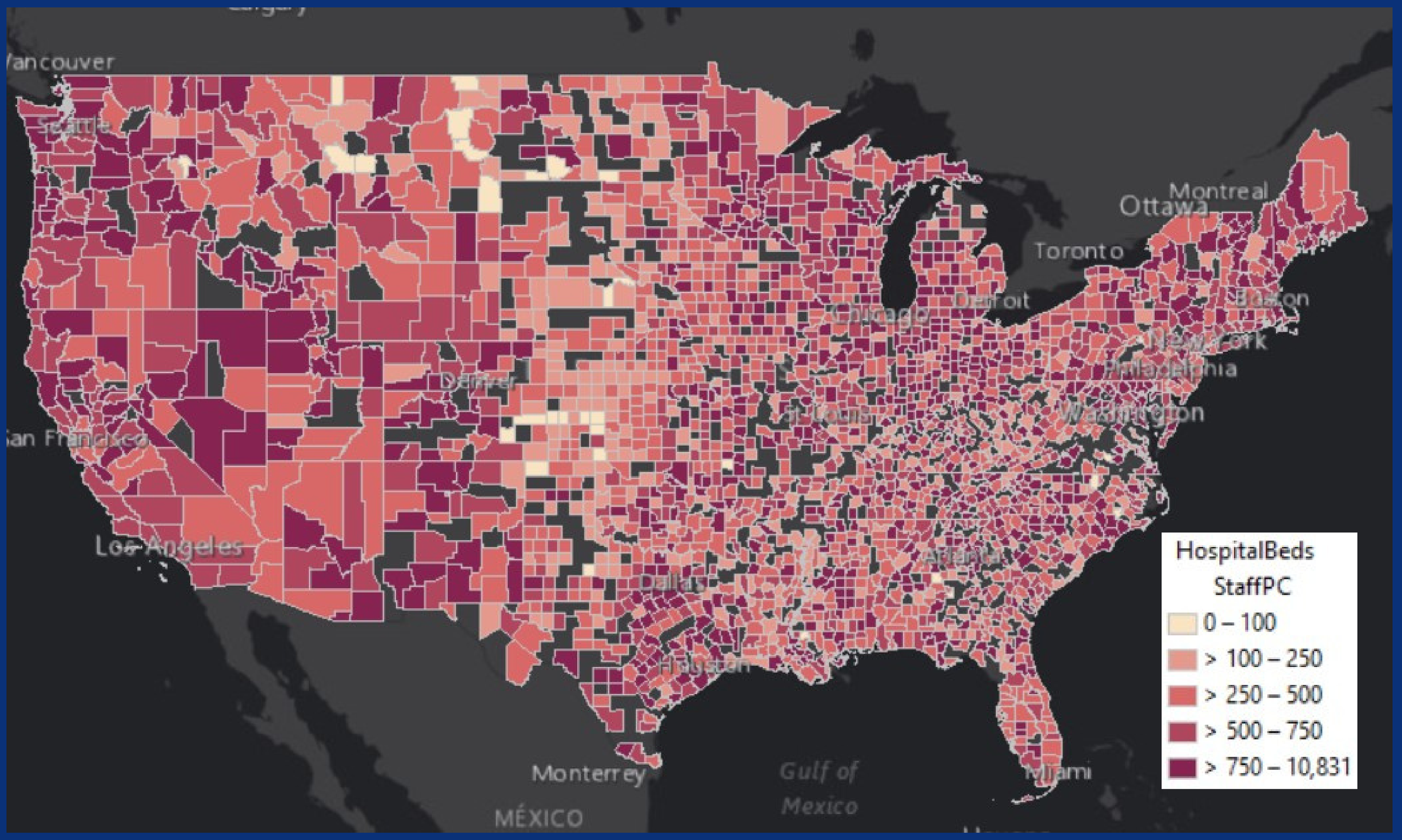


This is a Dot Distribution map that displays the active Covid 19 cases in the US, it is taken from a snapshot that was captured in March. It continues to build from the narrative constructed in the previous map. While that map illustrrated active Covid 19 Cases in March, this map shows the number of deaths due to Covid 19 during that month. Used in conjunction, these maps provide context, and this map in particular demonstrates the deaths that resulted directly from the high volume of Covid 19 transmission. It also paints the picture that this disease is deadly and we have been leaning heavily on our hospitals to protect our health in the event that our symptoms become too painful. In comparison to the previous map, it is safe to assume that an even larger number of cases from this subgroup required hospitalization and other medical care. Anyone who was having truly serious concerns, to the extent that they felt their life was in danger, was probably being directed to go see a doctor. This builds into my larger argument because a large number of deaths can likely be attributed to patients that went to a hospital seeking treatment from a medical professional, but were unfortunately unable to overcome the disease. The makority of the country was facing an abnormally high death count, except for a few minor regions where cases, and therefore deaths, were minimal. This sort of burden is not sustainable long term, and our hospital systems had to shift from their usual capacity to an overwhelming new wave of patients for a disease that was very new and unpredictable.

This map was created using ArcMap, using the data from the Johns Hopkins Center for Systems Science and Engineering (CSSE)

MARCH HOSPITAL CAPACITY

Map #3: Hospital Beds Per County and Per Capita During the Month of March, 2020

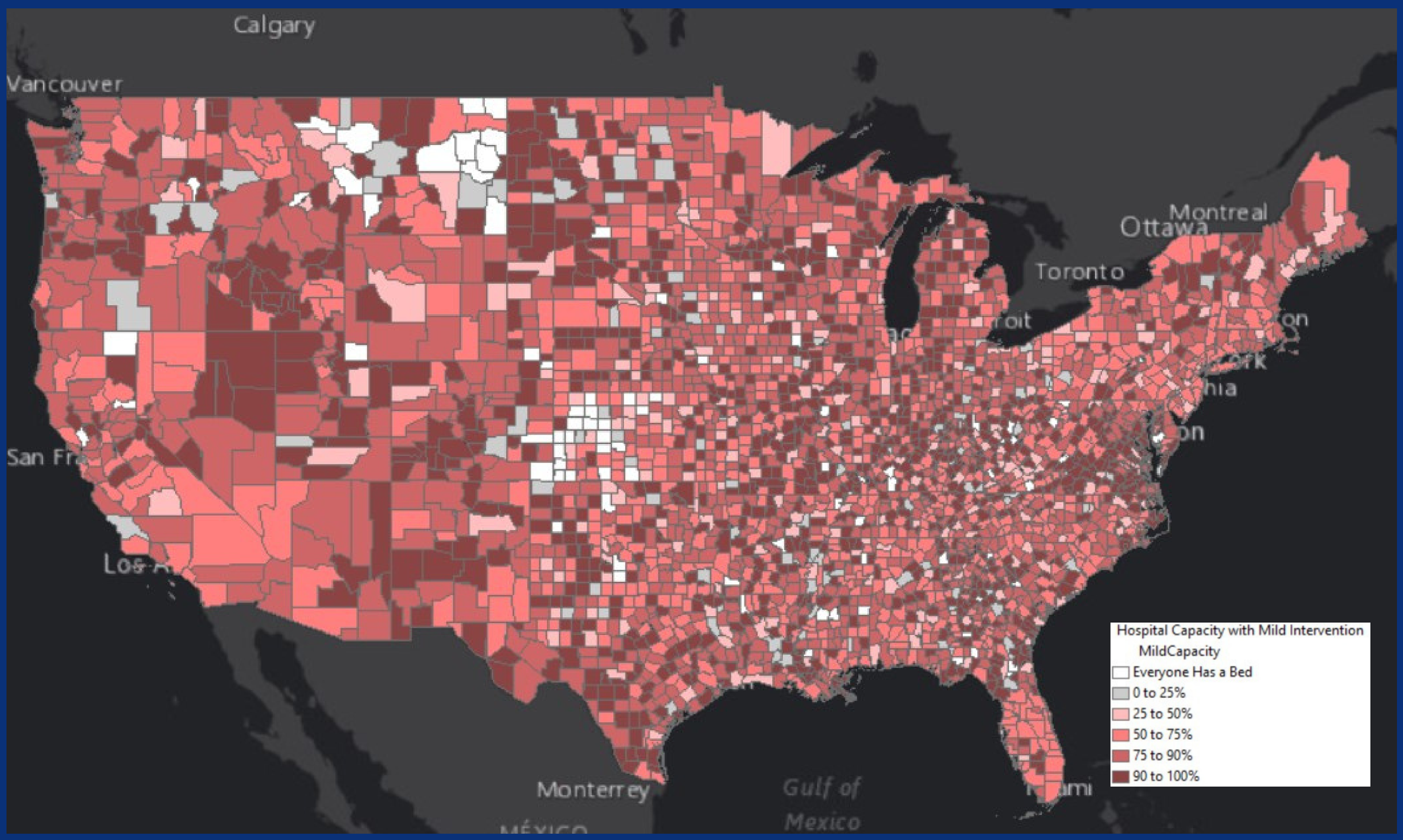


This is a Choropleth map that visually displays the number of licensed beds, staffed beds and ICU beds per county, per capita, in March 2020. This data is aggregated into primary flu and Covid 19 treatment hospitals and secondary flu and Covid 19 treatment hospitals. We are examining this data because it gives us insight on how prepared these hospitals were at the time for treating Covid 19 patients. The map shows that the majority of the country fell higher than the medum thresholds, or at least higher than the second to last threshold. However, it is important to note that not many states are in the highest threshold, which is not as much of an issue during the pre Covid 19 era but as of now, it would be ideal for most hospitals to fall within the top two capacity thresholds. Many regions in the middle of the country correspond with the lowest threshold, but don't have neighboring regions that are at the highest threshold. This map is beginning to do a deeper dive into what the hospital bed capacity looked like in March, during the initial stages of the pandemic. It supports my argument because I am examining whether our country's hospital system was fully prepared to hande the massive amount of Covid 19 cases that were surfacing, and I'm starting to see data that we weren't starting as strong as we could have on the bed capacity front.

This map was created using ArcMap, using the data from *"Definitive Healthcare: USA Hospital Beds"*

MARCH HOSPITAL INTERVENTION LEVELS

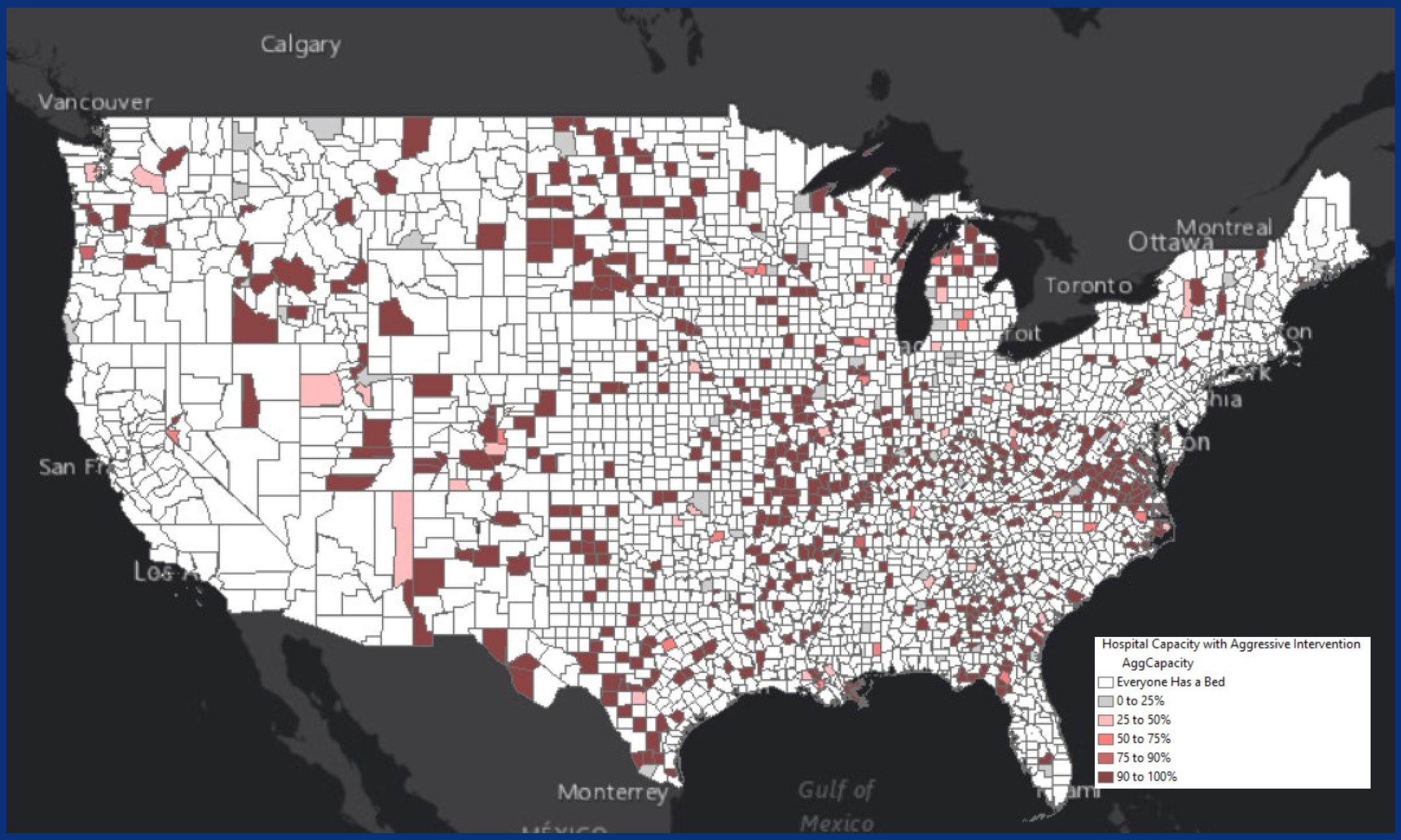
Map #4: County Level Hospital Capacity with Mild Intervention During the Month of March, 2020



This is a Choropleth map that serves as an illustrated approximation of hospital capacity by county, specifically the availability of hospital beds relative to an estimated demand of hospital beds for individuals who present with Covid 19 cases during March. The intervention level being estimated and displayed in this map is mild. This analysis assumes the following: 9.0 million individuals require a mild intervention, 3.1 million individuals require a moderate intervention and 533,000 individuals require an aggressive intervention. It is evident that with a mild intervention, there would be very few instances where every single bed in a hospital is occupied. Most regions fall into one of the upper thresholds in this event. This map is relevant to my larger argument because I would like to compare it to what experts believed an aggressive intervention would look like. It is important to note what our definitions of mild and aggressive looked like at the time in terms of intervention because it shows how we numerically defined case volumes as the pandemic hospitalization began to accelerate.

This map was created using ArcMap, using the data from *The New York Times, "How Much Worse The Coronavirus Could Get, In Charts"*

Map #5: County Level Hospital Capacity with Aggressive Intervention During the Month of March, 2020

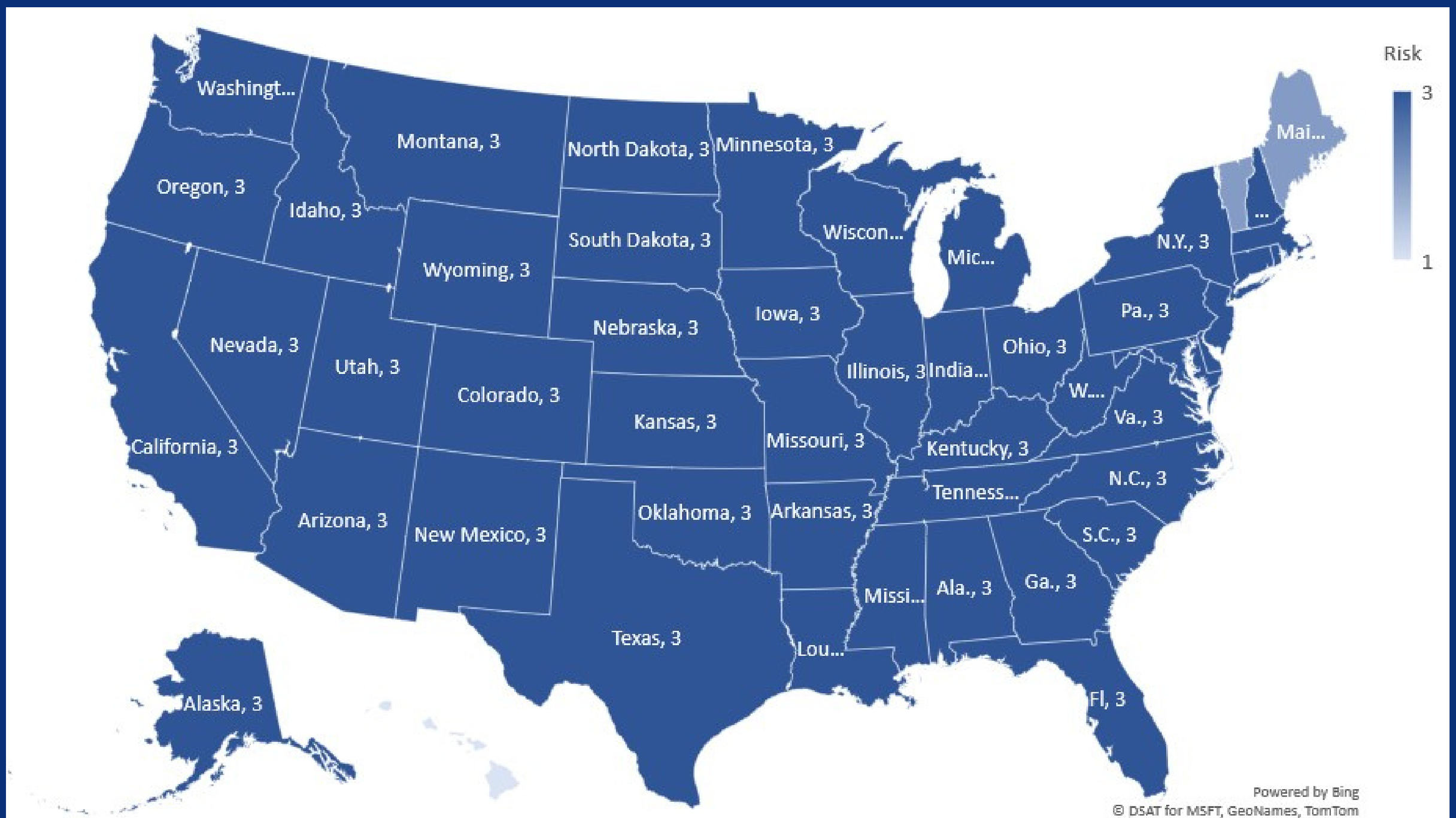


This is a Choropleth map that is meant to contrast the previous map, it shows a visual estimate of hospital capacity by county, more specifically it shows the availability of hospital beds relative to an estimated serves as an illustrated approximation of hospital capacity by county, specifically the availability of hospital beds relative to an estimated demand of hospital beds for individuals who present with Covid 19 cases during March. The intervention level being estimated and displayed in this map is aggressive. This analysis assumes the following: 9.0 million individuals require a mild intervention, 3.1 million individuals require a moderate intervention and 533,000 individuals require an aggressive intervention. This map is almost an inverse of the mild map, as there are a limited number of instances where every single bed in the hospital isn't occupied. It is important to note that the majority of regions that would have every bed full in this event have no neighboring regions to send cases to that aren't in the exact same position, capacity wise. This was touched upon in the last map but it is even more stark in this map. An at capacity hospital would have to transport a new patient that they don't have room to treat even further to make sure they do recieve medical care. My main takeway from this map is, experts who analyzed hospital data proclaimed that if the most aggressive approach were to be implemented, almost all the hospitals in the country would be at capacity and unabe to treat any additional patients. This frightening scenario is the last thing that any medical professional wants, as should be true for any member of the community. In the context of my research, this shows that hospitals did not have sufficient resources and capaciities in March. The most aggressive intervention should still be designed with more elasticity regarding hospital capacity, and there should be availability of beds in several states at this intervention level.

This map was created using ArcMap, using the data from *The New York Times, "How Much Worse The Coronavirus Could Get, In Charts"*

DECEMBER RISK LEVEL

Map #6: Covid 19 Risk Levels Across the US



Level 3	Level 2	Level 1
25+ new cases daily per 100K people	10-24 new cases daily per 100K people	1-9 new cases daily per 100K people

This is a Choropleth map demonstrating the current risk levels in different US states. This analysis operates under the assumption that any state with more than 25 daily cases per 100K people qualifies as a high risk state, labeled on this map as a Level 3 risk. This is an indication that there is a high level of community spread regarding Covid 19. Level 2 risk and Level 1 risk are segmented in similar ways, based on a threshold of 10-24 daily cases per 100K people and 1-9 daily cases per 100K people, respectively. This map shows that an alarming majority of the country is living in a location that has been deemed a Level 3 risk. Ideally, to best protect both our healthcare workers from being overworked and ourselves from the health ramifications of Covid 19 a community, reducing Covid 19 cases as drastically as possible would serve in our best interest. This means reinvesting in the flattening the curve mindset that was more heavily emphasized at the start of the pandemic. This is a critical component of my analysis on the country's current positoning regarding Covid 19 cases, the extent to which we are at risk and what affect this will have on our hospital system and healthcare workers. According to this data, updated as of December 9th, 48 states are at the highest Covid 19 risk level. The more we let risk levels skyrocket, the more strenuous of an impact it will have on the country's hospital capacity.

This map was created using Microsoft Excel Maps, using data from *Harvard Global Health Institute* and *Center for Systems Science and Engineering at Johns Hopkins University, Census Bureau 2019 population estimates, 2010 Census (U.S.)*

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