**Comprehensive Project Summary: Climate Change Impact Analysis on Virginia Reservoirs**

**Project Overview**:  
Over a 5-month period, I contributed to a peer-reviewed study with the Bukaveckas Lab at Virginia Commonwealth University, aimed at examining the impacts of climate change on 41 reservoirs across Virginia. This project involved extensive data analysis, statistical modeling, R programming, and GIS mapping, all of which played a crucial role in understanding the long-term trends in temperature and dissolved oxygen (DO) levels within these water bodies.

**Data Extraction and Preparation**:

* **Initial Dataset**: The project began with a large dataset containing approximately 19,000 depth profiles from various lake stations across Virginia, recorded over the past 40+ years.
* **Station Selection**: I extracted data specific to 41 selected lake stations that had at least 100 depth profiles available, reducing the dataset to around 7,700 profiles.
* **Variable Calculation**: I derived key statistics (mean, min, max, Nobs) for Tmax (maximum temperature) across the May-October period for each of the 41 stations. These results were compiled into a separate file containing approximately 246 rows (41 stations x 6 months) and 6 columns (station ID, month, mean, min, max, Nobs).

**Statistical Analysis and Modeling**:

* **Temperature Anomaly Calculation**: I created a new variable in the dataset, representing the temperature anomaly (difference between observed temperature and long-term average temperature for each station and month).
* **Median-Based Linear Modeling (mblm)**: Using the mblm function in R, I conducted linear regressions to analyze temperature anomaly trends over time. This method was chosen for its robustness against outliers, which are likely to be encountered in a dataset of this size that contains temperature and DO field observations.
  + **Key Outputs**: For each station and month, I calculated the slope, standard error of the slope, and p-value, which were then added to the Tmax statistics file.
* **Exploratory Analysis**: I conducted various exploratory analyses to identify potential relationships between warming rates and factors such as latitude, longitude, profile depth, length of monitoring record, and starting year.
  + **Geo-Spatial Analysis**: I tested for spatial gradients (e.g., North-South, East-West) in warming rates and examined whether lakes in close proximity had more similar warming rates.

**Advanced Data Visualization and Mapping**:

* **Scatterplots and Boxplots**: I created detailed scatterplots and boxplots to visualize relationships between warming rates and various factors, such as profile depth, ecoregion classifications, and seasonal changes.
  + **Monthly Warming Rates**: I developed boxplots that depicted the variation in warming rates for each month, as well as an overall average warming rate across all months for each station.
* **Mapping**: Using ArcGIS Pro, I created publication-ready maps to visually represent the results of the statistical analyses.
  + **Lake and Watershed Mapping**: I mapped the locations of the 41 stations, including major watershed boundaries (James, Roanoke, and New River). For lakes with multiple stations, I created detailed blow-out maps to show individual station locations.
  + **Temperature and DO Trends**: I plotted temperature and dissolved oxygen trends for stations with long-term data, adding regression lines to indicate significant trends.

**Additional Analyses**:

* **Air Temperature Comparison**: I retrieved NOAA monthly average air temperatures for Virginia’s four climate regions and ran mblm regressions on air temperature anomalies. I then compared these to water temperature anomalies to assess the correlation between air and water temperatures.
* **Long-Term Seasonal Trends**: I analyzed long-term trends in seasonal changes in temperature and dissolved oxygen, focusing on data from May to September. I calculated the rates of change for each year and fit mblm regressions to these rates to identify long-term trends.

**Documentation and Reporting**:

* **Result Compilation**: I compiled the key results, including rate of change estimates, into a well-organized file for review and further analysis.
* **Final Figures**: I developed final figures for the publication, including detailed plots and maps that effectively communicate the study’s findings.
* **Technical Documentation**: I provided thorough documentation of the R scripts and methodologies used throughout the project, ensuring reproducibility and clarity for future reference.

**Outcome and Impact**:  
This project provided critical insights into the effects of climate change on Virginia’s reservoirs, highlighting the variability in warming rates across different regions and lake types. The results are expected to contribute significantly to the scientific understanding of climate change impacts on mid-latitude reservoirs, potentially filling a gap in existing literature that has predominantly focused on natural lakes in northern boreal regions.

**Key Skills Demonstrated:**

* **Advanced R Programming**: Extensive use of R for data extraction, statistical modeling, and visualization.
* **Statistical Analysis**: Application of median-based linear modeling to assess long-term trends.
* **GIS Mapping**: Creation of detailed, publication-ready maps using ArcGIS Pro.
* **Data Management**: Handling large, complex datasets and ensuring accurate, reproducible results.
* **Scientific Communication**: Development of clear and impactful figures and reports for a peer-reviewed publication.

1 PARAGRAPH SUMMARY

Over a 5-month period, I played a key role in a peer-reviewed study with the Bukaveckas Lab at Virginia Commonwealth University, focusing on the impacts of climate change on 41 reservoirs across Virginia. My involvement spanned from data extraction to advanced statistical modeling and GIS mapping. I worked with a dataset of 19,000 depth profiles, refining it to 7,700 profiles specific to our study sites. I calculated critical variables such as temperature anomalies and employed median-based linear modeling (mblm) in R to analyze long-term trends in temperature and dissolved oxygen levels. My exploratory and geo-spatial analyses identified spatial gradients and relationships between warming rates and various environmental factors. Additionally, I created publication-ready maps and visualizations in ArcGIS Pro, effectively communicating our findings. Throughout the project, I ensured meticulous data management, developed reproducible R scripts, and contributed clear and impactful figures and documentation for the publication.