Potential impacts of sea level rise on natural infrastructure on Aberdeen Proving Ground

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Introduction

Aberdeen Proving Ground (APG) is a U.S. military installation that is home to major natural infrastructure and ecologically sensitive species, and it serves as a bedrock of the local economy. Sea level rise, one of the most clearly visible consequences of anthropogenic climate change, threatens APG and the greater Chesapeake Bay ecosystem (Wood, Boesch, & Kennedy, 2002). Forest interior-dwelling species (FIDS) are niche-sensitive birds whose habitats are jeopardized by forest fragmentation (Suarez-Rubio & Lookingbill, 2016). FIDS are described as indicator species; disturbances in a population of FIDS often presages further issues in an ecosystem. Sea level rise would reduce the amount of available FIDS habitat on APG. Another such niche-sensitive bird is the eastern black rail, which resides in high tidal marshes on APG. Sea level rise on APG is projected to result in the movement of flood plain and wetland conditions to higher-elevation areas, which eliminate black rail habitat while damaging rare, threatened, and endangered (RTE) plants. Bald eagles on APG typically nest near the shoreline; sea level rise would push their nesting forest inland, placing them in contact with human infrastructure.

The purpose of this project was to analyze the effects of sea level rise on various components of natural infrastructure on APG. It was predicted that there was a negative correlation between sea level rise and the acreage of FIDS habitat on APG. It was hoped that the research conducted during this project would provide guidance to policymakers with which the most sensitive habitats on APG could be preserved.

Materials and Methods

ArcGIS® software was used extensively throughout this project to model natural infrastructure on APG as individual sets of data. The effects of sea level rise on different components of natural infrastructure was modeled to reflect sea level increases of up to ten feet. The topographic effects of sea level rise were specifically analyzed to account for the effects of related ecological factors, such as forest fragmentation and estuarine wetland emergence. Extraneous data was removed from existing datasets to depict the changes to natural infrastructure resulting from sea level rise on APG. Datasets were produced to model the shorelines predicted on APG after sea level increases of up to sixteen feet, before they were compared with data modeling different components of natural infrastructure on APG, as shown in Figures 1 through 3. Specific shorelines were used to model the effects of sea level rise on FIDS habitat, eastern black rail habitat, hundred-year flood plains, estuarine wetlands, RTE plants, and potential eagle nesting habitat on APG.

Materials and Methods (cont.)

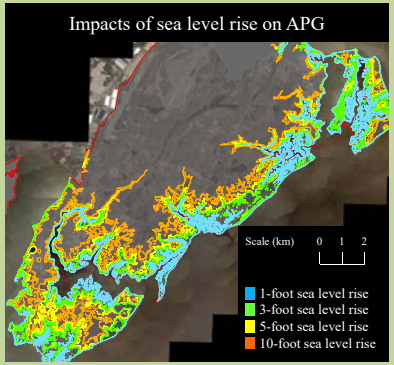


Figure 1 (left): APG at the current sea level, oriented to the north. Contours were drafted over the map to depict the projected shorelines on APG after different increments of sea level rise. Sea level rise would lead to erosion in coastal areas and estuarine wetland movement. Closely regulated areas on APG were blacked out of the map, and the land borders of APG were depicted as red lines.

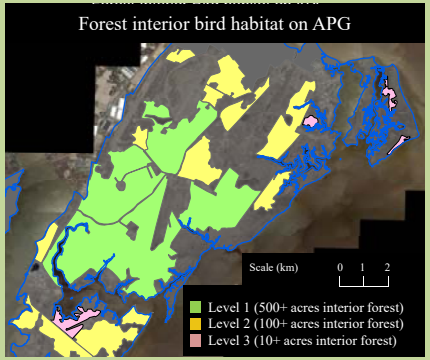


Figure 2 (left): APG at the current sea level with existing FIDS habitat, oriented identically to Figure 1. Larger tracts of inland FIDS habitat are characterized by upland forest, while riparian forest is dominant in the coastal areas of APG. Sea level rise reduces the size of FIDS habitat and can degrade it to lower levels as a result of forest fragmentation. The borders of APG were shown as blue lines.

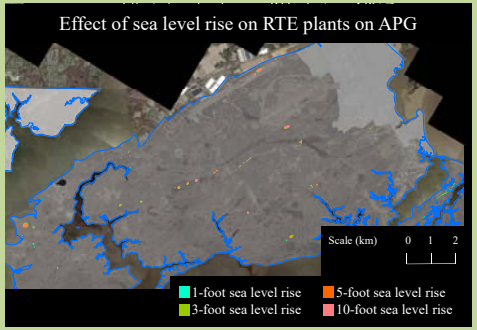
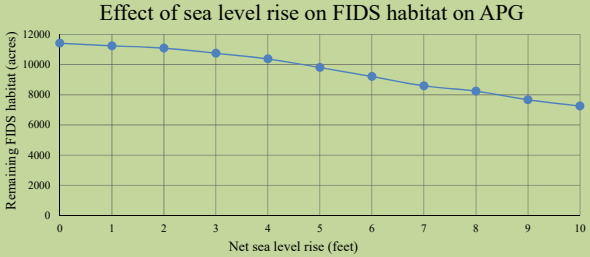


Figure 3 (left): APG at the current sea level with resident RTE plants highlighted, oriented to the northwest. RTE plants indicated by different colors on the map would be inundated at the specified increments of sea level rise. The borders of APG were represented by blue lines.

Results

After the normality of the data was confirmed, correlation testing was performed to quantify the strength of the relationship between sea level rise and the total area of FIDS habitat. It was determined that a significant negative relationship ($r = -0.989$, $p < 0.001$) existed between these two variables. As the modeled sea level increased, the total area of remaining FIDS habitat on APG consistently decreased.



Graph 1 (above): The direct negative relationship depicted indicated that sea level rise on APG was associated with FIDS habitat loss.

Conclusions

The purpose of this project was met; the use of ArcGIS® software allowed for the construction of accurate maps of APG after various increases in sea level. The null hypothesis was rejected at the 0.05 significance level ($p < 0.001$), and it was concluded that sea level rise would reduce the availability of FIDS habitat on APG. It was additionally determined that increasing sea levels in the Chesapeake Bay would contribute to habitat loss for niche-sensitive species like the eastern black rail, and that estuarine wetland movement would cause damage to existing forests and RTE plants on APG. The inland movement of potential eagle nesting forest would place eagles on APG at risk as a result of increased contact with human infrastructure. Future research should be performed to assess the resiliency of various response strategies to address the vulnerabilities of existing environmental infrastructure and wildlife on APG.

References

Suarez-Rubio, M. & Lookingbill, T. R. (2016). Forest birds respond to the spatial pattern of exurban development in the Mid-Atlantic region, USA. *PeerJ, 4*(5), 1-25.

Wood, R. J., Boesch, D. F., & Kennedy, V. S. (2002). Future consequences of climate change for the Chesapeake Bay ecosystem and its fisheries. *American Fisheries Society, 32*, 171-184.