Authors' Response to Reviewers and Associate Editor Feedback:

Thank you kindly for these reviews and positive feedback from the Associate Editor Ben Bond-Lamberty. We went through the suggested changes and incorporated them throughout the manuscript. We think the result is more transparent and clear. We appreciate the helpful suggestions.

We respond to each comment in turn, by inserting our responses between the paragraphs written by Reviewers in the letter below. To better differentiate our comments from those of the Reviewers, we have highlighted our text in teal and use Times New Roman font to contrast with the sans serif font of the text written by Reviewers.

We hope that our responses and the changes we made to the manuscript are sufficient to warrant consideration of a revised draft for publication in Biogeosciences.

Sincerely,
Dr. Rebecca Rooney (on behalf of co-authors Dr. Jody Daniel and Dr. Derek Robinson).

Associate Editor comments to the author:

Thanks for your extensive and careful revisions, which were evaluated by both original referees. R1 has a few minor comments but otherwise believes this ready for final publication; R2 acknowledges many improvements, but has two significant outstanding concerns, both revolving around clarity of the modeling and analysis (and has many other minor, useful, points to consider as well). I have read the revised ms and your responses, and generally agree with the referees—this has substantially improved. Please consider carefully the referees' remaining points, in particular R2's comments about being transparent about model performance. I do not anticipate that this will require a great deal of work, however.

Thank you for the opportunity.

Reviewer 1

L97: This is valuable information here and I am glad you added it. You describe the 25m DEM as being course but when your wetlands are occupying this many cells, that resolution of DEM is perfectly adequate.

We corrected our mix up regarding the number of cells in a median sized wetland and hope R1 still feels the DEM was adequate. It was the highest resolution available for our study area. Due to right skew, the average sized wetland is larger than the median (Appendix A). L103-107.

L201: You get to these distinctions a little further down but "surrounded by less natural land cover" is a bit misleading and seems to vary by region. Figure 5F shows semi-permanent and permanent wetlands seem unlikely to occur when natural cover is really high, i.e. over ~75%, but are likely to occur when natural cover is lower than that. However, Figure 5D shows them unlikely to occur when cropland is over ~25% in Boreal

Thank you for pointing out this inconsistency. We revised for greater specificity: "Longer hydroperiod wetlands were typically situated in landscapes with more summer precipitation and lower spring temperatures (e.g., Figure 5C), occupying relatively low topographic positions with low terrain convexity (e.g., Figure 5G, H), and, in the Grassland, were sometimes surrounded by less natural cover (Figure 5F), though in the Southern Boreal they were more common where cropland was less than 25% cover (Figure 5D).".

L289: are there supposed to be citations here?

L290: and again here?

Yes. Our apologies. There definitely was meant to be citations there. We have since added the two citations (~L305 and L307) which are the following:

Chen, S., Johnson, F., Drummond, C., Glamore, W., 2020. A new method to improve the accuracy of remotely sensed data for wetland water balance estimates. Journal of Hydrology: Regional Studies, 29, 100689. https://doi.org/10.1016/j.ejrh.2020.100689

LaBaugh, J.W., Rosenberry, D.O., Mushet, D.M., Neff, B.P., Nelson, R.D., Euliss Jr., N.H., 2018. Long-term changes in pond permanence, size, and salinity in Prairie Pothole Region wetlands: The role of groundwater-pond interaction. Journal of Hydrology: Regional Studies, 17, 1-23. https://doi.org/10.1016/j.ejrh.2018.03.003

L300: Wetland catchment sizes were also found to be similar in size among high-resolution and lower-resoution DEM data in McCauley, L.A. and Anteau, M.J., 2014. Generating nested wetland catchments with readily-available digital elevation data may improve evaluations of land-use change on wetlands. Wetlands, 34(6), pp.1123-1132.

We thank the reviewer for this suggestion, we have revised the text to include the following: *there was no detectible difference in wetland catchment size when they were derived from DEMs of low (10 m) versus high (3 m) resolution (McCauley and Anteau, 2014).* L317

Reviewer 2:

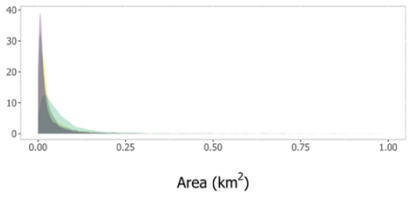
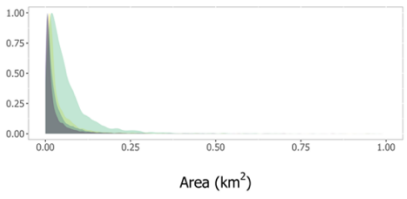
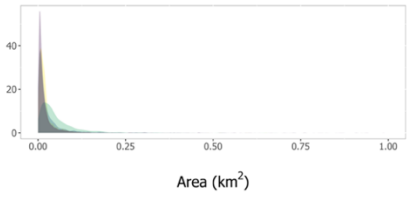
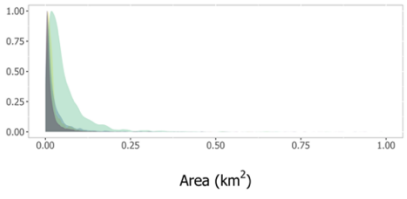
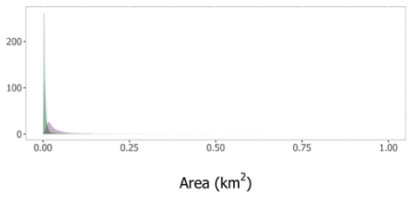
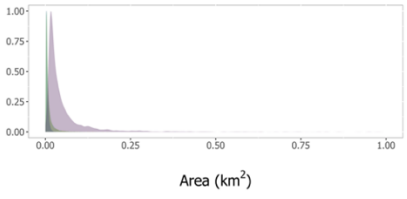
1. Be more transparent about the performance of your model so that readers can judge whether they agree with your conclusions based on your model outputs. From what I could tell In Appendix D The misclassification error rate is ~50% in both the training and test data. This is concerning to me that a model with a high number of covariates across multiple categories and with complex nonlinear functions still has a 50% chance of misclassifying a wetland permanence class. This error rate and model performance need to be better explained in section 3.2 "Model Performance." From the Abstract to the conclusions this manuscript centers around being able to predict wetland permanence class using three categories of covariates. I am concerned that with error rates so high the model is not doing what the authors claim and with such limited predictive power distributed across 19 covariates there is even less confidence in the variable importance analysis.

We revised the abstract (L15-18), the methods (~L170-181), results (L196-201), and the discussion section (L303-307 and 335-345) to increase clarity about the model misclassification error rates. We also expanded

on Appendix D to elaborate on class-based misclassification error rates as in some cases misclassifications were primarily into neighboring permanence class bins (e.g., a permanent wetland classified by the model as likely semi-permanent), and sometimes the misclassification errors were more major (e.g., a permanent wetland classified by the model as likely temporary). This effort was actually very useful as repeating the modeling was informative. We took the opportunity to tune the modeling parameters a bit, which did not ultimate change the results but did confirm our confidence in them. We discuss these class-based misclassification error rates in the final discussion section, but we also didn't want to lead readers down an unnecessary rabbit hole. We want to stick to our study objective of comparing the role of climate, land cover and topography variables in predicting permanence class. We struck a compromise in contextualizing what the misclassification error rate means and hope it is now clear to any reader that a misclassification error rate of 50% does not mean the model is "no better than flipping a coin." We also reinforce the message that site specific variables like depth, surface area, soils, ground water discharge, etc. are not accounted for in our model, but would most likely improve prediction accuracy.

2. I am still having a hard time following the way in which the authors use the terms permanence class, hydroperiod, and pond permanence. My understanding of the distribution of prairie wetlands is that wetlands of different permanence classes can exist within the same localized climate regions. To better establish the hypothesized relationship between climatic variables, such as seasonal temperature and snowpack, and wetland permanence class I would need to better visualize the distribution of wetland basins and their corresponding permanence classes in the three ecoregions. Section 3.3 starts to classify the environmental conditions that are related to different permanence classes, but it would be helpful to understand how homo/heterogeneously those wetlands of different classes are distributed throughout each ecoregion.

We recognize the reviewers concerns and adjusted Appendix A accordingly. Wetlands of all permanence classes are present in all Natural Regions, though their relative abundance differs across the latitudinal gradient of our study region (see Table 1). In Appendix A, we show a scaled density plot of wetland size by permanence class across the three Natural Regions. We also included a table that compares wetland permanence class size across the three Natural Regions (mean, median and standard deviation). Additionally, we included the following to help contextualize these additions: *While a disproportionate number of seasonal wetlands in the Boreal and Parkland were larger than permanent and semi-permanent wetlands (Appendix A), a disproportionate number of permanent wetlands in the Grassland were larger than other wetland classes (Appendix A).*

Natural Region	Permanence Class	Median (km²)	Mean (km²)	Standard Deviation	Raw Density Plot	Scaled Density Plot
Boreal	Temporary	0.0210	0.0542	0.1663		
	Seasonal	0.0438	0.0724	0.1126		
	Semi-Permanent	0.0159	0.0339	0.0604		
	Permanent	0.0130	0.1907	2.1872		
Parkland	Temporary	0.0139	0.0221	0.0376		
	Seasonal	0.0372	0.0584	0.0784		
	Semi-Permanent	0.0133	0.0305	0.0594		
	Permanent	0.0099	0.0554	0.5298		
Grassland	Temporary	0.0050	0.0121	0.0291		
	Seasonal	0.0051	0.0118	0.0276		
	Semi-Permanent	0.0040	0.0058	0.0143		
	Permanent	0.0286	0.0852	0.5761		

L65 some reference of when the wetlands in the Alberta inventory were classified.

The text has been revised to clarify the differences between different wetland data and the Alberta inventory has been cited as follows:

Government, A. E. and P., Government Alberta and Government of Alberta: Alberta Merged Wetland Inventory, [online] Available from: https://geodiscover.alberta.ca/geoportal/catalog/search/resource/details.page?uuid=%7BA73F5AE1-4677-4731-B3F6-700743A96C97%7D (Accessed 25 September 2017), 2014.

L65 should read “We quantify the relative contribution of climate, landcover/land use and topography for predicting different wetland permanence classes.”

Thank you, we have made this change.

Methods paragraph 2 is confusing to me. The first and second sentences seem to contradict each other. The first reads that there wetland permanence class has not been defined and the second sentence says permanence class has been defined.

Thank you for pointing out this lack of clarity. We revised the text to make clear that though the provincial and national wetland inventories do not provide information on wetland permanence classes

for the wetlands mapped, we used two smaller wetland inventories that span the Southern and Central regions of Alberta and that do characterize wetlands by permanence class. See Lines 81-86.

2.2 Second paragraph. Double check the number of cells occupied by median sized wetlands. My understanding is 25m DEM means that each cell is 25m x 25m or 750 sq-m. If that is the case the median wetland sizes would occupy 30, 20, and 7 pixels (cells) respectively.

Thank you for pointing out this error, which we would like to blame on covid brain fog. We have adjusted the pixel numbers to align the median wetland sizes with the 25x25 = 625m^2 area of each cell and have clarified the text to note the following:

"The distribution of wetland sizes was strongly right-skewed across the three Natural Regions of interest. Wetlands were typically small, with Boreal wetlands possessing the largest median size (2.26 ha), followed by Parkland wetlands (1.54 ha) 95 and Grassland wetlands (0.58 ha, Appendix A)….

The combination of wetland size and our digital elevation model (DEM) resolution of 25 m suggest that our median wetland sizes would occupy 36, 25, and 9 cells for Boreal, Parkland, and Grassland natural regions, respectively, and demonstrate our ability to capture variability among wetland sizes and shape."

L185-186 I know this is visually represented in fig 4, but listing the range of spring temperatures for each ecoregion would be helpful.

We added the following to assist in understanding the range in springe temperatures among the Natural Regions: *Boreal: 6.87±0.425 SD; Parkland: 6.85±0.206 SD; Grassland: 8.14±0.892 SD.*(~L205)

L238-240 This statement contradicts what is listed in Table 1, where permanently ponded wetlands are the lowest number.

Permanently ponded wetlands are less numerically abundant in all three Natural Regions, as indicated in Table 1. In this text, we are referencing Serran et al. 2017, who used deviations from the power-law relationship between the numerical abundance of wetlands and their areal extent to infer that smaller, less permanent wetlands have been disproportionately removed from the landscape. They are being lost at a greater rate, though they remain more numerically abundant than more permanently ponded wetlands. We revised for clarity L 261-263.

L130 physicochemical

Thank you, we have made this change.

L166 & 170 permeance should read permanence

Thank you, we have made this change. ~L

L224 witner should read winter

Thank you, we have made this change. ~L240

Appendix B is missing the Southern Boreal Ecoregion

Unfortunately, we lacked the relevant data for this comparison, as our inventory covered only a small southern portion of the Boreal Natural Region. As such, the plot was limited to the Grassland and Parkland. We added an explanation