Supplementary Materials

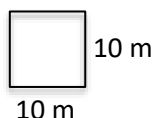**Ecological Risks from Atmospheric Deposition of Nitrogen and Sulphur to Jack Pine forests in Northwestern Canada**

Nicole Vandinther and Julian Aherne *
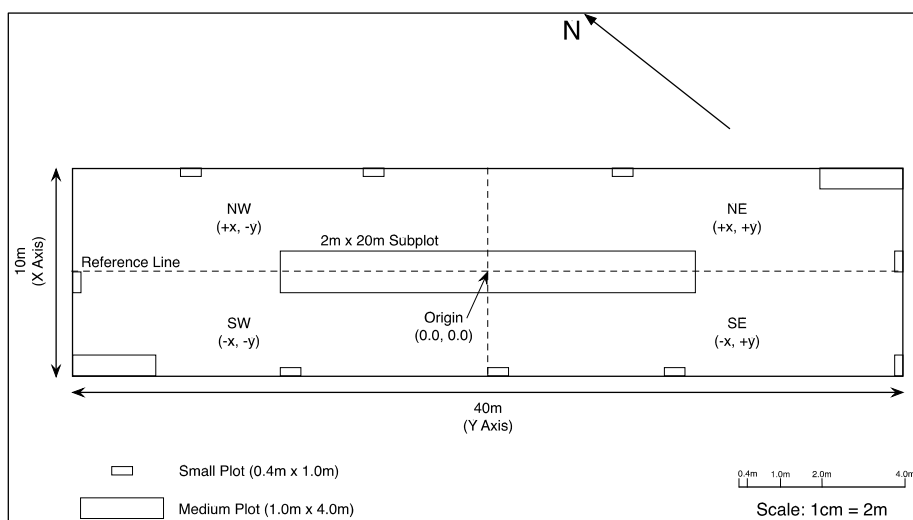School of Environment, Trent University, Peterborough, ON K9L 0G2, Canada
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SUPPLEMENTARY MATERIALS SI. Vegetation plot configurations and survey information

Supplementary Materials SI – i. SK-FEC survey: Vegetation information was collected across a 10 m x 10 m square plot and reported as average percent cover by layer.

10 m

10 m

Supplementary Materials SI – ii. WBEA survey: Understorey vegetation information added in 2004. Large plots measuring 10 m x 40 m were established at each site. Vegetation information was collected across 10 small subplots (seen in Figure legend), 2 medium subplots (seen in Figure legend) and 1 large subplot in the centre, all within the large plot. Vegetation information was collected using the Daubenmire method of cover class estimation and reported as species composition percent.
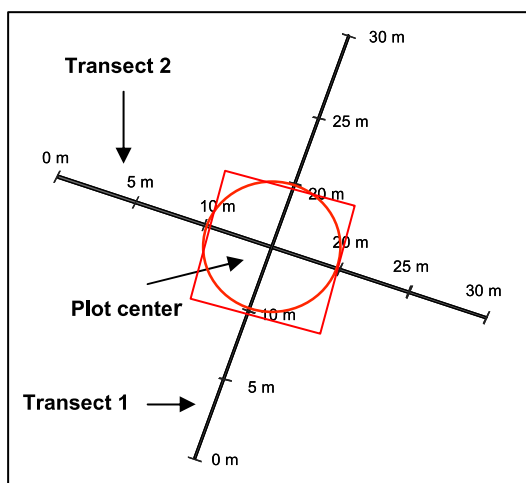

Source: Clair, T. A. and K. E. Percy (Editors) 2015. Assessing forest health in the Athabasca Oil Sands Region. *WBEA Technical Report*. 2015-05-25, 180 pp +Appendices.

Supplementary Materials SI – iii. Daubenmire Cover class estimation method
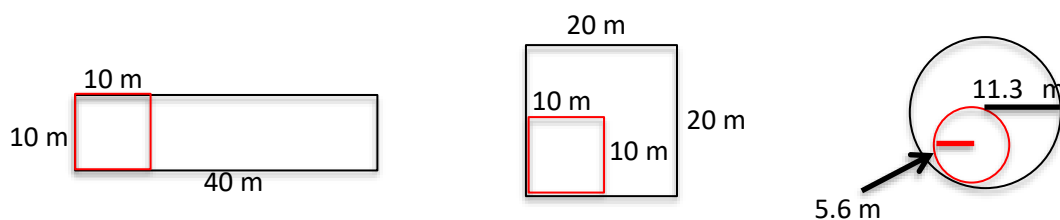
Daubenmire Cover Classes

Cover Class	Canopy Coverage	Midpoint of Range
1	0 to 5%	2.5%
2	6 to 25%	15.0%
3	26 to 50%	37.5%
4	51 to 75%	62.5%
5	76 to 95%	85.0%
6	96 to 100%	97.5%

Supplementary Materials SI – iv. Vegetation sampling plot configuration used in the NFI survey. Vegetation information was collected across a 10 m x 10 m ecological plot at the centre of the site (seen by the square) and reported as percent cover by layer.

Source: Canadian Forest Inventory Committee (CFIC). (2008). Canada's National Forest Inventory: Ground Sampling Guidelines. *Natural Resources Canada*, Canadian Forest Service, Pacific Forestry Centre, Victoria, British Columbia. ISBN: 978-1-100-11330-2

Supplementary Materials SI – v. Vegetation sampling plot configuration used the NWT-FEC survey. Sampling began with a 20 m x 20 m plot where site characteristics and tree species and percent cover were recorded. Plot shapes were either rectangular (10 m x 40 m), square (20 m x 20 m) or circular (with radius of 11.3 m^2) to reduce topographic variability. Within each plot, smaller subplots (in red) were established to record shrub, herb, grass, moss and lichen species. Subplot shapes were either square (10 m x 10 m) or circular (radius of 5.6 m^2) depending on the site topography and vegetation information was reported as percent cover.

SUPPLEMENTARY MATERIALS SII. Gradient Forest Information

Supplementary Materials SII – i. Random forest and extended forest components, description, and component use.

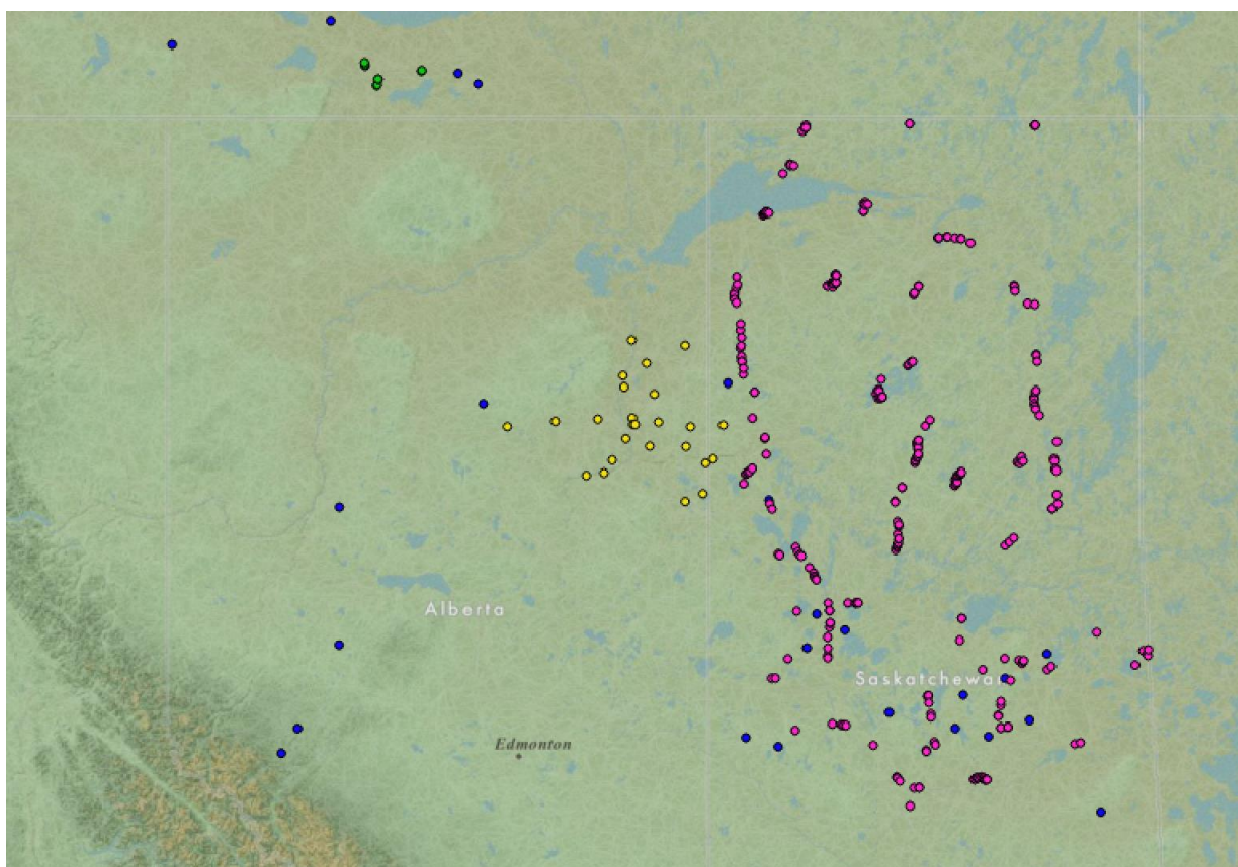| RANDOM FOREST & EXTENDED FOREST FUNCTION				
Component	**Goodness-of-fit values/Predictive Performance → R^2_S**	**Accuracy Importance Values**	**Raw Importance Values**	**Density of splits**
Description	R^2_S values given for a forest of any given species	Values are given for each predictor; determines how important a variable is for the model (predictive power)		Obtained in randomForest through Kernel density of estimations
Component Use	Gradient Forest: used in multiple plots; R^2_S values are partitioned into contributions (R^2_{SP}) from each predictor in proportion to the predictor importance	Gradient Forest: used in Conditional Importance Plot	Gradient Forest: used in Cumulative importance plots (both species and community)	Gradient Forest: used in densities plot

Supplementary Materials SII– ii. Gradient forest outputs, components included, descriptions and additional information.

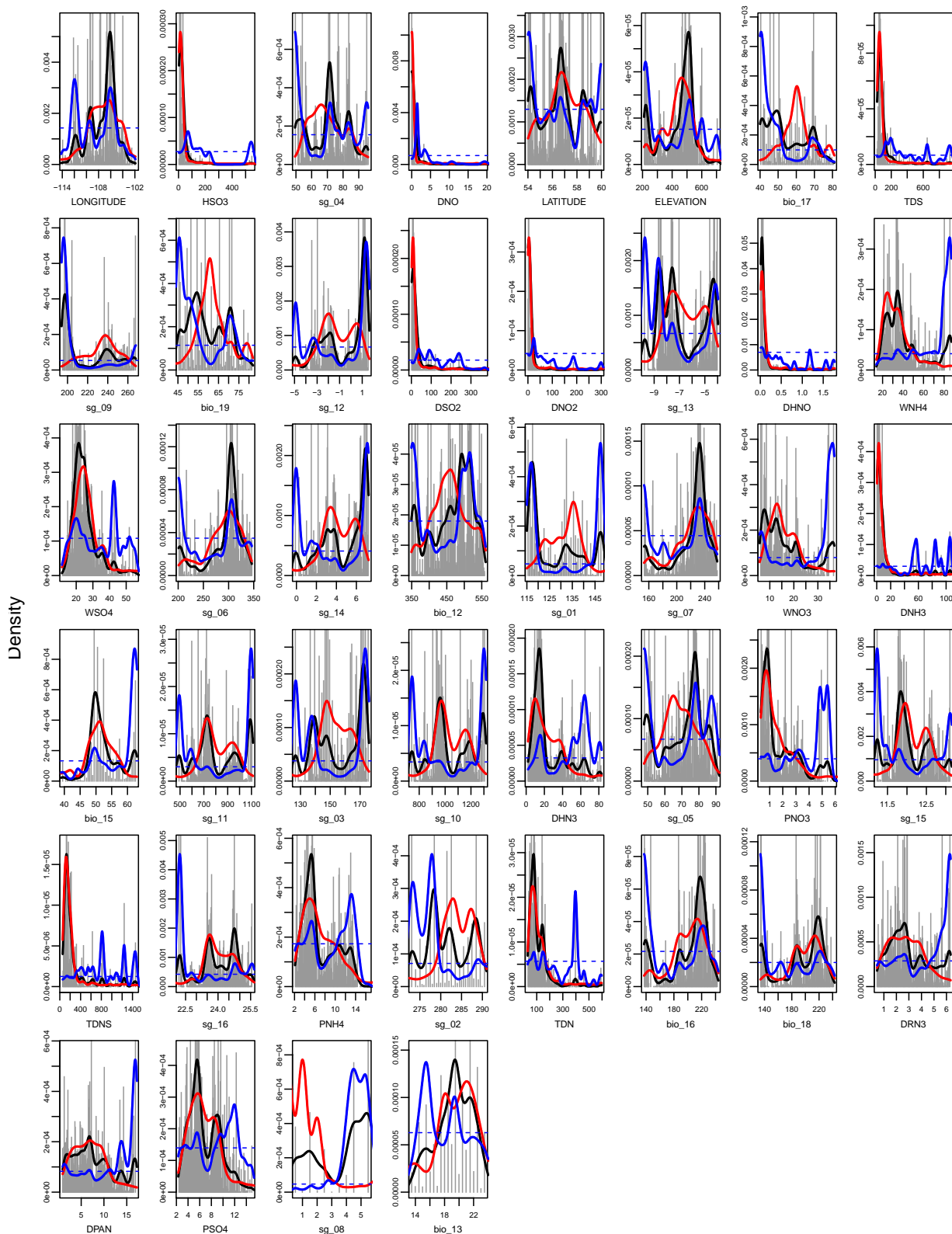| GRADIENT FOREST OUTPUT				
Plot Type	**Overall Conditional Importance Plot**	**Densities Plot**	**Cumulative Importance Plot (Species & Community)**	**Overall Performance (Species) R^2 Plot**
Included Components	• **Overall R^2 weighted importance** • **Accuracy importance**	• **Density of splits (black curve)** • **Density of data (red curve)** • **Ratio of densities (blue curve)** • **Ratio = 1 (dashed blue curve)** • **Binned Split Importance Values (grey bars)**	• **Individual species turnover functions** • **Community turnover functions**	• **R^2_{SP} values**
Output Description	Identifies the amount of variance in the model that is explained by each predictor and whether a predictor has predictive power	Identifies regions across an environmental variable of higher importance for plant species compositional change	Reveals Species associated with community thresholds	Shows species distributed according to their specific R^2 value; Indication of how well a species was predicted by all environmental variables
Additional Information	• **R^2_S are partitioned into contributions (R^2_{SP})** • **Sum of all R^2_{SP} = overall R^2 weighted importance (given to each predictor)**	• **Ratio of densities = $\frac{Density\ of\ splits}{Density\ of\ data}$** • **Area under the Curve = R^2 weighted importance** • **High peaks (where ratio >1) represent thresholds** • **Binned split importance represents both split locations and relative importance on the gradient**	• **Species turnover function: distribute R^2_S from all species among the predictors in proportion to the accuracy importance values and along the predictor gradients according to the density of raw importances** • **Community turnover functions: Aggregate the normalized cumulative distribution, scale by R^2 weighted importance and standardize by density of data and average across all species**	• **Overall Performance R^2 = Sum of all R^2_{SP} values per species** • **Output only shows positive response**

*The average of all overall R^2 weighted importance values = Mean R^2 weighted importance (how much of the overall model variation is explained by all predictors).
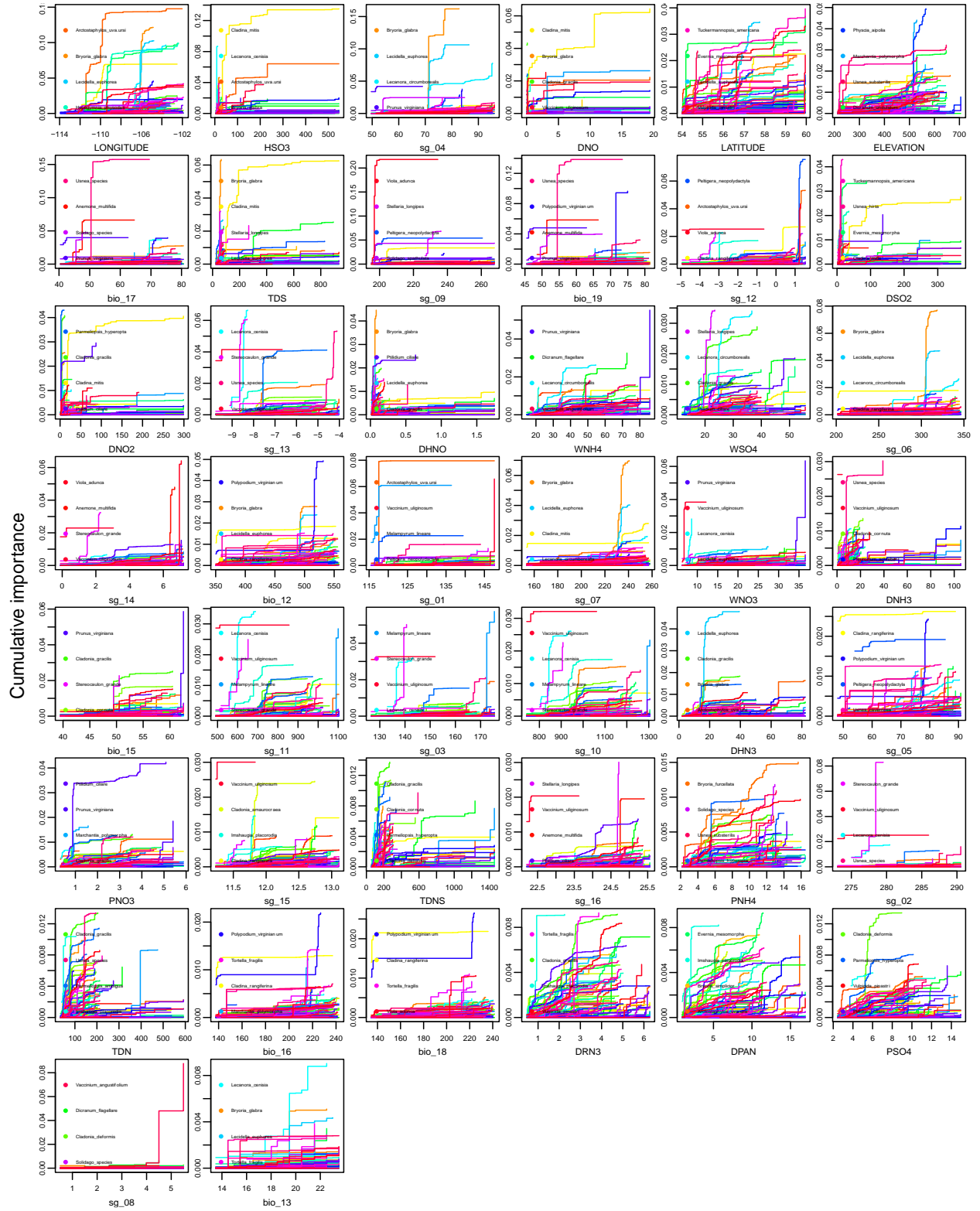
SUPPLEMENTARY MATERIALS SIII.

Supplementary Materials SIII – i. Location of all 357 sites initially considered before longitude and latitude thresholds were used to remove any geographic bias. Study sites are colour coded based on their survey of origin, with blue representing NFI survey sites (n = 24), yellow representing WBEA survey sites (n = 25), green representing NWT-FEC survey sites (n = 9) in green and pink representing SK-FEC survey sites (n = 299).

Supplementary Materials SIII – ii. Gradient forest density plots for all 43 environmental variables (TDNS included).

Supplementary Materials SIII – iii. Gradient forest species cumulative importance plots for all 43 environmental variables (TDNS included).

Supplementary Materials SIII – iv. Gradient forest community cumulative importance plots for all 43 environmental variables (TDNS included).