Appendix: listing of all available surrogate variables

Table 1: Listing of the variables used in the regression models at Hika Beach. For each variable, the listing indicates which summary statistics were computed, and over what time scales.

Covariate	Statistic	1h	2h	6h	12h	24h	48h	72h	120h
Sheboygan River Discharge									
	Diff			x					
Manitowoc River Discharge									
	Diff			x					
log Manitowoc River Discharge									
	Mean	x	x	x	x	x	x	x	x
	Min	x	x	x	x	x	x	x	x
	Max					x			
log Sheboygan River Discharge									
	Mean	x	x	x	x	x	x	x	x
	Min	x	x	x	x	x	x	x	x
	Max					x			
Cloud cover									
	Mean	x	x	x	x	x	x		
Lake level									
	Mean	x				x			
	Max	x				x			
	Min	x				x			
	Diff					x			
Surface current, perpendicular									
	Mean	x	x	x	x	x	x	x	x
Surface current, parallel									
	Mean	x	x	x	x	x	x	x	x
Subsurface current, perpendicular									
	Mean	x	x	x	x	x	x	x	x
Subsurface current, parallel									
	Mean	x	x	x	x	x	x	x	x
Wave height									
	Mean	x	x	x	x	x			
Wave height speed, perpendicular									
	Mean	x	x	x	x	x			
Wave height speed, parallel									
	Mean	x	x	x	x	x			
Wave speed, perpendicular									
	Mean	x	x	x	x	x			
Wave speed, parallel									
	Mean	x	x	x	x	x			
Wind speed, perpendicular									
	Mean	x	x	x	x	x			
Wind speed, parallel									
	Mean	x	x	x	x	x			
Air temperature									
	Mean	x	x	x	x	x	x	x	x
	St. Dev.		x	x	x	x	x	x	x
Water temperature									
	Mean	x	x	x	x	x	x	x	x
	St. Dev.			x	x	x	x	x	x
sqrt Rainfall over Manitowoc River									
	Sum	x	x	x	x	x	x	x	x
sqrt Rainfall over Hika									
	Sum	x	x	x	x	x	x	x	x
log Turbidity		Manual							
Wind speed, perpendicular		Manual							
Wind speed, perpendicular		Manual							
People in water		Manual							
People on beach		Manual							
Air temperature		Manual							
Water temperature		Manual							
Wave height		Manual							
Algae near shore		Manual							
Algae on beach		Manual							
Julian date		Manual							

Table 2: Listing of the variables used in the regression models at Kreher Beach. For each variable, the listing indicates which summary statistics were computed, and over what time scales.

Covariate	Statistic	1h	2h	6h	12h	24h	48h	72h	120h
Whittlesley Creek Discharge									
	Diff			x					
log Whittlesley Creek Discharge									
	Mean	x	x	x	x	x	x	x	x
	Min	x	x	x	x	x	x	x	x
	Max					x			
Cloud cover									
	Mean	x	x	x	x	x			
Lake level									
	Mean	x	x	x	x	x			
	Diff					x			
Wind speed, perpendicular									
	Mean	x	x	x	x	x			
Wind speed, parallel									
	Mean	x	x	x	x	x			
Air temperature									
	Mean	x	x	x	x	x	x	x	x
	St. Dev.		x	x	x	x	x	x	x
sqrt Rainfall over Kreher									
	Sum	x	x	x	x	x	x	x	x
sqrt Rainfall over Maslowski									
	Sum	x	x	x	x	x	x	x	x
sqrt Rainfall over Whittlesley Creek									
	Sum	x	x	x	x	x	x	x	x
log Turbidity		Manual							
Wind speed, perpendicular		Manual							
Wind speed, perpendicular		Manual							
Number of people in water		Manual							
Number of people on beach		Manual							
Number of geese present		Manual							
Number of gulls present		Manual							
Air temperature		Manual							
Water temperature		Manual							
Wave height		Manual							
Lakeshore current velocity		Manual							
Beach specific conductance		Manual							
Bay City Creek specific conductance		Manual							
Algae near shore		Manual							
Algae on beach		Manual							
Julian date		Manual							

Table 3: Listing of the variables used in the regression models at Maslowski Beach. For each variable, the listing indicates which summary statistics were computed, and over what time scales.

Covariate	Statistic	1h	2h	6h	12h	24h	48h	72h	120h
Whittlesley Creek Discharge									
	Diff			x					
log Whittlesley Creek Discharge									
	Mean	x	x	x	x	x	x	x	x
	Min	x	x	x	x	x	x	x	x
	Max					x			
Cloud cover									
	Mean	x	x	x	x	x			
Lake level									
	Mean	x	x	x	x	x			
	Diff					x			
Wind speed, perpendicular									
	Mean	x	x	x	x	x			
Wind speed, parallel									
	Mean	x	x	x	x	x			
Air temperature									
	Mean	x	x	x	x	x	x	x	x
	St. Dev.		x	x	x	x	x	x	x
sqrt Rainfall over Maslowski									
	Sum	x	x	x	x	x	x	x	x
sqrt Rainfall over Whittlesley Creek									
	Sum	x	x	x	x	x	x	x	x
log Turbidity		Manual							
Wind speed, perpendicular		Manual							
Wind speed, perpendicular		Manual							
Number of people in water		Manual							
Number of people on beach		Manual							
Number of geese present		Manual							
Number of gulls present		Manual							
Air temperature		Manual							
Water temperature		Manual							
Wave height		Manual							
Lakeshore current velocity		Manual							
Beach specific conductance		Manual							
Fish Creek (north) specific conductance		Manual							
Fish Creek (south) specific conductance		Manual							
Whittlesley Creek specific conductance		Manual							
Fish Creek (south) water elevation		Manual							
Algae near shore		Manual							
Algae on beach		Manual							
Julian date		Manual							

Table 4: Listing of the variables used in the regression models at the Point beaches. For each variable, the listing indicates which summary statistics were computed, and over what time scales.

Covariate	Statistic	1h	2h	6h	12h	24h	48h	72h	120h
Manitowoc River Discharge									
	Diff			x					
Sheboygan River Discharge									
	Diff			x					
log Manitowoc River Discharge									
	Mean	x	x	x	x	x	x	x	x
	Min	x	x	x	x	x	x	x	x
	Max					x			
log Sheboygan River Discharge									
	Mean	x	x	x	x	x	x	x	x
	Min	x	x	x	x	x	x	x	x
	Max					x			
Cloud cover									
	Mean	x	x	x	x	x	x		
Lake level									
	Mean	x				x			
	Max	x				x			
	Min	x				x			
	Diff					x			
Surface current, perpendicular									
	Mean	x	x	x	x	x	x	x	x
Surface current, parallel									
	Mean	x	x	x	x	x	x	x	x
Current at depth, perpendicular									
	Mean	x	x	x	x	x	x	x	x
Current at depth, parallel									
	Mean	x	x	x	x	x	x	x	x
Wind speed, perpendicular									
	Mean	x	x	x	x	x			
Wind speed, parallel									
	Mean	x	x	x	x	x			
Wave direction, perpendicular									
	Mean	x	x	x	x	x			
Wave direction, parallel									
	Mean	x	x	x	x	x			
Wave height									
	Mean	x	x	x	x	x			
Wave height direction, perpendicular									
	Mean	x	x	x	x	x			
Wave height direction, parallel									
	Mean	x	x	x	x	x			
Air temperature									
	Mean	x	x	x	x	x	x	x	x
	St. Dev.		x	x	x	x	x	x	x
Water temperature									
	Mean		x	x	x	x	x	x	x
	St. Dev.			x	x	x	x	x	x
sqrt Rainfall over Point beaches									
	Sum	x	x	x	x	x	x	x	x
sqrt Rainfall over Twin Rivers									
	Sum	x	x	x	x	x	x	x	x
log Turbidity		Manual							
Wind speed, perpendicular		Manual							
Wind speed, perpendicular		Manual							
Number of people in water		Manual							
Number of people on beach		Manual							
Air temperature		Manual							
Water temperature		Manual							
Wave height		Manual							
Lakeshore current velocity		Manual							
Algae near shore		Manual							
Algae on beach		Manual							
Julian date		Manual							

Table 5: Listing of the variables used in the regression models at Thompson Beach. For each variable, the listing indicates which summary statistics were computed, and over what time scales.

Covariate	Statistic	1h	2h	6h	12h	24h	48h	72h	120h
Whittlesley Creek Discharge									
	Diff			x					
log Whittlesley Creek Discharge									
	Mean	x	x	x	x	x	x	x	x
	Min	x	x	x	x	x	x	x	x
	Max					x			
Cloud cover									
	Mean	x	x	x	x	x			
Lake level									
	Mean	x	x	x	x	x			
	Diff					x			
Wind speed, perpendicular									
	Mean	x	x	x	x	x			
Wind speed, parallel									
	Mean	x	x	x	x	x			
Air temperature									
	Mean	x	x	x	x	x	x	x	x
	St. Dev.		x	x	x	x	x	x	x
sqrt Rainfall over Whittlesley Creek									
	Sum	x	x	x	x	x	x		
sqrt Rainfall over Thompson Creek									
	Sum	x	x	x	x	x	x	x	x
sqrt Rainfall over Maslowski									
	Sum	x	x	x	x	x	x	x	x
log Turbidity		Manual							
Wind speed, perpendicular		Manual							
Wind speed, perpendicular		Manual							
Number of people in water		Manual							
Number of people on beach		Manual							
Beach specific conductance		Manual							
Thompson Creek specific conductance		Manual							
Air temperature		Manual							
Water temperature		Manual							
Wave height		Manual							
Lakeshore current velocity		Manual							
Algae near shore		Manual							
Algae on beach		Manual							
Julian date		Manual							

Table 6: Listing of the variables used in the regression models at Neshotah Beach. For each variable, the listing indicates which summary statistics were computed, and over what time scales.

Covariate	Statistic	1h	2h	6h	12h	24h	48h	72h	120h
Manitowoc River Discharge									
	Diff			x					
Kewaunee River Discharge									
	Diff			x					
log Manitowoc River Discharge									
	Mean	x	x	x	x	x	x	x	x
	Min	x	x	x	x	x	x	x	x
	Max					x			
log Kewaunee River Discharge									
	Mean	x	x	x	x	x	x	x	x
	Min	x	x	x	x	x	x	x	x
	Max					x			
Cloud cover									
	Mean	x	x	x	x	x	x		
Lake level									
	Mean	x				x			
	Max					x			
	Min					x			
	Diff					x			
Surface current, perpendicular									
	Mean	x	x	x	x	x	x	x	x
Surface current, parallel									
	Mean	x	x	x	x	x	x	x	x
Current at depth, perpendicular									
	Mean	x	x	x	x	x	x	x	x
Current at depth, parallel									
	Mean	x	x	x	x	x	x	x	x
Wind speed, perpendicular									
	Mean	x	x	x	x	x			
Wind speed, parallel									
	Mean	x	x	x	x	x			
Wave direction, perpendicular									
	Mean	x	x	x	x	x			
Wave direction, parallel									
	Mean	x	x	x	x	x			
Wave height									
	Mean	x	x	x	x	x			
Wave height direction, perpendicular									
	Mean	x	x	x	x	x			
Wave height direction, parallel									
	Mean	x	x	x	x	x			
Air temperature									
	Mean	x	x	x	x	x	x	x	x
	St. Dev.			x	x	x	x	x	x
Water temperature									
	Mean	x	x	x	x	x	x	x	x
	St. Dev.			x	x	x	x	x	x
sqrt Rainfall over Neshotah									
	Sum	x	x	x	x	x	x	x	x
sqrt Rainfall over Twin Rivers									
	Sum	x	x	x	x	x	x	x	x
log Turbidity		Manual							
Wind speed, perpendicular		Manual							
Wind speed, perpendicular		Manual							
Number of people in water		Manual							
Number of people on beach		Manual							
Number of gulls present		Manual							
Air temperature		Manual							
Water temperature		Manual							
Wave height		Manual							
Lakeshore current velocity		Manual							
Algae near shore		Manual							
Algae on beach		Manual							
Julian date		Manual							

Table 7: Listing of the variables used in the regression models at Red Arrow Beach. For each variable, the listing indicates which summary statistics were computed, and over what time scales.

Covariate	Statistic	1h	2h	6h	12h	24h	48h	72h	120h
Manitowoc River Discharge									
	Diff			x					
log Manitowoc River Discharge									
	Mean	x	x	x	x	x	x	x	x
	Min	x	x	x	x	x	x	x	x
	Max					x			
Cloud cover									
	Mean	x	x	x	x	x	x		
Lake level									
	Mean	x				x			
	Max	x				x			
	Min	x				x			
	Diff					x			
Surface current, perpendicular									
	Mean	x	x	x	x	x	x	x	x
Surface current, parallel									
	Mean	x	x	x	x	x	x	x	x
Current at depth, perpendicular									
	Mean	x	x	x	x	x	x	x	x
Current at depth, parallel									
	Mean	x	x	x	x	x	x	x	x
Wind speed, perpendicular									
	Mean	x	x	x	x	x			
Wind speed, parallel									
	Mean	x	x	x	x	x			
Wave direction, perpendicular									
	Mean	x	x	x	x	x			
Wave direction, parallel									
	Mean	x	x	x	x	x			
Wave height									
	Mean	x	x	x	x	x			
Wave height direction, perpendicular									
	Mean	x	x	x	x	x			
Wave height direction, parallel									
	Mean	x	x	x	x	x			
Air temperature									
	Mean	x	x	x	x	x	x	x	x
	St. Dev.		x	x	x	x	x	x	x
Water temperature									
	Mean	x	x	x	x	x	x	x	x
	St. Dev.			x	x	x	x	x	x
sqrt Rainfall over Manitowoc River									
	Sum	x	x	x	x	x	x	x	x
sqrt Rainfall over Red Arrow beach									
	Sum	x	x	x	x	x	x	x	x
log Turbidity		Manual							
Wind speed, perpendicular		Manual							
Wind speed, perpendicular		Manual							
Number of people in water		Manual							
Number of people on beach		Manual							
Number of gulls present		Manual							
Air temperature		Manual							
Water temperature		Manual							
Wave height		Manual							
Lakeshore current velocity		Manual							
Algae near shore		Manual							
Algae on beach		Manual							
Julian date		Manual							