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	Α.	Λ	Λ	Λ	X	А	л	Λ.
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	Х	X	X	X	X	X	X	X
Subsurface current, parallel								
Mean	X	Х	X	X	X	X	X	X
Wave height								
Mean	X	Х	X	X	X			
Wave height speed, perpendicular								
Mean Wave height speed, parallel	X	X	X	X	X			
Mean	x	v	37	v	37			
Wave speed, perpendicular	A	Х	X	X	X			
Mean	x	x	x	x	x			
Wave speed, parallel	A.				- 11			
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	\mathbf{x}	X	X	X	X	X
St. Dev.			\mathbf{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.

Ci-t- Ct-ti-ti-							701-	1001-
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	\mathbf{x}	\mathbf{X}	X	X			
Air temperature								
Mean	x	\mathbf{x}	X	X	x	x	X	\mathbf{x}
St. Dev.		\mathbf{x}	X	X	x	x	X	x
sqrt Rainfall over Kreher								
Sum	X	\mathbf{x}	X	X	x	x	X	\mathbf{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							
~	Manual							
Algae on beach								
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	\mathbf{x}	x
St. Dev.		x	X	X	X	x	X	x
sqrt Rainfall over Maslowski								
Sum	X	\mathbf{x}	\mathbf{x}	\mathbf{x}	X	\mathbf{x}	\mathbf{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.

Maintiowoc River Discharge Diff	Covariate Statistic				$\frac{10 \text{ ove}}{12\text{h}}$	r wnat 24h			120h
Sheboygan River Discharge Diff		1h	2h	6h	12n	24n	48h	72h	120n
Sheboygan River Discharge	© .								
Diff				X					
Mean									
Mean				X					
Min	-								
Max									
Mean		X	x	X	X	X	X	X	X
Mean						X			
Min									
Max		X	X	X	X	X	X	X	x
Cloud cover		X	x	X	X	X	x	X	X
Mean						X			
Mean	Cloud cover								
Mean	Mean	x	\mathbf{x}	\mathbf{x}	X	\mathbf{x}	\mathbf{x}		
Max	Lake level								
Min Diff x<	Mean	x				x			
Diff Surface current, perpendicular Mean	Max	x				x			
Surface current, perpendicular Mean	Min	x				x			
Mean x	Diff					x			
Mean x	Surface current, perpendicular								
Surface current, parallel Mean x		x	x	X	X	x	x	x	x
Mean x	Surface current, parallel								
Current at depth, perpendicular Mean		x	x	x	x	x	x	x	x
Mean x									
Current at depth, parallel Mean		v	v	v	v	v	v	v	v
Mean x		Α	А.	Λ	- Л	А.	А.	А.	Λ.
Wind speed, perpendicular Mean x		v	v	v	v	v	v	v	v
Mean x		A	А.	Λ.	Λ.	А.	А.	А	А.
Wind speed, parallel x									
Mean x		X	Х	X	Х	Х			
Wave direction, perpendicular									
Mean x		X	X	X	X	X			
Wave direction, parallel x <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>									
Mean x		X	X	X	X	X			
Wave height Mean x	· -								
Mean x		X	X	X	X	X			
Wave height direction, perpendicular Mean									
Mean x		X	X	X	X	X			
Wave height direction, parallel x <t< td=""><td>Wave height direction, perpendicular</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>	Wave height direction, perpendicular								
Mean x		X	X	X	X	X			
Air temperature Mean x	Wave height direction, parallel								
Mean x	Mean	x	\mathbf{x}	X	X	\mathbf{x}			
Mean x	Air temperature								
Mean		x	x	x	x	x	X	x	x
Mean St. Dev. Sqrt Rainfall over Point beaches Sum X X X X X X X X X X X X X X X X X X X	St. Dev.		x	x	X	x	x	x	x
St. Dev.	Water temperature								
St. Dev.	Mean		x	X	X	x	x	x	x
sqrt Rainfall over Point beaches Sum x x x x x x x x x x x x x x x x x x x									
Sum x x x x x x x x x x x x x x x x x x x									
sqrt Rainfall over Twin Rivers Sum x x x x x x x x x x x x x x x x x x x		v	v	v	v	v	v	v	v
Sum x x x x x x x x x x x x x x x x x x x		A.			21.			74	
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		v	v	v	v	v	v	v	v
Wind speed, perpendicular 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 Algae near shore Manual Algae on beach Manual			А.	- 1	- Л	- Л	л.		
Wind speed, perpendicular Number of people in water Number of people on beach Manual Air temperature Manual Water temperature Manual Wave height Manual Lakeshore current velocity Algae near shore Algae on beach 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	Wind speed, perpendicular								
Number of people on beach Air temperature Manual Water temperature Manual Wave height Manual Lakeshore current velocity Algae near shore Algae on beach Manual Manual Manual Manual	wind speed, perpendicular								
Air temperature Manual Water temperature Manual Wave height Manual Lakeshore current velocity Manual Algae near shore Manual Algae on beach Manual									
Water temperature Manual Wave height Manual Lakeshore current velocity Manual Algae near shore Manual Algae on beach Manual									
Wave height Manual Lakeshore current velocity Manual Algae near shore Manual Algae on beach Manual									
Lakeshore current velocity Manual Algae near shore Manual Algae on beach Manual	Water temperature	Manual							
Lakeshore current velocity Manual Algae near shore Manual Algae on beach Manual	Wave height	Manual							
Algae near shore Manual Algae on beach Manual		Manual							
Algae on beach Manual									
•									
	TIGOU OII DUNNII								

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	h 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	\mathbf{x}			
Wind speed, parallel								
Mean	x	X	X	X	X			
Air temperature								
Mean	X	X	X	X	\mathbf{x}	x	X	X
St. Dev.		X	X	X	\mathbf{x}	x	\mathbf{x}	X
sqrt Rainfall over Whittlesley Creek								
Sum	x	\mathbf{x}	\mathbf{x}	\mathbf{X}	X	X		
sqrt Rainfall over Thompson Creek								
Sum	X	X	X	X	X	X	X	X
sqrt Rainfall over Maslowski								
Sum	X	X	\mathbf{X}	X	\mathbf{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							

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.

listing indicates which summary statist								1001
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 Min	X	X	X	X	X	X	X	X
Max	X	X	Х	X	X	X	X	X
					X			
log Kewaunee River Discharge Mean								
Min	X	X	X	X	X	X	X	X
	X	X	Х	X	X	X	X	X
Max Cloud cover					X			
Mean								
Lake level	X	X	Х	X	X	X		
Mean								
Max	X				X			
Min					X			
Diff					X			
Surface current, perpendicular					X			
Mean	.,						**	
Surface current, parallel	X	X	Х	X	X	X	X	X
Mean Current at depth, perpendicular	X	X	X	X	X	X	X	X
Mean	X	X	Х	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

listing indicates which summary statist	ics were co		ed, a		er what	t 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	Х	X	X	X	X		
Lake level								
Mean	X				X			
Max	X				X			
Min	X				X			
Diff					X			
Surface current, perpendicular								
Mean	X	Х	Х	X	X	X	X	X
Surface current, parallel								
Mean	X	Х	Х	X	X	X	X	X
Current at depth, perpendicular Mean								
	X	Х	Х	X	X	X	X	X
Current at depth, parallel								
Mean Wind speed, perpendicular	X	Х	Х	X	X	X	X	X
Mean								
Wind speed, parallel	X	Х	Х	X	X			
Mean								
Wave direction, perpendicular	X	Х	Х	X	X			
Mean		37	3.5	37	v			
Wave direction, parallel	X	Х	Х	X	X			
Mean	x	v	v	v	x			
Wave height	_ ^	Х	Х	X				
Mean	x	x	x	x	x			
Wave height direction, perpendicular	A							
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							
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