Supplementary Materials

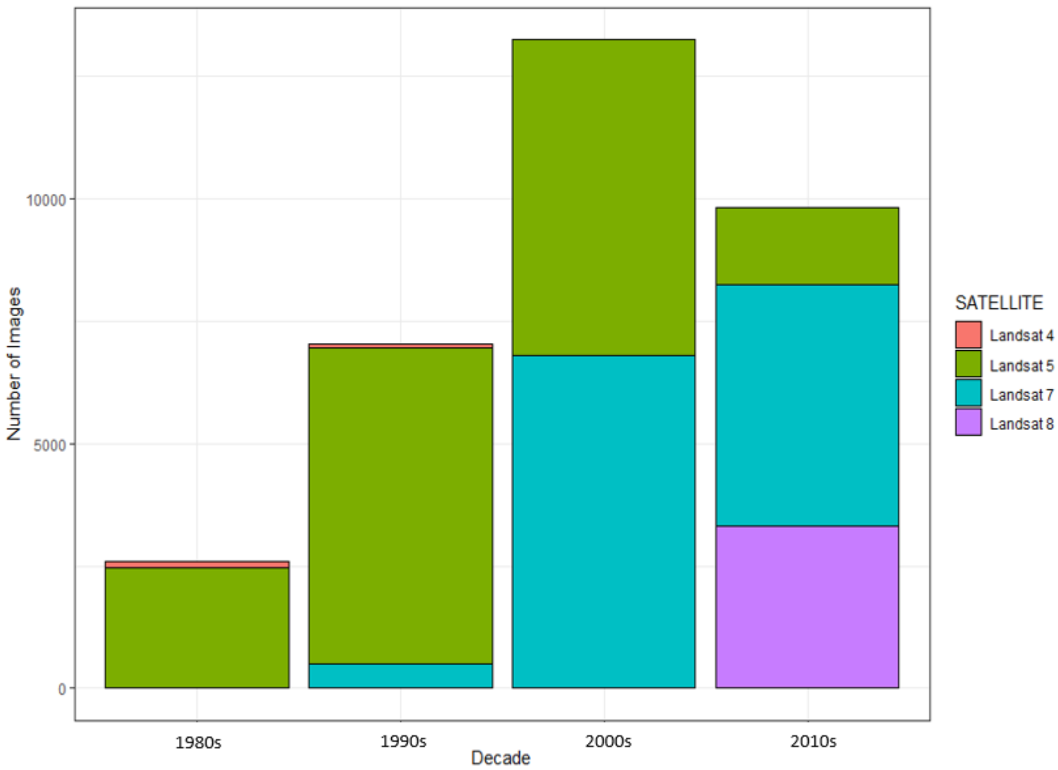

Figure S1. Distribution of Landsat imagery used in this study by satellite and decade.

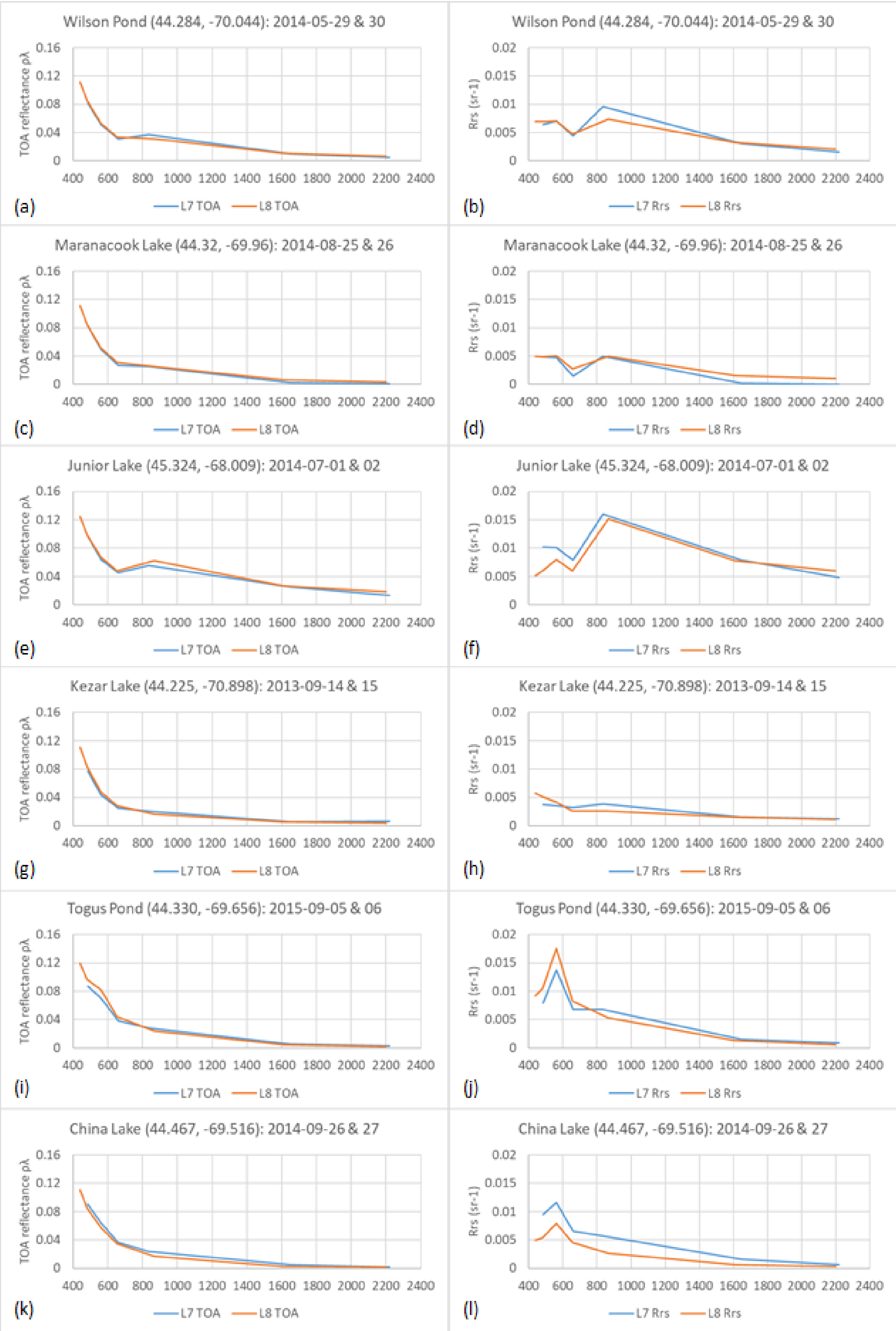

Figure S2. Comparison of TOA reflectance (ρ_λ; **a,c,e,g,i,k**) and R_{rs} (**b,d,f,h,j,l**) for six randomly selected lakes with Landsat-7 (blue) and Landsat-8 (orange) images one day apart. Chart titles include lake name, latitude/longitude coordinates, and dates of the two images. Note that Landsat-8 includes an extra short-wavelength band.

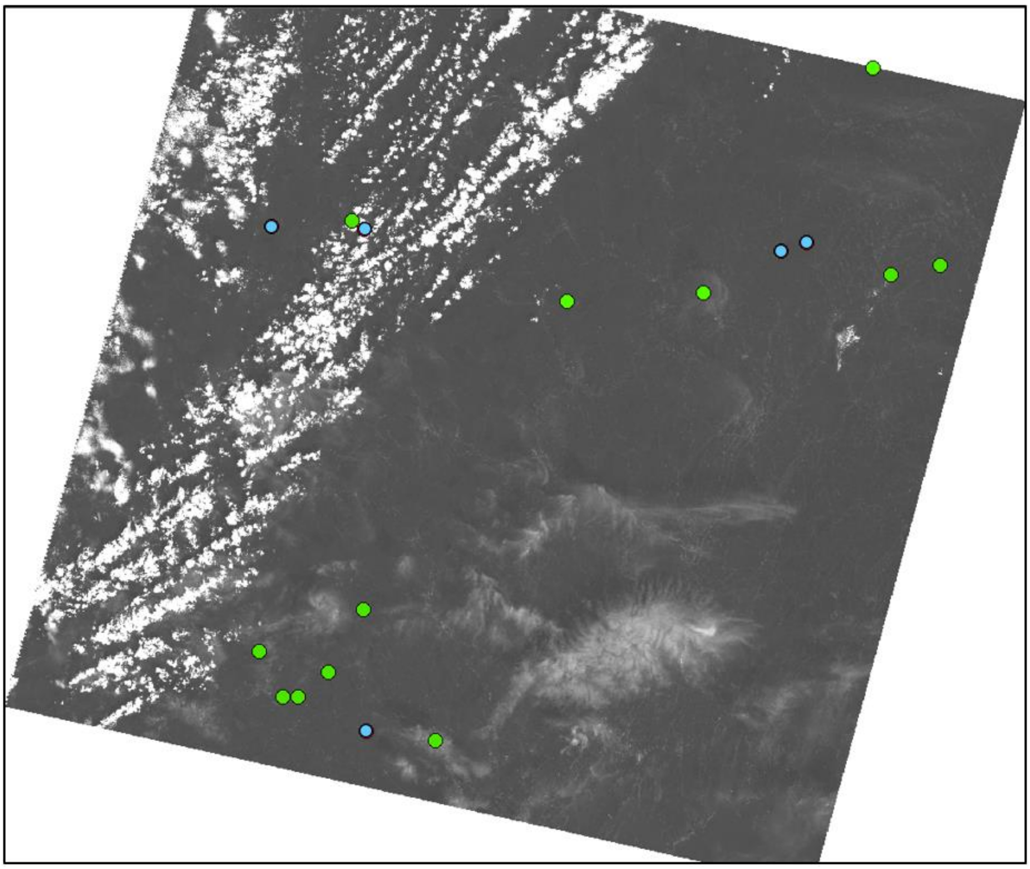

Figure S3. Landsat-8 image (ultrablue band). Green points are pixels properly included in the dataset when filtering with the BQA band and blue points are pixels properly excluded.

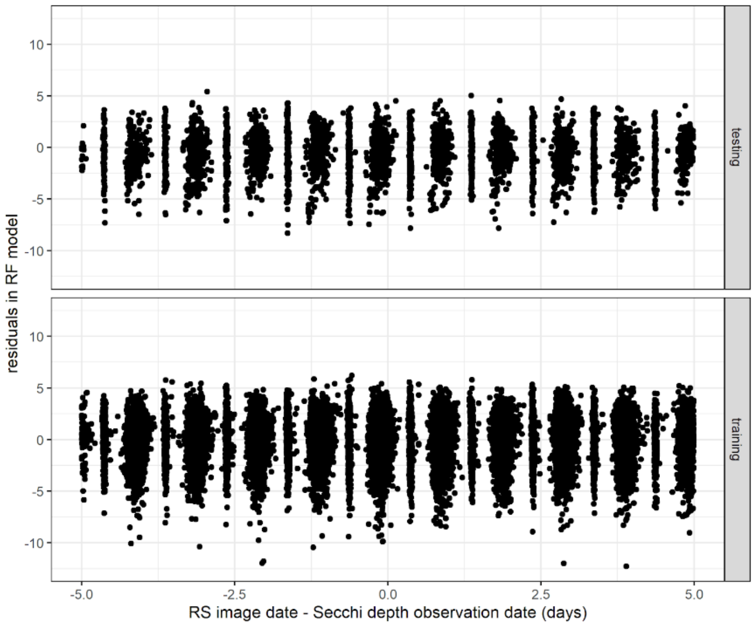

Figure S4. The residuals from the RF algorithm versus the difference in days from the Secchi measurement. There is no clear pattern in the residuals.

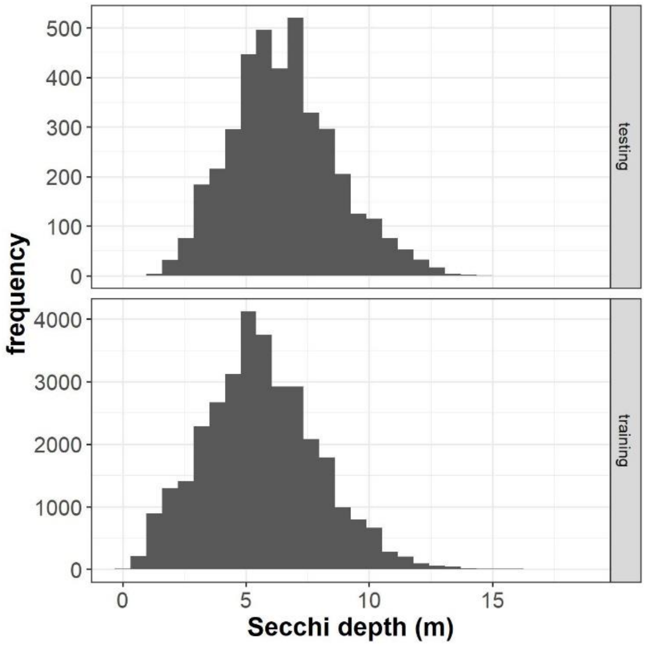

Figure S5. Histograms of the (**top**) test and (**bottom**) training set showing similar Scheme 6. 4 m) was slightly higher than that of the 'training' set (5.5 m).

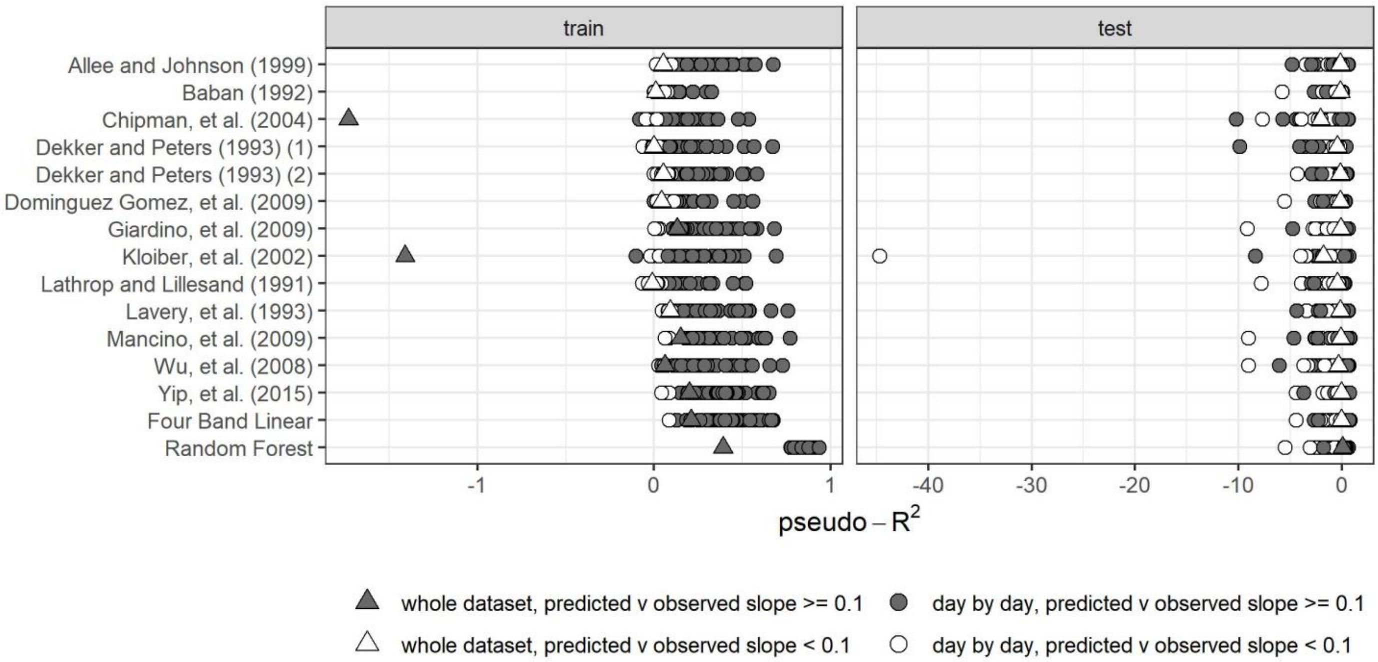

Figure S6. Full-range of pseudo-R^2 for 15 tested algorithms for predicting Secchi depth from Landsat imagery.

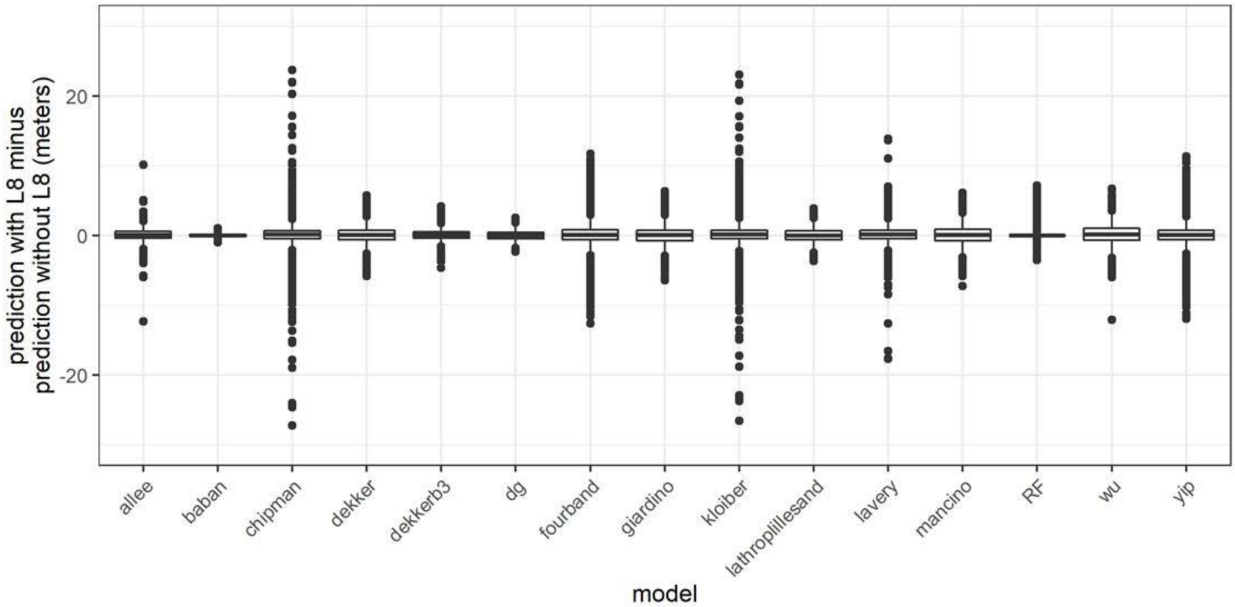

Figure S7. The difference between predictions from the overall models with Landsat-8 and the overall model predictions without Landsat-8.

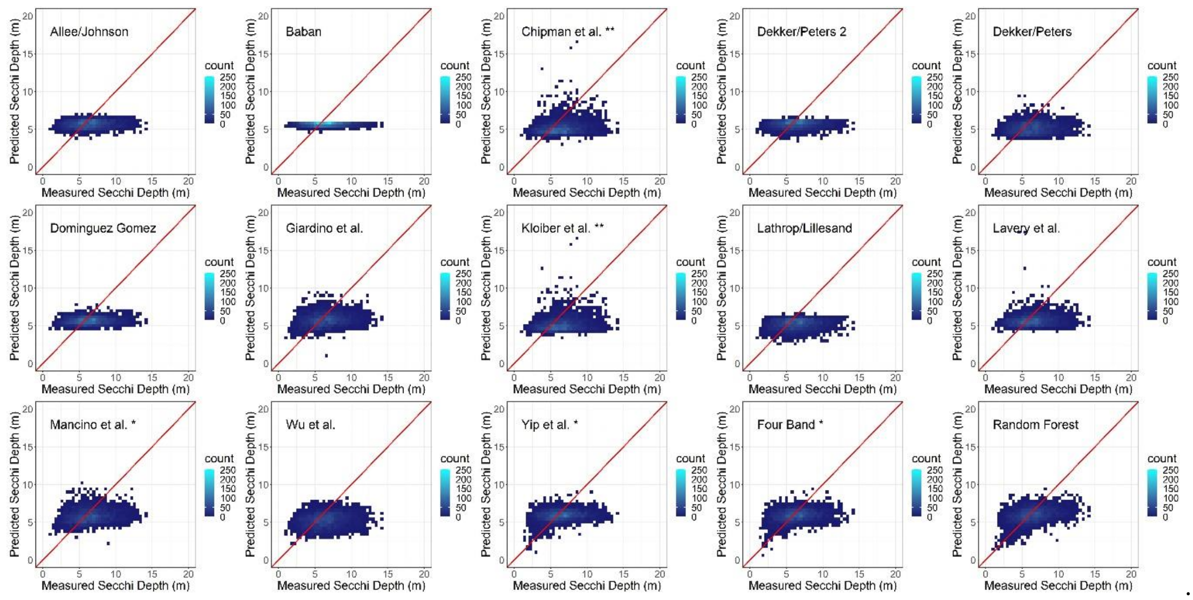

Figure S8. Testing dataset model output for the overall dataset. Panels with a single asterisk ("*") after the model indicate that there are values that are not displayed because there are negatively predicted Secchi. Panels with two asterisks ("**") indicate that there are values that are not displayed because they are outside of the bounds of the limits displayed here (maximum Secchi depth displayed is 20m).

Table S1. The sources for a four-state (Maine, New Hampshire, Vermont, and New York) in-lake Secchi database consisting of six data providers.

Database Name	Data Provider	Website	Data Temporal Extent	Access Means	Version Information	Accessed Date
Maine lakes water quality - Secchi transparency (by date)	Maine Department of Environmental Protection	http://www.gulfofmaine.org/kb/2.0/record.html?recordid=9213	1952–2016	Public communication	Released 10 August 2017	11 December 2017
New Hampshire Volunteer Lake Assessment Program	New Hampshire Department of Environmental Services	https://www.des.nh.gov/organization/divisions/water/wmb/vlap/index.htm	1986–2017	Personal communication	N/A	13 December 2017
Vermont Lay Monitoring Program	Vermont Department of Environmental Conservation	https://anrweb.vt.gov/DEC/_DEC/LayMonitoring.aspx	1979-2017	Personal communication	N/A	7 March 2018
New York Citizen Statewide Lake Assessment Program	New York Department of Environmental Conservation	https://www.dec.ny.gov/chemical/81576.html	1986–2016	Personal communication	N/A	21 December 2017
Lake Champlain Basin Program	Vermont Department of Environmental Conservation	https://www.lcbp.org/water-environment/data-monitoring/monitoring-programs/	1992–2016	Personal communication	N/A	7 March 2018
Environmental Protection Agency Water Quality Portal	Environmental Protection Agency	https://www.waterqualitydata.us/portal	1986–2016	Public communication	N/A	11 December 2017

Table S2. Further description of published algorithms for predicting Secchi depth from Landsat imagery, as reported by original sources.

Name	Lakes	Location	Error	Atmospheric Processing
Allee and Johnson	oligo-meso-trophic	Arkansas, USA		[122]
Baban	eutrophic	Norfolk, UK		
Chipman et al.		Wisconsin, USA		
Dekker and Peters 1	eutrophic	Utrecht, Netherlands		
Dekker and Peters 2	eutrophic	Utrecht, Netherlands		
Dominguez Gomez et al.		Madrid, Spain	RMSE = 0.51	[123]
Giardino et al.	sub-alpine	Lake Iseo, Italy	RMSE = 0.45	
Kloiber et al.		Minnesota, USA	SE = 0.18	
Lathrop and Lillesand		Wisconsin, USA	SE = 1.05	
Lavery et al.	estuaries	Perth, Australia	SE = 0.4	
Mancino et al.		Monticchio Lakes, Italy	RMSE = 0.54	[124]
Wu et al.		Poyang Lake, China	SE = 0.2	[124]
Yip et al.		Saskatchewan, Canada	RMSE = 1.01	DOS, low-pass filter

Table S3. Summary statistics for the overall model training and testing data, in meters.

	Minimum Secchi Depth	First Quartile Secchi Depth	Median Secchi Depth	Third Quartile Secchi Depth	Maximum Secchi Depth
Training	0.1	4	5.5	7	18.6
Testing	1	5	6.4	7.8	14.4

Table S4. Summary statistics for the single-date model training and testing data, in meters.

	Train						Test					
Image Date	n	Minimum Secchi	First Quartile Secchi	Median Secchi	Third Quartile Secchi	Maximum Secchi	n	Minimum Secchi	First Quartile Secchi	Median Secchi	Third Quartile Secchi	Maximum Secchi
12 March 1993	89	2	4	5.3	6.5	12.2	10	2.6	4.8	5.4	6.1	10
14 July 1993	79	1	4.7	6	7.3	12	10	4.2	5.5	6.3	7.2	10
15 August 1993	87	0.6	4.8	6.5	8.2	11.1	15	2.5	6	6.9	7.9	10
4 July 1995	141	0.2	5.1	6.4	7.8	16.7	8	2.9	5.2	6	6.8	8.5
6 September 1995	79	0.9	4.9	6.3	7.7	18.2	9	3.5	5.8	6.6	7.4	10.7
22 July 1996	76	1.9	4.2	5.3	6.4	11.6	8	3.1	3.5	4.8	6.1	7.9
7 August 1996	82	2	4	5.2	6.4	12.9	10	4.6	4.8	6.2	7.5	9
26 August 1997	94	1.1	4.4	5.7	6.9	11.8	9	5.1	6.1	6.7	7.3	10.9
13 August 1998	91	1	4.7	5.8	6.9	12.7	11	4	4.9	6.8	8.7	12.4
28 May 1999	80	1.4	4	5.4	6.8	9.3	6	5.2	6.7	7.2	7.7	8.8
13 June 1999	91	1.1	4.6	5.6	6.6	13.2	7	4.8	6.1	6.4	6.7	6.6
15 July 1999	93	1.4	5.2	6.3	7.4	13.9	13	3.8	6.3	7.4	8.5	9.9
16 August 1999	87	1.4	5.4	6.4	7.5	10	10	3.6	5.2	6.8	8.5	11.5
1 July 2000	75	1.8	5	5.7	6.5	12	9	3.5	4.5	5.6	6.7	9.3
26 August 2000	100	1	3.6	5.3	7.1	13.1	7	4.5	5	5.7	6.4	10.3
26 June 2001	98	1.7	5.1	5.9	6.8	12.1	9	4.2	6	6.4	6.9	8.5
21 June 2002	76	2	4.3	5.5	6.8	10.6	14	2.7	5.5	6.3	7.1	8.3
29 June 2002	104	0.9	4.2	5.5	6.8	10.7	7	4.9	5.9	7.1	8.3	9.6
19 August 2003	85	1.1	4.3	5.9	7.5	11.6	5	5.2	6.7	7.2	7.7	8.5
12 September 2003	79	1.1	3.2	5.7	8.2	13.8	10	2.7	5.7	7.2	8.6	12.7
15 July 2005	91	1.8	3.9	5.3	6.8	12	7	3.6	6.2	6.9	7.6	8.7
16 June 2006	96	1.4	4.7	5.8	7	13.2	13	1.9	4.6	6	7.4	7.6
26 July 2006	99	1.2	4	5.7	7.4	10.7	10	5.2	6.1	6.8	7.6	14.3
11 August 2006	75	1.4	3.9	5.3	6.7	11.5	7	3	4.6	5.3	6.1	6.3
19 June 2007	77	2.2	4	5.3	6.5	9.5	3	4.7	5.8	6.2	6.5	6.2
27 June 2007	78	2.2	4.8	5.8	6.8	10.3	5	3.7	5.1	5.8	6.5	6.7
13 July 2007	85	3	4.9	6.3	7.7	10.4	15	2.6	6.9	8	9.1	10.3
14 August 2007	81	1.2	4.8	6	7.2	11.6	6	6.4	6.7	7.7	8.7	9.4
30 August 2007	75	1	5.2	6.8	8.4	11.2	4	5.1	6.1	7	8	8.2

21 June 2008	82	1.5	4.6	6	7.3	12.6	7	4.3	5	5.9	6.9	7.6
15 July 2008	88	2.1	5.7	6.6	7.5	12.2	7	4.8	4.9	7.2	9.5	10.8
24 August 2008	104	0.8	3.9	5.2	6.5	10.4	9	5.1	5.1	7.3	9.4	12.3
1 September 2008	77	1.2	4.7	5.9	7.2	13.2	8	5	5	5.8	6.6	12.4
10 July 2009	128	1.9	3.6	5	6.5	12.7	19	2.7	6.7	7.4	8.1	8.8
3 August 2009	87	1.8	4	5.4	6.7	10.3	11	4.2	6.5	8.5	10.5	10.2
27 August 2009	92	1.4	4.1	5.5	7	10.7	9	3.5	4.8	6	7.2	7.9
4 September 2009	91	1.3	3.9	5.4	6.9	14.2	7	5.1	6.7	7	7.4	7.9
5 July 2010	79	1.5	5	6.5	8	16.9	5	6.7	7.3	7.5	7.7	7.9
21 July 2010	77	1.4	5.4	6.9	8.4	14.7	5	6.8	6.8	7.2	7.7	8.8
14 August 2010	91	1.5	5.7	6.8	7.8	14.8	9	3.8	5.1	6.4	7.8	7.2
30 August 2010	114	1.2	4.4	6	7.6	15.2	13	2.6	5.5	7.2	9	12.3
16 July 2011	106	1.3	5	6.2	7.5	10.9	14	2.5	5.8	6.6	7.3	8.6
1 August 2011	108	1.1	5.2	6.3	7.5	10.9	8	5.3	6.9	9.1	11.4	11.6
17 August 2011	125	0.8	5.2	6.4	7.6	12.4	16	2.9	5.7	7.1	8.4	9.5
2 September 2011	104	1.5	3.1	4.8	6.5	11.9	20	2.5	3.1	4.7	6.2	9.8
10 July 2012	93	1.8	5.1	6.4	7.7	13.6	10	4	5.6	6.7	7.9	12.8
12 September 2012	85	1.2	3.6	5.1	6.6	13.8	6	4.1	4.1	5	6	6.9
22 August 2013	80	1	4.8	6.3	7.8	11.2	7	3.7	6.1	8.1	10	10.5
25 August 2014	85	0.7	4.1	5.9	7.7	10.5	7	5.3	6.4	8.2	10.1	11.5
11 July 2015	96	2.6	5	6.6	8.2	14.3	5	6.5	8.6	9	9.4	10.6
28 August 2015	94	1.3	5	6.8	8.5	16	15	4.3	4.7	7.5	10.3	13.1
21 September 2015	78	1.2	4.2	6.5	8.8	14.5	9	3.1	4.8	7.7	10.5	12.2

Table S5. This table reports the Gini-based importance values [113] for the four variables used in the random forest algorithm. Since Gini importance values are relative to one another, this indicates that the four bands used in this algorithm are all fairly balanced in importance in the building of the algorithm.

Band	Gini-Based Importance
B1	38,842.47
B2	44,432.64
B3	40,320.54
B4	36,905.26