# Supporting Information for

# Photochemical Characterization of Surface Waters from Lakes in the Adirondack Region of New York

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(Total 96 pages, 10 texts, 22 tables, 8 figures)

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## 1. Chemicals, reagents, and glassware

Chemicals and reagents were used as received without further purification unless otherwise noted. Methanol (MeOH; HPLC grade), acetonitrile (ACN; HPLC grade), water (HPLC grade), sodium hydroxide solution (NaOH; 0.1 N certified), sulfuric acid solution ($H_2SO_4$; 0.1 N certified), hydrochloric acid solution (HCl; 0.1 N certified), *o*-phosphoric acid ($H_3PO_4$; certified ACS grade), acetic acid (HPLC grade), trifluoroacetic acid (TFA; ≥98.5%), ammonium acetate (≥97%), sodium sulfate ($Na_2SO_4$; ≥99.0%), sodium bicarbonate ($NaHCO_3$; 99.7 to 100.3%), aluminum sulfate hydrate ($Al_2(SO_4)_3 \cdot 18H_2O$; 98.0 to 102.0%), and iron(III) sulfate hydrate ($Fe_2(SO_4)_3 \cdot H_2O$; 99.99%) were purchased from Fisher Scientific. Sodium fluoride (NaF; ≥99%), sodium chloride (NaCl; 99.5%), sodium bromide (NaBr; 99+%), sodium carbonate ($Na_2CO_3$; 99.95%), sodium nitrite ($NaNO_2$; ≥99.0%), sodium nitrate ($NaNO_3$; 99+%), sodium dihydrogen phosphate monohydrate ($NaH_2PO_4 \cdot H_2O$; 99+%), sodium phosphate dibasic heptahydrate ($Na_2HPO_4 \cdot 7H_2O$; 99+%), ammonium hydroxide ($NH_4OH$; 25% free ammonia in water), terephthalic acid (TPA; 99+%), furfuryl alcohol (FFA; 98%), 2,4,6-trimethylphenol (TMP; 99%), *p*-nitroanisole (PNA; 99+%), and pyridine (pyr; 99+%) were purchased from ACROS Organics. Folin & Ciocalteu's phenol reagent (2N), gallic acid (≥98.0%), 2-hydroxyterephthalic acid (hTPA; 97%), and *trans*,*trans*-2,4-hexadien-1-ol (*t,t*-HDO; sorbic alcohol; 97%) were purchased from Sigma-Aldrich. Potassium hydrogen phthalate solution (certified carbon standard, 1000±10 ppm) was purchased from LabChem. pH buffer solutions (pH 4.01, 7.00, and 10.01) and conductivity calibration solution (1413 μS/cm) were purchased from Mettler Toledo. Suwannee River natural organic matter (SRNOM; 2R101N), Suwannee River fulvic acid (SRFA; 3S101F), and Suwannee River humic acid (SRHA; 3S101H) were purchased from the International Humic Substance Society (IHSS).

Stock solutions were prepared by dissolving or diluting a gravimetrically weighted amount of solid or liquid standards into HPLC grade water or pH-adjusted water (to facilitate dissolution). Bimolecular PNA/pyr actinometer solutions (10 μM PNA/5 mM pyr) were prepared freshly on the day of experimentation by mixing 10 mM of *p*-nitroanisole and 12.36 M of pyridine stock solutions at a predetermined volumetric ratio.[1,2] Working solutions and calibration standards were prepared by diluting predetermined volumes of stock solutions into ultrapure water (resistivity 18.2 MΩ•cm) generated by a Thermo Scientific Barnstead MicroPure UV/UF water purification system. All stock and working solutions were stored at 4 °C until use. Mobile phases for HPLC or HPIC analysis were prepared using HPLC grade water and organic solvents.

Non-volumetric glassware was rinsed 5 times with HPLC grade methanol, followed by 5 times with ultrapure water, and combusted at 450 °C in a Thermo Scientific Lindberg/Blue M Moldatherm box furnace for a minimum of 5 h. Volumetric glassware, quartz vessels, and microsyringes were rinsed with HPLC grade methanol and ultrapure water and dried overnight at 70 °C in a Fisherbrand Isotemp general purpose heating and drying oven.

## 2. Characteristics of Adirondack lakes

**Table S1.** Geographic location, morphometry, and hydrology of Adirondack lakes

| Lake Name | ALSC ID[a] | Sampling Coordinates | Sampling Date | Elevation (m) | Mean Depth (m) | Volume ($10^4$ $m^3$) | Surface Area (ha) | Watershed Area (ha) | Surficial Geology | Lake Type | Retention Time (years)[b] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Arbutus Lake | 050684 | 43.983350, -74.235737 | 9/19/2018 | 516 | 2.8 | 134.5 | 48.9 | 354 | medium till | drainage | 0.50 |
| Big Moose Lake | 040752 | 43.837263, -74.822176 | 7/23/2018 | 558 | 6.8 | 3488.2 | 512.5 | 9643.8 | thin till | chain drainage | 0.48 |
| Black Pond | 030255 | 44.432591, -74.297836 | 9/16/2018 | 495 | 6.2 | 180.5 | 29.0 | 237.9 | thick till | chain drainage | 0.66 |
| Dart Lake | 040750 | 43.799611, -74.853656 | 7/23/2018 | 537 | 7.3 | 380.7 | 51.8 | 10804.5 | thin till | chain drainage | 0.05 |
| G Lake | 070859 | 43.415344, -74.633610 | 7/9/2018 | 620 | 4.5 | 143.7 | 32.2 | 409.6 | thin till | drainage | 0.39 |
| Honnedaga Lake[3-6] | NA[b] | 43.531398, -74.853429 | 5/16/2018 | 701 | 16.1 | 5097.0 | 308.5 | 1052.2 | thin till | drainage | NA[b] |
| Limekiln Lake | 040826 | 43.717766, -74.790064 | 7/24/2018 | 575 | 6.1 | 1147.6 | 186.9 | 1409.7 | medium till | chain drainage | 1.07 |
| Little Hope Pond | 020058 | 44.516432, -74.125455 | 9/16/2018 | 517 | 3.5 | 10.0 | 2.8 | 53.6 | medium till | drainage | 0.29 |
| Moss Lake | 040746 | 43.788073, -74.846356 | 7/23/2018 | 536 | 5.7 | 259.8 | 45.7 | 1234.6 | medium till | chain drainage | 0.28 |
| North Lake | 041007 | 43.528518, -74.938799 | 7/11/2018 | 555 | 5.7 | 1010.7 | 176.8 | 7700.8 | thin till | chain drainage | 0.15 |
| Lake Rondaxe | 040739 | 43.757783, -74.914560 | 7/23/2018 | 524 | 3.0 | 273.3 | 90.5 | 14155.6 | thin till | chain drainage | 0.03 |
| Sagamore Lake | 060313 | 43.768805, -74.625736 | 7/24/2018 | 580 | 10.5 | 713.1 | 68.0 | 4723 | medium till | chain drainage | 0.20 |
| South Lake | 041004 | 43.514768, -74.906541 | 7/11/2018 | 615 | 8.3 | 1630.2 | 197.4 | 1662.2 | thin till | chain drainage | 1.30 |
| Squaw Lake | 040850 | 43.633669, -74.739336 | 7/24/2018 | 646 | 3.4 | 124.9 | 36.4 | 182.7 | thin till | chain drainage | 0.77 |
| Willis Lake | 050215 | 43.371021, -74.241691 | 7/9/2018 | 400 | 1.6 | 22.9 | 14.6 | 136.4 | medium till | drainage | 0.22 |
| Wolf Lake[7-10] | NA[b] | 44.017985, -74.220643 | 9/19/2018 | 556 | 2.5 | 338 | 58.2 | 840 | medium till | drainage | NA[b] |

[a] Adirondack Lakes Survey Corporation site-specific identifier (unique to New York State).[11] [b] NA = not available.

**3. Water chemistry parameters and bulk DOM properties of Adirondack lake water samples**

For each filtered lake water sample, pH and specific conductance were measured by a Mettler Toledo SevenExcellence multi-channel meter with an InLab Science Pro ISM pH/ATC electrode (calibrated by pH 4.01, 7.00, and 10.01 buffer solutions) and an InLab 731 conductivity probe (calibrated by a 1413 µS/cm conductivity solution), respectively. Dissolved organic carbon (DOC) was measured by high-temperature catalytic combustion[12] using a Teledyne-Tekmar Torch total organic carbon analyzer (calibrated by potassium hydrogen phthalate solutions). Five anions (fluoride, chloride, bromide, nitrate, and sulfate) were measured by a Thermo Scientific Integrion high-pressure ion chromatograph (HPIC). Base cations (sodium, potassium, magnesium, calcium, strontium) and trace metals (aluminum, iron, manganese, cobalt, nickel, copper, zinc, chromium, cadmium, lead) were analyzed by a PerkinElmer NexION 2000 inductively coupled plasma mass spectrometer (ICP-MS). The total phenolic content ([Phenolic]) was measured by the Folin-Ciocalteu assay[13] following a modified protocol.[14] Briefly, each sample (0.5 mL) was mixed with the Folin-Ciocalteu reagent (0.2 mL), diluted by HPLC grade water (2 mL), thoroughly vortexed, and left to stand in the dark for 5 min. The mixture was then amended with $Na_2CO_3$ (0.6 mL of 20% w/v solution) and incubated at 45 °C in a Fisherbrand Isotemp water bath for 30 min. The concentration of total phenolics (in gallic acid equivalents) was determined spectrophotometrically at 765 nm in a Starna Cells 1-I-10 quartz cuvette (1-cm pathlength) using a Thermo Scientific Evolution 201 UV-visible spectrophotometer.

For each filtered lake water sample, fluorescence excitation-emission matrices (EEMs) were measured in a Starna Cells 3-Q-10 quartz cuvette (1-cm pathlength) using a Horiba Scientific Aqualog spectrofluorometer equipped with a 150 W Xenon excitation lamp and a Peltier-cooled CCD emission detector. Lamp, cuvette, and Raman water scans were checked prior to each analysis following the manufacturer's recommended protocol. EEMs were recorded across an excitation wavelength range of 240 to 550 nm in 2-nm increments and an emission wavelength range of 247.68 to 830.02 nm in 2.33-nm increments with an integration time of 1 s and a medium CCD gain. Prior to data analysis, EEMs were corrected for instrument-specific correction factors[15] and inner filter effects,[16, 17] blank subtracted, and normalized against the Raman peak area of a Starna Cells RM-$H_2O$ Raman water fluorescence reference standard.[18, 19] Furthermore, UV-visible absorbance spectra were recorded in Starna Cells 1-I-10 quartz cuvettes (1-cm pathlength) from 200 to 700 nm in 1-nm increments using the Thermo Scientific Evolution 201 UV-visible spectrophotometer and corrected for blank (with reference to the RM-$H_2O$ reference standard) and long-wavelength baseline (i.e., subtracting an average of the absorbance between 700 nm and 800 nm from each spectrum). Optical indices[20-23] were extracted from the absorbance and EEM fluorescence data using a self-written *MATLAB* script. Major water chemistry parameters and bulk DOM properties of native Adirondack lake water samples are summarized in **Table S2**. Complete data sets are provided in **Tables S3-S5**. Principal component analysis (PCA) of bulk DOM properties is shown in **Figure S1**.

**Table S2.** Overview of water chemistry and DOM quality of native Adirondack lake water samples ($n$=16)

| Parameter | Mean | Median | Minimum | Maximum |
|---|---|---|---|---|
| pH | 6.47 | 6.45 | 5.95 | 7.19 |
| Specific Conductance (μS/cm) | 21.5 | 20.4 | 13.6 | 36.6 |
| Acid Neutralizing Capacity (μeq/L) | 79.1 | 57.8 | 11.2 | 224.8 |
| [DOC] (mg C/L) | 4.12 | 3.39 | 1.75 | 11.07 |
| [Al] (μM) | 3.89 | 2.33 | 0.24 | 12.95 |
| [Fe] (μM) | 0.73 | 0.41 | 0.07 | 4.06 |
| [$NO_3^-$] (μM) | 6.43 | 5.12 | 0.73 | 19.58 |
| [Anions] (μM) | 82.1 | 74.5 | 29.3 | 186.1 |
| [Base Cations] (μM) | 121.7 | 119.4 | 68.8 | 202.0 |
| [Trace Metals] (μM) | 0.33 | 0.26 | 0.11 | 0.83 |
| $S_{290–400}$ (μm$^{-1}$) | 17.6 | 17.4 | 15.7 | 20.4 |
| $S_{300–600}$ (μm$^{-1}$) | 15.9 | 15.3 | 11.5 | 25.2 |
| $S_R$ | 1.04 | 1.06 | 0.86 | 1.26 |
| *E2*:*E3* | 6.78 | 6.65 | 5.03 | 9.32 |
| $SUVA_{254}$ (L mg C$^{-1}$•m$^{-1}$) | 2.71 | 2.75 | 1.62 | 3.95 |
| $CDOM_{250-450}$ (m$^{-1}$) | 921 | 648 | 337 | 3473 |
| FI | 1.51 | 1.51 | 1.40 | 1.69 |
| HIX | 0.91 | 0.90 | 0.86 | 0.95 |
| $\beta:\alpha$ | 0.51 | 0.49 | 0.41 | 0.62 |
| Peak A : Peak T | 4.34 | 3.60 | 2.26 | 7.70 |
| Peak C : Peak A | 0.89 | 0.89 | 0.79 | 0.94 |
| Peak C : Peak M | 1.18 | 1.16 | 1.02 | 1.33 |
| Peak C : Peak T | 3.87 | 3.17 | 1.95 | 7.26 |
| FDOM (R.U.) | 34058 | 23621 | 12936 | 106111 |
| [Phenolic] (mg gallic acid/mg C) | 0.52 | 0.52 | 0.33 | 0.77 |

[DOC] = dissolved organic carbon; [Al] = the concentration of Al; [Fe] = the concentration of Fe; [Anions] = the summed concentration of $F^-$, $Cl^-$, and $SO_4^{2-}$; [Base Cations] = the summed concentration of $Na^+$, $K^+$, $Ca^{2+}$, $Mg^{2+}$, and $Sr^{2+}$; [Trace Metals] = the summed concentration of Mn, Co, Ni, Cu, Zn, Cr, Cd, and Pb; $S_{290–400}$ = the spectral slope coefficient from 290 to 400 nm; $S_{300–600}$ = the spectral slope coefficient from 300 to 600 nm; $S_R$ = the ratio of $S_{275-295}$ to $S_{290-350}$; *E2*:*E3* = the ratio of absorption coefficients at 250 and 365 nm; $SUVA_{254}$ = specific UV absorbance at 254 nm; $CDOM_{250-450}$ = the integrated absorption of chromophoric DOM from 250 to 450 nm; FI = fluorescence index; HIX = humification index; $\beta:\alpha$ = freshness index; FDOM = the integrated volumetric fluorescence intensity of fluorescent DOM with excitation wavelengths from 240 nm to 550 nm and emission wavelengths from 248.242 nm to 600.903 nm; [Phenolic] = the total phenolic content in gallic acid equivalents.

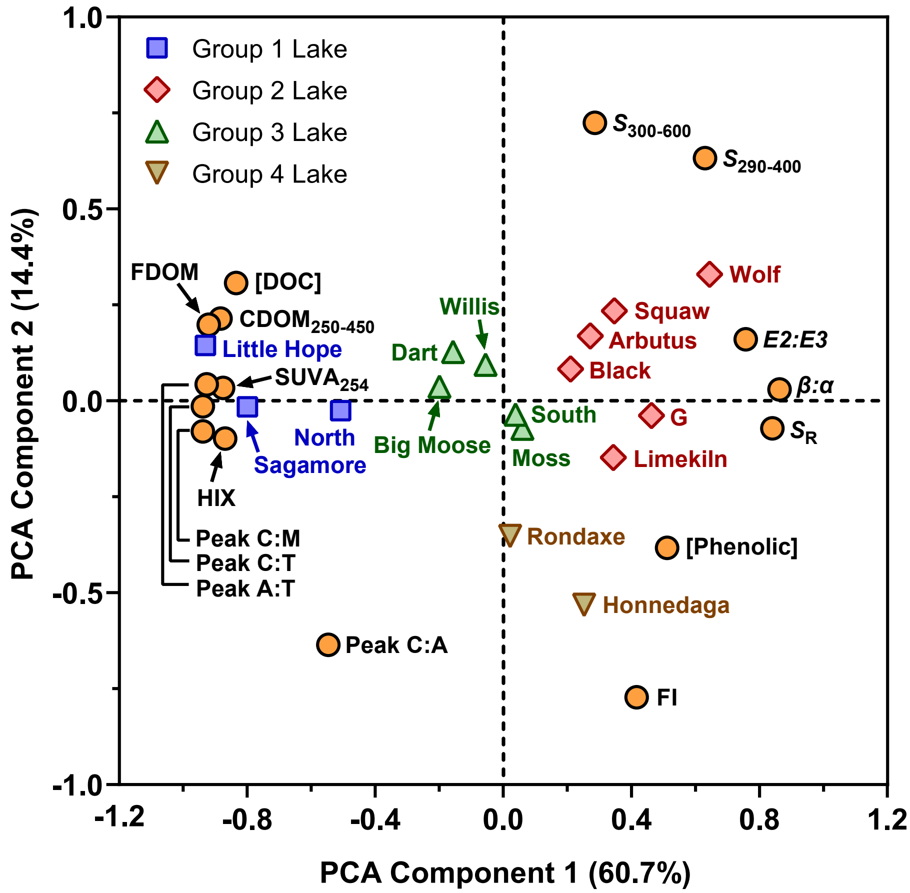


**Figure S1.** Biplot of scores and loadings from the principal component analysis of bulk DOM properties of Adirondack lake waters. Lakes were further grouped by hierarchical clustering using the Ward's criterion on the two PCA components.

| **Table S3.** Water chemistry of native Adirondack lake water samples | | | | | |
|---|---|---|---|---|---|
| Sample Name | pH | Specific Conductance (μS/cm) | [DOC] (mg C/L) | ANC (μeq/L) | [Phenolic] (mg gallic acid/mg C) |
| Arbutus Lake | 6.75 | 20.4 | 4.31 | 79.6 | 0.532 |
| Big Moose Lake | 6.21 | 14.3 | 4.37 | 33.2 | 0.551 |
| Black Pond | 7.19 | 36.6 | 3.02 | 224.8 | 0.513 |
| Dart Lake | 6.33 | 16.3 | 4.12 | 52.5 | 0.348 |
| G Lake | 6.09 | 35.1 | 2.77 | 26.0 | 0.652 |
| Honnedaga Lake | 6.65 | 20.0 | 1.75 | 14.7 | 0.770 |
| Limekiln Lake | 6.57 | 20.4 | 3.18 | 61.5 | 0.523 |
| Little Hope Pond | 6.08 | 15.4 | 11.07 | 54.1 | 0.413 |
| Moss Lake | 6.89 | 27.5 | 3.35 | 129.5 | 0.394 |
| North Lake | 5.95 | 14.2 | 4.49 | 43.8 | 0.377 |
| Lake Rondaxe | 6.58 | 26.7 | 3.16 | 107.1 | 0.572 |
| Sagamore Lake | 6.40 | 21.1 | 7.25 | 128.1 | 0.459 |
| South Lake | 6.31 | 19.5 | 3.42 | 11.2 | 0.585 |
| Squaw Lake | 6.15 | 13.6 | 2.97 | 34.4 | 0.724 |
| Willis Lake | 6.81 | 22.4 | 3.91 | 134.9 | 0.330 |
| Wolf Lake | 6.50 | 20.3 | 2.82 | 130.9 | 0.498 |
| Anions | | | | | |
| Sample Name | $[F^-]$ (μM) | $[Cl^-]$ (μM) | $[Br^-]$ (μM) | $[SO_4^{2-}]$ (μM) | $[NO_3^-]$ (μM) |
| Arbutus Lake | 28.9 | 42.5 | <0.5 | 32.9 | 1.48 |
| Big Moose Lake | 21.0 | 26.9 | <0.5 | 23.0 | 9.01 |
| Black Pond | 33.0 | 32.1 | <0.5 | 33.2 | 1.23 |
| Dart Lake | 27.6 | 32.8 | <0.5 | 24.6 | 8.56 |
| G Lake | 27.1 | 165.6 | <0.5 | 20.5 | 5.09 |
| Honnedaga Lake | 10.7 | 15.8 | <0.5 | 27.6 | 19.58 |
| Limekiln Lake | 39.0 | 93.0 | <0.5 | 23.4 | 8.01 |
| Little Hope Pond | 16.3 | 21.6 | <0.5 | 7.7 | 0.73 |
| Moss Lake | 58.6 | 41.7 | <0.5 | 35.0 | 10.55 |
| North Lake | 21.9 | 34.0 | <0.5 | 22.6 | 6.04 |
| Lake Rondaxe | 35.1 | 114.6 | <0.5 | 28.1 | 3.87 |
| Sagamore Lake | 38.0 | 25.5 | <0.5 | 33.6 | 5.15 |
| South Lake | 42.1 | 63.0 | <0.5 | 25.4 | 13.81 |
| Squaw Lake | 36.1 | 72.6 | <0.5 | 23.2 | 3.59 |
| Willis Lake | 33.0 | 48.7 | <0.5 | 24.9 | 4.97 |
| Wolf Lake | 46.6 | 64.6 | <0.5 | 32.9 | 1.23 |

[DOC] = dissolved organic carbon; [Phenolic] = the total phenolic content in gallic acid equivalents; ANC = acid neutralizing capacity (unpublished data from personal communications with Corey L. Laxson at the Adirondack Watershed Institute and Dr. Douglas A. Burns at the U.S. Geological Survey). The limit of detection for [DOC] was 0.02 mg C/L. The HPIC limit of detection for $[F^-]$, $[Cl^-]$, $[Br^-]$, $[SO_4^{2-}]$, and $[NO_3^-]$ was 2.1 μM, 1.1 μM, 0.5 μM, 0.4 μM, and 0.6 μM, respectively.

**Table S3.** Water chemistry of native Adirondack lake water samples (continued)

Base Cations

| Sample Name | [$Na^+$] (µM) | [$K^+$] (µM) | [$Mg^{2+}$] (µM) | [$Ca^{2+}$] (µM) | [$Sr^{2+}$] (µM) |
|---|---|---|---|---|---|
| Arbutus Lake | 43.4 | 4.8 | 18.3 | 49.5 | 0.135 |
| Big Moose Lake | 40.2 | 5.5 | 8.5 | 26.2 | 0.060 |
| Black Pond | 60.1 | 11.3 | 48.4 | 82.1 | 0.189 |
| Dart Lake | 40.5 | 5.3 | 11.0 | 32.5 | 0.074 |
| G Lake | 46.1 | 124.8 | 10.8 | 19.0 | 0.050 |
| Honnedaga Lake | 56.3 | 3.7 | 9.7 | 31.2 | 0.046 |
| Limekiln Lake | 64.6 | 8.8 | 12.8 | 37.3 | 0.070 |
| Little Hope Pond | 48.6 | 11.2 | 16.0 | 31.7 | 0.065 |
| Moss Lake | 61.3 | 8.6 | 21.9 | 55.6 | 0.124 |
| North Lake | 41.9 | 6.5 | 10.6 | 23.4 | 0.050 |
| Lake Rondaxe | 64.2 | 6.9 | 21.3 | 48.3 | 0.112 |
| Sagamore Lake | 53.6 | 6.1 | 21.8 | 41.1 | 0.093 |
| South Lake | 34.7 | 3.9 | 8.9 | 21.4 | 0.042 |
| Squaw Lake | 37.8 | 37.3 | 13.6 | 23.8 | 0.053 |
| Willis Lake | 68.8 | 7.3 | 16.0 | 34.1 | 0.087 |
| Wolf Lake | 58.9 | 3.1 | 15.1 | 48.1 | 0.138 |

Trace Metals

| Sample Name | [Al] (µM) | [Fe] (µM) | [Mn] (µM) | [Co] (µM) | [Ni] (µM) | [Cu] (µM) | [Zn] (µM) | [Cr] (µM) | [Cd] (µM) | [Pb] (µM) |
|---|---|---|---|---|---|---|---|---|---|---|
| Arbutus Lake | 2.564 | 0.221 | 0.016 | <0.001 | 0.004 | 0.031 | 0.101 | 0.003 | <0.001 | 0.001 |
| Big Moose Lake | 2.470 | 0.512 | 0.127 | 0.001 | 0.004 | 0.014 | 0.168 | 0.003 | <0.001 | <0.001 |
| Black Pond | 0.300 | 0.442 | 0.010 | <0.001 | 0.005 | 0.012 | 0.077 | 0.004 | <0.001 | 0.001 |
| Dart Lake | 2.199 | 0.681 | 0.039 | <0.001 | 0.008 | 0.017 | 0.157 | 0.003 | <0.001 | <0.001 |
| G Lake | 4.920 | 0.314 | 0.155 | 0.001 | 0.004 | 0.019 | 0.139 | 0.002 | <0.001 | 0.001 |
| Honnedaga Lake | 6.906 | 0.177 | 0.265 | <0.001 | 0.007 | 0.027 | 0.064 | 0.005 | <0.001 | <0.001 |
| Limekiln Lake | 1.644 | 0.152 | 0.026 | <0.001 | 0.004 | 0.014 | 0.093 | 0.002 | <0.001 | <0.001 |
| Little Hope Pond | 12.952 | 1.936 | 0.414 | 0.001 | 0.022 | 0.043 | 0.313 | 0.010 | 0.001 | 0.002 |
| Moss Lake | 1.623 | 0.371 | 0.019 | <0.001 | 0.005 | 0.012 | 0.096 | 0.002 | <0.001 | <0.001 |
| North Lake | 4.830 | 1.413 | 0.625 | 0.004 | 0.005 | 0.018 | 0.170 | 0.003 | <0.001 | 0.001 |
| Lake Rondaxe | 5.388 | 0.111 | 0.109 | <0.001 | 0.006 | 0.017 | 0.128 | 0.002 | 0.001 | 0.001 |
| Sagamore Lake | 11.175 | 4.065 | 0.392 | 0.003 | 0.008 | 0.052 | 0.132 | 0.006 | <0.001 | 0.001 |
| South Lake | 2.124 | 0.470 | 0.316 | 0.001 | 0.003 | 0.011 | 0.126 | 0.001 | <0.001 | 0.001 |
| Squaw Lake | 1.929 | 0.068 | 0.052 | <0.001 | 0.005 | 0.021 | 0.169 | 0.002 | <0.001 | 0.001 |
| Willis Lake | 0.939 | 0.673 | 0.047 | <0.001 | 0.005 | 0.024 | 0.123 | 0.003 | <0.001 | 0.001 |
| Wolf Lake | 0.240 | 0.094 | 0.006 | <0.001 | 0.003 | 0.013 | 0.085 | 0.002 | <0.001 | <0.001 |

The ICP-MS limit of detection for base cations and trace metals was 0.001 µM.

**Table S4.** Absorbance properties of native and altered Adirondack lake water samples

| Sample Name | $a_{254}$ ($m^{-1}$) | $a_{280}$ ($m^{-1}$) | $a_{440}$ ($m^{-1}$) | $S_{290–400}$ ($\mu m^{-1}$) | $S_{300–600}$ ($\mu m^{-1}$) | $S_R$ | *E2*:*E3* | $SUVA_{254}$ (L mg $C^{-1}$•$m^{-1}$) | $CDOM_{250-450}$ ($m^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|
| **Native** | | | | | | | | | |
| Arbutus Lake | 24.73 | 17.12 | 0.84 | 18.38 | 17.98 | 1.04 | 7.04 | 2.49 | 760.1 |
| Big Moose Lake | 29.80 | 20.52 | 0.99 | 18.34 | 19.03 | 0.90 | 6.50 | 2.96 | 948.3 |
| Black Pond | 19.80 | 14.07 | 0.92 | 17.03 | 14.98 | 1.13 | 6.36 | 2.84 | 636.1 |
| Dart Lake | 27.49 | 19.05 | 0.95 | 18.46 | 16.72 | 0.95 | 6.80 | 2.89 | 862.4 |
| G Lake | 13.37 | 9.09 | 0.42 | 18.74 | 17.11 | 1.12 | 7.44 | 2.09 | 398.2 |
| Honnedaga Lake | 12.92 | 8.82 | 0.30 | 15.90 | 11.92 | 1.08 | 8.30 | 3.20 | 373.6 |
| Limekiln Lake | 14.97 | 10.08 | 0.53 | 17.40 | 11.49 | 1.26 | 8.21 | 2.05 | 433.3 |
| Little Hope Pond | 97.16 | 70.76 | 5.88 | 15.66 | 13.83 | 0.89 | 5.03 | 3.81 | 3472.7 |
| Moss Lake | 20.64 | 14.59 | 0.94 | 17.39 | 14.04 | 1.10 | 6.45 | 2.68 | 660.6 |
| North Lake | 37.46 | 26.66 | 1.85 | 16.56 | 14.88 | 0.90 | 5.43 | 3.62 | 1288.3 |
| Lake Rondaxe | 11.82 | 8.42 | 0.69 | 15.90 | 11.68 | 1.08 | 5.53 | 1.63 | 401.5 |
| Sagamore Lake | 65.92 | 48.11 | 3.52 | 16.26 | 14.79 | 0.86 | 5.19 | 3.95 | 2329.3 |
| South Lake | 16.84 | 11.46 | 0.63 | 18.46 | 15.73 | 1.16 | 7.44 | 2.46 | 506.6 |
| Squaw Lake | 16.45 | 11.21 | 0.39 | 19.67 | 25.15 | 0.93 | 7.38 | 2.08 | 495.1 |
| Willis Lake | 25.46 | 18.26 | 1.11 | 17.10 | 15.98 | 1.00 | 6.00 | 2.83 | 839.0 |
| Wolf Lake | 12.15 | 8.08 | 0.28 | 20.37 | 19.87 | 1.17 | 9.32 | 1.87 | 336.7 |
| **pH 6.5 (DOC Standardized)** | | | | | | | | | |
| Sample Name | $a_{254}$ ($m^{-1}$) | $a_{280}$ ($m^{-1}$) | $a_{440}$ ($m^{-1}$) | $S_{290–400}$ ($\mu m^{-1}$) | $S_{300–600}$ ($\mu m^{-1}$) | $S_R$ | *E2*:*E3* | $SUVA_{254}$ (L mg $C^{-1}$•$m^{-1}$) | $CDOM_{250-450}$ ($m^{-1}$) |
| Arbutus Lake | 20.37 | 13.49 | 0.55 | 19.31 | 18.90 | 1.07 | 8.20 | 2.95 | 586.6 |
| Big Moose Lake | 19.85 | 13.79 | 0.54 | 18.83 | 24.20 | 0.87 | 6.59 | 2.87 | 627.1 |
| Black Pond | 19.80 | 14.07 | 1.42 | 17.03 | 14.98 | 1.13 | 6.36 | 2.84 | 636.1 |
| Dart Lake | 19.71 | 13.74 | 0.63 | 18.43 | 24.27 | 0.95 | 6.63 | 2.85 | 622.5 |
| G Lake | 13.37 | 9.09 | 0.74 | 18.74 | 17.11 | 1.12 | 7.44 | 2.09 | 398.2 |
| Honnedaga Lake | 11.82 | 8.42 | 1.05 | 15.90 | 11.68 | 1.08 | 5.53 | 2.93 | 401.5 |
| Limekiln Lake | 14.09 | 9.48 | 0.63 | 18.92 | 14.02 | 1.43 | 7.55 | 2.04 | 418.5 |
| Little Hope Pond | 27.19 | 19.72 | 1.49 | 16.24 | 15.93 | 0.85 | 5.22 | 3.94 | 954.9 |
| Moss Lake | 19.34 | 13.63 | 0.77 | 17.55 | 15.69 | 1.01 | 6.56 | 2.80 | 616.1 |
| North Lake | 25.94 | 18.63 | 1.50 | 15.76 | 15.16 | 0.94 | 5.17 | 3.75 | 910.0 |
| Lake Rondaxe | 13.90 | 9.37 | 0.78 | 17.40 | 11.52 | 1.39 | 6.54 | 2.01 | 432.7 |
| Sagamore Lake | 27.03 | 19.84 | 1.43 | 16.19 | 14.72 | 0.89 | 5.17 | 3.91 | 955.4 |
| South Lake | 16.45 | 11.21 | 0.80 | 18.46 | 15.73 | 0.93 | 7.38 | 2.40 | 495.1 |
| Squaw Lake | 14.32 | 9.42 | 0.23 | 21.88 | 31.57 | 0.84 | 8.83 | 2.07 | 393.4 |
| Willis Lake | 18.69 | 13.32 | 0.70 | 17.53 | 17.84 | 0.98 | 6.15 | 2.71 | 606.9 |
| Wolf Lake | 12.15 | 8.08 | 0.50 | 20.37 | 19.87 | 1.17 | 9.32 | 1.87 | 336.7 |

*a* = Napierian absorption coefficient; $S_{290–400}$ = the spectral slope coefficient from 290 to 400 nm;[24] $S_{300–600}$ = the spectral slope coefficient from 300 to 600 nm;[25] $S_R$ = the ratio of $S_{275-295}$ to $S_{290-350}$ (an indicator of DOM molecular size and photobleaching[26]); *E2*:*E3* = the ratio of absorption coefficients at 250 and 365 nm (an inverse proxy of DOM molecular size[27]); $SUVA_{254}$ = specific UV absorbance at 254 nm (a proxy of DOM aromaticity[28]); $CDOM_{250-450}$ = the integrated absorption of chromophoric DOM from 250 to 450 nm.[26]

**Table S4.** Absorbance properties of native and altered Adirondack lake water samples (continued)

| Sample Name | $a_{254}$ ($m^{-1}$) | $a_{280}$ ($m^{-1}$) | $a_{440}$ ($m^{-1}$) | $S_{290–400}$ ($μm^{-1}$) | $S_{300–600}$ ($μm^{-1}$) | $S_R$ | $E2:E3$ | $SUVA_{254}$ (L mg $C^{-1}$•$m^{-1}$) | $CDOM_{250-450}$ ($m^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|
| pH 4.5 (DOC Standardized) | | | | | | | | | |
| Arbutus Lake | 17.37 | 11.65 | 0.58 | 18.59 | 18.90 | 1.14 | 7.66 | 2.51 | 518.4 |
| Big Moose Lake | 25.42 | 17.10 | 1.41 | 16.56 | 11.59 | 1.16 | 6.54 | 3.68 | 805.0 |
| Black Pond | 19.56 | 13.54 | 0.78 | 17.59 | 15.76 | 1.13 | 6.83 | 2.81 | 607.4 |
| Dart Lake | 19.65 | 13.46 | 0.46 | 19.76 | 24.16 | 0.88 | 7.32 | 2.84 | 597.8 |
| G Lake | 12.61 | 8.34 | 0.53 | 17.55 | 12.71 | 1.36 | 7.49 | 1.98 | 376.2 |
| Honnedaga Lake | 11.81 | 8.20 | 0.50 | 17.29 | 17.18 | 1.00 | 6.19 | 2.92 | 382.1 |
| Limekiln Lake | 14.89 | 9.98 | 0.58 | 17.86 | 14.80 | 1.37 | 7.83 | 2.15 | 436.9 |
| Little Hope Pond | 25.28 | 18.48 | 1.24 | 16.47 | 18.14 | 0.88 | 5.28 | 3.66 | 883.6 |
| Moss Lake | 22.52 | 15.76 | 1.33 | 15.60 | 11.57 | 1.30 | 6.00 | 3.26 | 735.7 |
| North Lake | 32.41 | 22.38 | 1.72 | 16.56 | 12.58 | 1.01 | 5.84 | 4.69 | 1078.1 |
| Lake Rondaxe | 10.10 | 6.68 | 0.18 | 20.67 | 25.25 | 1.05 | 8.57 | 1.46 | 283.5 |
| Sagamore Lake | 26.26 | 18.89 | 1.23 | 16.83 | 15.76 | 0.92 | 5.66 | 3.80 | 892.9 |
| South Lake | 15.12 | 10.05 | 0.17 | 21.78 | 30.06 | 0.82 | 8.56 | 2.21 | 432.8 |
| Squaw Lake | 14.94 | 9.88 | 0.22 | 21.08 | 28.20 | 0.97 | 8.79 | 2.16 | 421.8 |
| Willis Lake | 19.57 | 13.88 | 0.63 | 18.18 | 23.19 | 0.96 | 6.50 | 2.83 | 623.9 |
| Wolf Lake | 11.72 | 7.60 | 0.13 | 22.67 | 27.91 | 1.05 | 10.77 | 1.80 | 308.5 |
| pH 8.5 (DOC Standardized) | | | | | | | | | |
| Sample Name | $a_{254}$ ($m^{-1}$) | $a_{280}$ ($m^{-1}$) | $a_{440}$ ($m^{-1}$) | $S_{290–400}$ ($μm^{-1}$) | $S_{300–600}$ ($μm^{-1}$) | $S_R$ | $E2:E3$ | $SUVA_{254}$ (L mg $C^{-1}$•$m^{-1}$) | $CDOM_{250-450}$ ($m^{-1}$) |
| Arbutus Lake | 18.62 | 12.70 | 0.96 | 16.50 | 13.10 | 1.29 | 6.76 | 2.70 | 580.9 |
| Big Moose Lake | 21.37 | 14.67 | 0.90 | 17.42 | 15.97 | 1.02 | 6.55 | 3.09 | 679.6 |
| Black Pond | 20.43 | 14.09 | 0.77 | 17.61 | 16.80 | 1.14 | 6.96 | 2.93 | 630.8 |
| Dart Lake | 20.69 | 14.22 | 0.82 | 17.80 | 16.01 | 1.07 | 6.87 | 2.99 | 646.0 |
| G Lake | 13.09 | 8.67 | 0.49 | 17.99 | 16.17 | 1.32 | 7.90 | 2.05 | 384.5 |
| Honnedaga Lake | 11.72 | 8.13 | 0.48 | 17.57 | 15.83 | 1.03 | 6.58 | 2.90 | 372.8 |
| Limekiln Lake | 13.40 | 8.92 | 0.41 | 19.66 | 14.86 | 1.18 | 8.94 | 1.94 | 380.9 |
| Little Hope Pond | 26.18 | 19.05 | 1.60 | 15.59 | 13.79 | 0.93 | 5.11 | 3.79 | 932.8 |
| Moss Lake | 18.84 | 13.11 | 0.75 | 17.94 | 16.03 | 1.09 | 6.90 | 2.73 | 589.6 |
| North Lake | 24.70 | 17.68 | 1.15 | 16.91 | 17.25 | 0.90 | 5.64 | 3.57 | 839.7 |
| Lake Rondaxe | 12.44 | 8.25 | 0.17 | 22.24 | 30.25 | 1.01 | 10.26 | 1.80 | 338.0 |
| Sagamore Lake | 26.78 | 19.46 | 1.59 | 15.85 | 13.76 | 0.95 | 5.26 | 3.88 | 942.2 |
| South Lake | 16.12 | 11.02 | 0.67 | 17.98 | 13.88 | 1.09 | 7.01 | 2.35 | 500.9 |
| Squaw Lake | 15.44 | 10.50 | 0.63 | 17.95 | 13.76 | 1.23 | 7.53 | 2.24 | 464.2 |
| Willis Lake | 19.53 | 13.99 | 0.94 | 16.67 | 14.68 | 1.08 | 5.99 | 2.83 | 645.4 |
| Wolf Lake | 13.40 | 8.95 | 0.67 | 16.68 | 11.69 | 1.61 | 7.76 | 2.06 | 395.0 |

$a$ = Napierian absorption coefficient; $S_{290–400}$ = the spectral slope coefficient from 290 to 400 nm; $S_{300–600}$ = the spectral slope coefficient from 300 to 600 nm; $S_R$ = the ratio of $S_{275-295}$ to $S_{290-350}$ (an indicator of DOM molecular size and photobleaching[26]); $E2:E3$ = the ratio of absorption coefficients at 250 and 365 nm (an inverse proxy of DOM molecular size[27]); $SUVA_{254}$ = specific UV absorbance at 254 nm (a proxy of DOM aromaticity[28]); $CDOM_{250-450}$ = the integrated absorption of chromophoric DOM from 250 to 450 nm.[26]

**Table S4.** Absorbance properties of native and altered Adirondack lake water samples (continued)

pH 4.5 + Al (DOC Standardized)

| Sample Name | $a_{254}$ ($m^{-1}$) | $a_{280}$ ($m^{-1}$) | $a_{440}$ ($m^{-1}$) | $S_{290-400}$ ($\mu m^{-1}$) | $S_{300-600}$ ($\mu m^{-1}$) | $S_R$ | *E2*:*E3* | $SUVA_{254}$ (L mg $C^{-1}$•$m^{-1}$) | $CDOM_{250-450}$ ($m^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|
| Arbutus Lake | 16.95 | 11.80 | 0.55 | 18.14 | 18.16 | 1.14 | 7.47 | 2.45 | 513.0 |
| Big Moose Lake | 20.48 | 14.36 | 0.78 | 18.11 | 16.76 | 1.00 | 6.75 | 2.96 | 648.3 |
| Black Pond | 21.01 | 14.88 | 0.93 | 16.74 | 13.69 | 1.27 | 7.14 | 3.02 | 647.8 |
| Dart Lake | 18.67 | 13.11 | 0.52 | 18.91 | 23.19 | 0.97 | 7.23 | 2.70 | 575.8 |
| G Lake | 12.34 | 8.47 | 0.53 | 17.08 | 12.68 | 1.32 | 7.40 | 1.93 | 373.8 |
| Honnedaga Lake | 11.89 | 8.48 | 0.41 | 17.91 | 19.27 | 1.06 | 6.91 | 2.94 | 374.1 |
| Limekiln Lake | 14.13 | 9.64 | 0.38 | 19.73 | 16.70 | 1.22 | 9.31 | 2.05 | 396.8 |
| Little Hope Pond | 24.64 | 18.34 | 1.66 | 15.00 | 13.08 | 1.03 | 5.03 | 3.57 | 888.2 |
| Moss Lake | 19.45 | 13.78 | 0.65 | 18.13 | 18.22 | 1.12 | 7.50 | 2.82 | 593.4 |
| North Lake | 23.37 | 16.95 | 1.12 | 16.56 | 14.70 | 0.97 | 5.65 | 3.38 | 798.6 |
| Lake Rondaxe | 12.63 | 8.65 | 0.11 | 22.91 | 28.29 | 0.96 | 10.70 | 1.83 | 342.2 |
| Sagamore Lake | 25.81 | 19.13 | 1.45 | 15.89 | 13.79 | 0.97 | 5.32 | 3.74 | 907.9 |
| South Lake | 16.33 | 11.40 | 0.57 | 18.43 | 16.90 | 1.11 | 7.66 | 2.38 | 493.0 |
| Squaw Lake | 16.26 | 11.35 | 0.53 | 18.60 | 15.89 | 1.21 | 8.40 | 2.35 | 472.9 |
| Willis Lake | 19.00 | 13.61 | 0.65 | 17.84 | 19.85 | 1.02 | 6.55 | 2.75 | 604.0 |
| Wolf Lake | 12.07 | 8.17 | 0.24 | 20.22 | 22.18 | 1.22 | 9.52 | 1.86 | 335.0 |

pH 8.5 + Fe (DOC Standardized)

| Sample Name | $a_{254}$ ($m^{-1}$) | $a_{280}$ ($m^{-1}$) | $a_{440}$ ($m^{-1}$) | $S_{290-400}$ ($\mu m^{-1}$) | $S_{300-600}$ ($\mu m^{-1}$) | $S_R$ | *E2*:*E3* | $SUVA_{254}$ (L mg $C^{-1}$•$m^{-1}$) | $CDOM_{250-450}$ ($m^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|
| Arbutus Lake | 20.82 | 14.48 | 0.93 | 16.33 | 11.59 | 1.18 | 6.49 | 3.01 | 662.4 |
| Big Moose Lake | 22.58 | 15.73 | 0.66 | 18.67 | 22.17 | 0.89 | 6.64 | 3.27 | 714.3 |
| Black Pond | 21.13 | 14.95 | 0.61 | 18.22 | 25.30 | 0.96 | 6.56 | 3.03 | 669.7 |
| Dart Lake | 21.69 | 15.15 | 0.42 | 19.76 | 28.10 | 0.85 | 6.99 | 3.14 | 670.9 |
| G Lake | 14.33 | 9.91 | 0.33 | 19.18 | 25.10 | 0.94 | 7.06 | 2.25 | 433.0 |
| Honnedaga Lake | 14.41 | 10.36 | 0.46 | 17.59 | 20.12 | 0.91 | 5.95 | 3.57 | 477.0 |
| Limekiln Lake | 16.33 | 11.36 | 0.39 | 18.80 | 24.06 | 1.04 | 7.10 | 2.36 | 498.2 |
| Little Hope Pond | 28.33 | 20.51 | 1.34 | 16.32 | 18.10 | 0.86 | 5.19 | 4.10 | 997.4 |
| Moss Lake | 20.90 | 14.77 | 0.67 | 18.10 | 20.32 | 1.01 | 6.60 | 3.03 | 661.6 |
| North Lake | 25.52 | 18.67 | 1.08 | 17.27 | 18.99 | 0.81 | 5.38 | 3.69 | 887.9 |
| Lake Rondaxe | 15.81 | 11.37 | 0.88 | 16.18 | 12.93 | 1.06 | 5.66 | 2.29 | 533.6 |
| Sagamore Lake | 27.82 | 20.37 | 1.53 | 16.20 | 16.10 | 0.85 | 5.06 | 4.03 | 995.2 |
| South Lake | 19.69 | 14.09 | 1.10 | 15.69 | 14.22 | 1.08 | 5.53 | 2.87 | 670.1 |
| Squaw Lake | 18.71 | 13.37 | 1.56 | 13.99 | 9.99 | 1.36 | 5.11 | 2.71 | 656.9 |
| Willis Lake | 22.56 | 16.59 | 1.47 | 15.18 | 12.83 | 1.07 | 5.07 | 3.27 | 801.0 |
| Wolf Lake | 15.62 | 10.99 | 0.66 | 16.78 | 16.14 | 1.21 | 6.35 | 2.40 | 496.0 |

*a* = Napierian absorption coefficient; $S_{290-400}$ = the spectral slope coefficient from 290 to 400 nm; $S_{300-600}$ = the spectral slope coefficient from 300 to 600 nm; $S_R$ = the ratio of $S_{275-295}$ to $S_{290-350}$ (an indicator of DOM molecular size and photobleaching[26]); *E2:E3* = the ratio of absorption coefficients at 250 and 365 nm (an inverse proxy of DOM molecular size[27]); $SUVA_{254}$ = specific UV absorbance at 254 nm (a proxy of DOM aromaticity[28]); $CDOM_{250-450}$ = the integrated absorption of chromophoric DOM from 250 to 450 nm.[26]

**Table S5.** Fluorescence properties of native and altered Adirondack lake water samples

| Native | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Name | Peak A (R.U.) | Peak B (R.U.) | Peak C (R.U.) | Peak M (R.U.) | Peak T (R.U.) | Peak A : Peak T | Peak C : Peak A | Peak C : Peak M | Peak C : Peak T | FI | HIX | $\beta$:$\alpha$ | FDOM (R.U.) |
| Arbutus Lake | 1.56 | 0.09 | 1.37 | 1.24 | 0.59 | 2.64 | 0.88 | 1.11 | 2.32 | 1.44 | 0.88 | 0.62 | 30829 |
| Big Moose Lake | 2.26 | 0.00 | 2.03 | 1.64 | 0.41 | 5.45 | 0.90 | 1.24 | 4.91 | 1.54 | 0.94 | 0.48 | 43327 |
| Black Pond | 1.03 | 0.09 | 0.84 | 0.74 | 0.32 | 3.22 | 0.81 | 1.12 | 2.60 | 1.46 | 0.89 | 0.54 | 18977 |
| Dart Lake | 2.07 | 0.03 | 1.81 | 1.50 | 0.37 | 5.66 | 0.87 | 1.20 | 4.94 | 1.50 | 0.93 | 0.48 | 37864 |
| G Lake | 0.93 | 0.06 | 0.80 | 0.73 | 0.25 | 3.68 | 0.87 | 1.10 | 3.19 | 1.57 | 0.89 | 0.55 | 16671 |
| Honnedaga Lake | 0.99 | 0.09 | 0.93 | 0.85 | 0.35 | 2.81 | 0.94 | 1.10 | 2.65 | 1.69 | 0.89 | 0.58 | 19244 |
| Limekiln Lake | 0.93 | 0.10 | 0.80 | 0.73 | 0.41 | 2.26 | 0.86 | 1.10 | 1.95 | 1.59 | 0.86 | 0.53 | 17711 |
| Little Hope Pond | 5.33 | 0.00 | 4.87 | 3.67 | 0.77 | 6.90 | 0.91 | 1.33 | 6.31 | 1.40 | 0.94 | 0.42 | 106111 |
| Moss Lake | 1.28 | 0.03 | 1.19 | 1.04 | 0.37 | 3.43 | 0.92 | 1.14 | 3.16 | 1.50 | 0.90 | 0.49 | 24224 |
| North Lake | 2.61 | 0.00 | 2.32 | 1.78 | 0.38 | 6.85 | 0.89 | 1.30 | 6.08 | 1.51 | 0.94 | 0.44 | 51427 |
| Lake Rondaxe | 0.84 | 0.03 | 0.79 | 0.63 | 0.18 | 4.57 | 0.94 | 1.25 | 4.29 | 1.58 | 0.93 | 0.47 | 16364 |
| Sagamore Lake | 3.85 | 0.00 | 3.64 | 2.78 | 0.50 | 7.70 | 0.94 | 1.31 | 7.26 | 1.46 | 0.95 | 0.41 | 76192 |
| South Lake | 1.04 | 0.10 | 0.92 | 0.80 | 0.32 | 3.25 | 0.88 | 1.14 | 2.85 | 1.47 | 0.90 | 0.51 | 19655 |
| Squaw Lake | 1.22 | 0.01 | 1.10 | 0.93 | 0.27 | 4.58 | 0.90 | 1.17 | 4.10 | 1.52 | 0.93 | 0.50 | 23019 |
| Willis Lake | 1.56 | 0.06 | 1.39 | 1.18 | 0.44 | 3.53 | 0.89 | 1.18 | 3.13 | 1.43 | 0.90 | 0.48 | 30381 |
| Wolf Lake | 0.71 | 0.11 | 0.56 | 0.55 | 0.25 | 2.87 | 0.79 | 1.02 | 2.26 | 1.52 | 0.87 | 0.61 | 12936 |

Peak A = an indicator of the abundance of "terrestrial humic-like" DOM; [29-31] Peak B = an indicator of the abundance of "tyrosine-like, protein-like" DOM;[29-31] Peak C = an indicator of the abundance of "terrestrial fulvic-like" DOM;[29-31] Peak M = an indicator of the abundance of "marine humic-like" DOM;[29-31] Peak T = an indicator of the abundance of "tryptophan-like, protein-like" DOM;[29-31] FI = fluorescence index (an indicator of the source of DOM, which is either microbially derived from bacteria and algae or terrestrially derived from plant litter and soil[15, 32-34]); HIX = humification index (an indicator of the degree of DOM humification[16, 35, 36]); $\beta$:$\alpha$ = freshness index (an indicator of the contribution of recently plant-derived or autochthonous DOM, where $\beta$ represents more recently produced DOM and $\alpha$ represents more decomposed DOM[37-39]); FDOM = the integrated volumetric fluorescence intensity of fluorescent DOM with excitation wavelengths from 240 nm to 550 nm and emission wavelengths from 248.242 nm to 600.903 nm in Water Raman unit (R.U.).[40-42]

| **Table S5.** Fluorescence properties of native and altered Adirondack lake water samples (continued) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH 6.5 (DOC Standardized) | | | | | | | | | | | | | |
| Sample Name | Peak A (R.U.) | Peak B (R.U.) | Peak C (R.U.) | Peak M (R.U.) | Peak T (R.U.) | Peak A : Peak T | Peak C : Peak A | Peak C : Peak M | Peak C : Peak T | FI | HIX | $\beta$:$\alpha$ | FDOM (R.U.) |
| Arbutus Lake | 0.89 | 0.25 | 0.86 | 0.87 | 0.53 | 1.67 | 0.97 | 0.98 | 1.62 | 1.54 | 0.77 | 0.61 | 19057 |
| Big Moose Lake | 1.14 | 0.01 | 1.06 | 0.83 | 0.23 | 5.02 | 0.93 | 1.28 | 4.67 | 1.48 | 0.92 | 0.45 | 21924 |
| Black Pond | 1.03 | 0.09 | 0.84 | 0.74 | 0.32 | 3.22 | 0.81 | 1.12 | 2.60 | 1.46 | 0.89 | 0.54 | 18977 |
| Dart Lake | 1.03 | 0.02 | 0.97 | 0.79 | 0.24 | 4.33 | 0.94 | 1.23 | 4.09 | 1.47 | 0.91 | 0.48 | 19544 |
| G Lake | 0.93 | 0.10 | 0.80 | 0.73 | 0.41 | 2.26 | 0.86 | 1.10 | 1.95 | 1.59 | 0.86 | 0.53 | 17711 |
| Honnedaga Lake | 0.84 | 0.03 | 0.79 | 0.63 | 0.18 | 4.57 | 0.94 | 1.25 | 4.29 | 1.58 | 0.93 | 0.47 | 16364 |
| Limekiln Lake | 0.56 | 0.08 | 0.52 | 0.48 | 0.20 | 2.84 | 0.93 | 1.10 | 2.63 | 1.47 | 0.85 | 0.54 | 10147 |
| Little Hope Pond | 1.12 | 0.00 | 1.02 | 0.77 | 0.21 | 5.38 | 0.91 | 1.33 | 4.91 | 1.38 | 0.92 | 0.42 | 22187 |
| Moss Lake | 0.92 | 0.26 | 0.88 | 0.76 | 0.62 | 1.48 | 0.96 | 1.16 | 1.42 | 1.54 | 0.81 | 0.50 | 18175 |
| North Lake | 1.29 | 0.00 | 1.19 | 0.90 | 0.23 | 5.70 | 0.92 | 1.32 | 5.25 | 1.52 | 0.93 | 0.43 | 25566 |
| Lake Rondaxe | 0.62 | 0.17 | 0.62 | 0.58 | 0.26 | 2.38 | 1.00 | 1.08 | 2.39 | 1.63 | 0.82 | 0.58 | 12196 |
| Sagamore Lake | 1.14 | 0.00 | 1.11 | 0.84 | 0.21 | 5.37 | 0.97 | 1.31 | 5.19 | 1.44 | 0.93 | 0.41 | 23055 |
| South Lake | 1.22 | 0.01 | 1.10 | 0.93 | 0.27 | 4.58 | 0.90 | 1.17 | 4.10 | 1.52 | 0.93 | 0.50 | 23019 |
| Squaw Lake | 0.69 | 0.09 | 0.63 | 0.53 | 0.22 | 3.16 | 0.91 | 1.19 | 2.89 | 1.47 | 0.86 | 0.50 | 12595 |
| Willis Lake | 0.81 | 0.07 | 0.76 | 0.63 | 0.29 | 2.83 | 0.94 | 1.20 | 2.65 | 1.36 | 0.87 | 0.47 | 16011 |
| Wolf Lake | 0.81 | 0.11 | 0.70 | 0.64 | 0.34 | 2.39 | 0.86 | 1.10 | 2.06 | 1.54 | 0.85 | 0.62 | 15027 |

Peak A = an indicator of the abundance of "terrestrial humic-like" DOM; [29-31] Peak B = an indicator of the abundance of "tyrosine-like, protein-like" DOM;[29-31] Peak C = an indicator of the abundance of "terrestrial fulvic-like" DOM;[29-31] Peak M = an indicator of the abundance of "marine humic-like" DOM;[29-31] Peak T = an indicator of the abundance of "tryptophan-like, protein-like" DOM;[29-31] FI = fluorescence index (an indicator of the source of DOM, which is either microbially derived from bacteria and algae or terrestrially derived from plant litter and soil[15, 32-34]); HIX = humification index (an indicator of the degree of DOM humification[16, 35, 36]); $\beta$:$\alpha$ = freshness index (an indicator of the contribution of recently plant-derived or autochthonous DOM, where $\beta$ represents more recently produced DOM and $\alpha$ represents more decomposed DOM[37-39]); FDOM = the integrated volumetric fluorescence intensity of fluorescent DOM with excitation wavelengths from 240 nm to 550 nm and emission wavelengths from 248.242 nm to 600.903 nm in Water Raman unit (R.U.).[40-42]

| **Table S5.** Fluorescence properties of native and altered Adirondack lake water samples (continued) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH 4.5 (DOC Standardized) | | | | | | | | | | | | | |
| Sample Name | Peak A (R.U.) | Peak B (R.U.) | Peak C (R.U.) | Peak M (R.U.) | Peak T (R.U.) | Peak A : Peak T | Peak C : Peak A | Peak C : Peak M | Peak C : Peak T | FI | HIX | $\beta$:$\alpha$ | FDOM (R.U.) |
| Arbutus Lake | 1.27 | 0.33 | 4.22 | 1.03 | 0.63 | 2.01 | 3.34 | 4.11 | 6.70 | 1.53 | 0.83 | 0.63 | 27421 |
| Big Moose Lake | 2.03 | 0.46 | 1.78 | 1.58 | 0.85 | 2.39 | 0.88 | 1.13 | 2.10 | 1.53 | 0.83 | 0.52 | 40506 |
| Black Pond | 1.19 | 0.20 | 1.01 | 0.90 | 0.56 | 2.13 | 0.84 | 1.12 | 1.79 | 1.46 | 0.86 | 0.55 | 22736 |
| Dart Lake | 1.67 | 0.07 | 1.52 | 1.23 | 0.41 | 4.07 | 0.91 | 1.23 | 3.71 | 1.56 | 0.91 | 0.51 | 31925 |
| G Lake | 1.01 | 0.16 | 0.92 | 0.81 | 0.54 | 1.89 | 0.91 | 1.13 | 1.71 | 1.64 | 0.83 | 0.60 | 20251 |
| Honnedaga Lake | 1.06 | 0.08 | 0.97 | 0.71 | 0.29 | 3.61 | 0.92 | 1.37 | 3.31 | 1.70 | 0.90 | 0.57 | 21267 |
| Limekiln Lake | 1.01 | 0.26 | 0.86 | 0.77 | 0.56 | 1.81 | 0.85 | 1.12 | 1.55 | 1.59 | 0.82 | 0.60 | 19462 |
| Little Hope Pond | 1.64 | 0.00 | 1.44 | 1.08 | 0.34 | 4.78 | 0.88 | 1.34 | 4.20 | 1.45 | 0.93 | 0.42 | 32811 |
| Moss Lake | 1.57 | 0.56 | 1.41 | 1.26 | 1.20 | 1.32 | 0.90 | 1.12 | 1.18 | 1.51 | 0.75 | 0.56 | 32600 |
| North Lake | 2.96 | 0.51 | 2.80 | 4.16 | 0.95 | 3.11 | 0.95 | 0.67 | 2.94 | 1.48 | 0.86 | 0.45 | 58064 |
| Lake Rondaxe | 0.93 | 0.22 | 0.87 | 0.77 | 0.44 | 2.10 | 0.94 | 1.13 | 1.97 | 1.69 | 0.84 | 0.64 | 18591 |
| Sagamore Lake | 1.85 | 0.04 | 1.68 | 1.26 | 0.46 | 4.02 | 0.91 | 1.33 | 3.65 | 1.51 | 0.91 | 0.45 | 37140 |
| South Lake | 1.31 | 0.10 | 1.17 | 0.97 | 0.40 | 3.30 | 0.89 | 1.21 | 2.95 | 1.54 | 0.89 | 0.53 | 25113 |
| Squaw Lake | 1.22 | 0.17 | 1.08 | 0.94 | 0.46 | 2.66 | 0.89 | 1.15 | 2.36 | 1.54 | 0.86 | 0.55 | 23597 |
| Willis Lake | 1.36 | 0.38 | 1.21 | 1.02 | 0.89 | 1.53 | 0.89 | 1.19 | 1.36 | 1.51 | 0.81 | 0.52 | 28347 |
| Wolf Lake | 0.81 | 0.11 | 0.70 | 0.64 | 0.34 | 2.39 | 0.86 | 1.10 | 2.06 | 1.54 | 0.85 | 0.62 | 15027 |

Peak A = an indicator of the abundance of "terrestrial humic-like" DOM; [29-31] Peak B = an indicator of the abundance of "tyrosine-like, protein-like" DOM;[29-31] Peak C = an indicator of the abundance of "terrestrial fulvic-like" DOM;[29-31] Peak M = an indicator of the abundance of "marine humic-like" DOM;[29-31] Peak T = an indicator of the abundance of "tryptophan-like, protein-like" DOM;[29-31] FI = fluorescence index (an indicator of the source of DOM, which is either microbially derived from bacteria and algae or terrestrially derived from plant litter and soil[15, 32-34]); HIX = humification index (an indicator of the degree of DOM humification[16, 35, 36]); $\beta$:$\alpha$ = freshness index (an indicator of the contribution of recently plant-derived or autochthonous DOM, where $\beta$ represents more recently produced DOM and $\alpha$ represents more decomposed DOM[37-39]); FDOM = the integrated volumetric fluorescence intensity of fluorescent DOM with excitation wavelengths from 240 nm to 550 nm and emission wavelengths from 248.242 nm to 600.903 nm in Water Raman unit (R.U.).[40-42]

| **Table S5.** Fluorescence properties of native and altered Adirondack lake water samples (continued) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH 8.5 (DOC Standardized) | | | | | | | | | | | | | |
| Sample Name | Peak A (R.U.) | Peak B (R.U.) | Peak C (R.U.) | Peak M (R.U.) | Peak T (R.U.) | Peak A : Peak T | Peak C : Peak A | Peak C : Peak M | Peak C : Peak T | FI | HIX | $\beta$:$\alpha$ | FDOM (R.U.) |
| Arbutus Lake | 1.30 | 0.06 | 1.15 | 1.08 | 0.54 | 2.41 | 0.88 | 1.07 | 2.13 | 1.51 | 0.87 | 0.61 | 25920 |
| Big Moose Lake | 1.81 | 0.00 | 1.70 | 1.39 | 0.35 | 5.24 | 0.94 | 1.22 | 4.90 | 1.48 | 0.93 | 0.45 | 34372 |
| Black Pond | 1.25 | 0.04 | 1.06 | 0.95 | 0.36 | 3.52 | 0.84 | 1.11 | 2.98 | 1.47 | 0.90 | 0.55 | 23414 |
| Dart Lake | 1.70 | 0.00 | 1.56 | 1.31 | 0.31 | 5.42 | 0.92 | 1.20 | 4.98 | 1.47 | 0.93 | 0.47 | 31054 |
| G Lake | 1.00 | 0.09 | 0.93 | 0.83 | 0.50 | 2.02 | 0.93 | 1.13 | 1.88 | 1.55 | 0.85 | 0.54 | 19591 |
| Honnedaga Lake | 0.99 | 0.02 | 0.98 | 0.77 | 0.22 | 4.57 | 0.99 | 1.27 | 4.52 | 1.57 | 0.92 | 0.48 | 19562 |
| Limekiln Lake | 0.96 | 0.04 | 0.87 | 0.79 | 0.28 | 3.38 | 0.91 | 1.10 | 3.07 | 1.52 | 0.88 | 0.56 | 17510 |
| Little Hope Pond | 1.69 | 0.00 | 1.53 | 1.18 | 0.24 | 7.18 | 0.90 | 1.30 | 6.49 | 1.43 | 0.95 | 0.42 | 33073 |
| Moss Lake | 1.38 | 0.00 | 1.29 | 1.13 | 0.40 | 3.45 | 0.94 | 1.14 | 3.23 | 1.47 | 0.90 | 0.50 | 25761 |
| North Lake | 1.97 | 0.00 | 1.83 | 1.45 | 0.28 | 7.11 | 0.93 | 1.26 | 6.61 | 1.47 | 0.95 | 0.43 | 38192 |
| Lake Rondaxe | 1.14 | 0.11 | 1.12 | 1.01 | 0.40 | 2.84 | 0.98 | 1.11 | 2.79 | 1.68 | 0.88 | 0.57 | 21986 |
| Sagamore Lake | 1.76 | 0.00 | 1.66 | 1.28 | 0.21 | 8.41 | 0.94 | 1.30 | 7.92 | 1.45 | 0.95 | 0.42 | 34068 |
| South Lake | 1.36 | 0.01 | 1.29 | 1.08 | 0.32 | 4.25 | 0.94 | 1.19 | 4.01 | 1.52 | 0.92 | 0.49 | 25959 |
| Squaw Lake | 1.17 | 0.12 | 1.07 | 0.92 | 0.36 | 3.28 | 0.91 | 1.16 | 2.99 | 1.56 | 0.89 | 0.51 | 21743 |
| Willis Lake | 1.35 | 0.04 | 1.22 | 1.03 | 0.43 | 3.14 | 0.91 | 1.18 | 2.85 | 1.45 | 0.88 | 0.49 | 26384 |
| Wolf Lake | 0.83 | 0.08 | 0.72 | 0.66 | 0.31 | 2.70 | 0.87 | 1.08 | 2.33 | 1.57 | 0.87 | 0.62 | 15395 |

Peak A = an indicator of the abundance of "terrestrial humic-like" DOM; [29-31] Peak B = an indicator of the abundance of "tyrosine-like, protein-like" DOM;[29-31] Peak C = an indicator of the abundance of "terrestrial fulvic-like" DOM;[29-31] Peak M = an indicator of the abundance of "marine humic-like" DOM;[29-31] Peak T = an indicator of the abundance of "tryptophan-like, protein-like" DOM;[29-31] FI = fluorescence index (an indicator of the source of DOM, which is either microbially derived from bacteria and algae or terrestrially derived from plant litter and soil[15, 32-34]); HIX = humification index (an indicator of the degree of DOM humification[16, 35, 36]); $\beta$:$\alpha$ = freshness index (an indicator of the contribution of recently plant-derived or autochthonous DOM, where $\beta$ represents more recently produced DOM and $\alpha$ represents more decomposed DOM[37-39]); FDOM = the integrated volumetric fluorescence intensity of fluorescent DOM with excitation wavelengths from 240 nm to 550 nm and emission wavelengths from 248.242 nm to 600.903 nm in Water Raman unit (R.U.).[40-42]

| **Table S5.** Fluorescence properties of native and altered Adirondack lake water samples (continued) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH 4.5 + Al (DOC Standardized) | | | | | | | | | | | | | |
| Sample Name | Peak A (R.U.) | Peak B (R.U.) | Peak C (R.U.) | Peak M (R.U.) | Peak T (R.U.) | Peak A : Peak T | Peak C : Peak A | Peak C : Peak M | Peak C : Peak T | FI | HIX | $\beta$:$\alpha$ | FDOM (R.U.) |
| Arbutus Lake | 1.36 | 0.06 | 1.10 | 0.90 | 0.48 | 2.82 | 0.81 | 1.22 | 2.28 | 1.57 | 0.87 | 0.80 | 28028 |
| Big Moose Lake | 1.95 | 0.00 | 1.65 | 1.18 | 0.39 | 5.02 | 0.85 | 1.40 | 4.25 | 1.71 | 0.92 | 0.67 | 38575 |
| Black Pond | 1.37 | 0.01 | 1.08 | 0.90 | 0.31 | 4.37 | 0.79 | 1.20 | 3.46 | 1.56 | 0.90 | 0.73 | 26887 |
| Dart Lake | 1.66 | 0.01 | 1.39 | 1.04 | 0.35 | 4.77 | 0.84 | 1.35 | 4.01 | 1.68 | 0.92 | 0.70 | 32568 |
| G Lake | 1.00 | 0.07 | 0.87 | 0.69 | 0.44 | 2.28 | 0.86 | 1.25 | 1.97 | 1.74 | 0.86 | 0.73 | 20541 |
| Honnedaga Lake | 1.04 | 0.06 | 0.97 | 0.66 | 0.27 | 3.89 | 0.93 | 1.47 | 3.61 | 1.77 | 0.89 | 0.68 | 21398 |
| Limekiln Lake | 1.04 | 0.07 | 0.87 | 0.72 | 0.34 | 3.10 | 0.83 | 1.21 | 2.58 | 1.71 | 0.85 | 0.77 | 20471 |
| Little Hope Pond | 1.74 | 0.00 | 1.45 | 0.94 | 0.26 | 6.78 | 0.84 | 1.54 | 5.67 | 1.56 | 0.94 | 0.58 | 35481 |
| Moss Lake | 1.45 | 0.03 | 1.29 | 0.98 | 0.45 | 3.24 | 0.89 | 1.32 | 2.89 | 1.62 | 0.89 | 0.71 | 28923 |
| North Lake | 2.03 | 0.00 | 1.76 | 1.17 | 0.34 | 5.98 | 0.87 | 1.50 | 5.20 | 1.67 | 0.93 | 0.62 | 41417 |
| Lake Rondaxe | 1.16 | 0.09 | 1.06 | 0.89 | 0.41 | 2.83 | 0.92 | 1.19 | 2.59 | 1.81 | 0.87 | 0.77 | 23218 |
| Sagamore Lake | 1.84 | 0.00 | 1.61 | 1.10 | 0.26 | 7.01 | 0.88 | 1.47 | 6.16 | 1.60 | 0.93 | 0.62 | 37986 |
| South Lake | 1.37 | 0.00 | 1.24 | 0.88 | 0.32 | 4.31 | 0.90 | 1.41 | 3.90 | 1.64 | 0.90 | 0.72 | 27554 |
| Squaw Lake | 1.29 | 0.07 | 1.07 | 0.86 | 0.39 | 3.28 | 0.83 | 1.25 | 2.72 | 1.68 | 0.88 | 0.72 | 25356 |
| Willis Lake | 1.50 | 0.04 | 1.26 | 0.98 | 0.45 | 3.30 | 0.84 | 1.28 | 2.78 | 1.56 | 0.89 | 0.69 | 30970 |
| Wolf Lake | 0.87 | 0.09 | 0.70 | 0.61 | 0.30 | 2.88 | 0.80 | 1.15 | 2.32 | 1.69 | 0.85 | 0.81 | 17244 |

Peak A = an indicator of the abundance of "terrestrial humic-like" DOM; [29-31] Peak B = an indicator of the abundance of "tyrosine-like, protein-like" DOM;[29-31] Peak C = an indicator of the abundance of "terrestrial fulvic-like" DOM;[29-31] Peak M = an indicator of the abundance of "marine humic-like" DOM;[29-31] Peak T = an indicator of the abundance of "tryptophan-like, protein-like" DOM;[29-31] FI = fluorescence index (an indicator of the source of DOM, which is either microbially derived from bacteria and algae or terrestrially derived from plant litter and soil[15, 32-34]); HIX = humification index (an indicator of the degree of DOM humification[16, 35, 36]); $\beta$:$\alpha$ = freshness index (an indicator of the contribution of recently plant-derived or autochthonous DOM, where $\beta$ represents more recently produced DOM and $\alpha$ represents more decomposed DOM[37-39]); FDOM = the integrated volumetric fluorescence intensity of fluorescent DOM with excitation wavelengths from 240 nm to 550 nm and emission wavelengths from 248.242 nm to 600.903 nm in Water Raman unit (R.U.).[40-42]

| **Table S5.** Fluorescence properties of native and altered Adirondack lake water samples (continued) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH 8.5 + Fe (DOC Standardized) | | | | | | | | | | | | | |
| Sample Name | Peak A (R.U.) | Peak B (R.U.) | Peak C (R.U.) | Peak M (R.U.) | Peak T (R.U.) | Peak A : Peak T | Peak C : Peak A | Peak C : Peak M | Peak C : Peak T | FI | HIX | $\beta$:$\alpha$ | FDOM (R.U.) |
| Arbutus Lake | 1.16 | 0.07 | 1.04 | 0.97 | 0.41 | 2.84 | 0.90 | 1.07 | 2.54 | 1.49 | 0.87 | 0.63 | 23283 |
| Big Moose Lake | 1.53 | 0.00 | 1.45 | 1.18 | 0.20 | 7.57 | 0.95 | 1.23 | 7.21 | 1.49 | 0.94 | 0.47 | 28525 |
| Black Pond | 1.06 | 0.00 | 0.92 | 0.86 | 0.17 | 6.40 | 0.86 | 1.06 | 5.52 | 1.47 | 0.92 | 0.55 | 20207 |
| Dart Lake | 1.35 | 0.00 | 1.28 | 1.06 | 0.16 | 8.55 | 0.94 | 1.21 | 8.07 | 1.48 | 0.94 | 0.47 | 24971 |
| G Lake | 0.78 | 0.00 | 0.75 | 0.67 | 0.29 | 2.68 | 0.96 | 1.12 | 2.58 | 1.57 | 0.88 | 0.56 | 15519 |
| Honnedaga Lake | 0.79 | 0.04 | 0.81 | 0.66 | 0.17 | 4.50 | 1.03 | 1.22 | 4.62 | 1.54 | 0.90 | 0.49 | 15752 |
| Limekiln Lake | 0.79 | 0.00 | 0.72 | 0.66 | 0.15 | 5.30 | 0.92 | 1.10 | 4.86 | 1.51 | 0.90 | 0.58 | 14335 |
| Little Hope Pond | 1.39 | 0.00 | 1.30 | 0.98 | 0.10 | 14.26 | 0.93 | 1.33 | 13.30 | 1.42 | 0.97 | 0.40 | 27398 |
| Moss Lake | 1.11 | 0.00 | 1.02 | 0.89 | 0.25 | 4.47 | 0.92 | 1.16 | 4.13 | 1.49 | 0.91 | 0.49 | 20576 |
| North Lake | 1.60 | 0.00 | 1.52 | 1.20 | 0.13 | 12.16 | 0.95 | 1.27 | 11.54 | 1.42 | 0.96 | 0.42 | 31172 |
| Lake Rondaxe | 0.94 | 0.01 | 0.93 | 0.84 | 0.25 | 3.69 | 0.99 | 1.11 | 3.67 | 1.58 | 0.89 | 0.55 | 18108 |
| Sagamore Lake | 1.41 | 0.00 | 1.34 | 1.04 | 0.09 | 15.87 | 0.95 | 1.29 | 15.03 | 1.46 | 0.96 | 0.41 | 27281 |
| South Lake | 1.10 | 0.00 | 1.01 | 0.86 | 0.17 | 6.59 | 0.92 | 1.18 | 6.08 | 1.49 | 0.93 | 0.50 | 20879 |
| Squaw Lake | 0.98 | 0.01 | 0.89 | 0.77 | 0.19 | 5.17 | 0.91 | 1.15 | 4.70 | 1.49 | 0.91 | 0.50 | 17791 |
| Willis Lake | 1.13 | 0.00 | 1.05 | 0.87 | 0.24 | 4.64 | 0.93 | 1.20 | 4.33 | 1.47 | 0.91 | 0.49 | 22112 |
| Wolf Lake | 0.68 | 0.01 | 0.58 | 0.53 | 0.15 | 4.43 | 0.86 | 1.09 | 3.81 | 1.46 | 0.87 | 0.63 | 12252 |

Peak A = an indicator of the abundance of "terrestrial humic-like" DOM; [29-31] Peak B = an indicator of the abundance of "tyrosine-like, protein-like" DOM;[29-31] Peak C = an indicator of the abundance of "terrestrial fulvic-like" DOM;[29-31] Peak M = an indicator of the abundance of "marine humic-like" DOM;[29-31] Peak T = an indicator of the abundance of "tryptophan-like, protein-like" DOM;[29-31] FI = fluorescence index (an indicator of the source of DOM, which is either microbially derived from bacteria and algae or terrestrially derived from plant litter and soil[15, 32-34]); HIX = humification index (an indicator of the degree of DOM humification[16, 35, 36]); $\beta$:$\alpha$ = freshness index (an indicator of the contribution of recently plant-derived or autochthonous DOM, where $\beta$ represents more recently produced DOM and $\alpha$ represents more decomposed DOM[37-39]); FDOM = the integrated volumetric fluorescence intensity of fluorescent DOM with excitation wavelengths from 240 nm to 550 nm and emission wavelengths from 248.242 nm to 600.903 nm in Water Raman unit (R.U.).[40-42]

## 4. Simulated sunlight irradiation experiments

Over the course of irradiation, 500 μL of sample aliquots were withdrawn from quartz test tubes at predetermined time intervals and analyzed for the concentrations of 2-hydroxyterephthalic acid (hTPA), furfuryl alcohol (FFA), 2,4,6-trimethylphenol (TMP), four sorbic alcohol isomers (i.e., *cis*,*cis*-2,4-hexadien-1-ol, *cis*,*trans*-2,4-hexadien-1-ol, *trans*,*cis*-2,4-hexadien-1-ol, *trans*,*trans*-2,4-hexadien-1-ol), as well as *p*-nitroanisole (PNA) by an Agilent 1260 Infinity II high-performance liquid chromatograph with a variable wavelength detector and a fluorescence detector with instrument configurations and settings detailed in **Table S6**. The formation of hTPA from terephthalic acid (TPA),[89, 90] the loss of FFA,[43, 44] the loss of TMP,[45, 46] and the isomerization of *t,t*-HDO[47] were monitored as a function of time following previously established analytical methods.

**Table S6.** HPLC methods

| Analyte | Mobile Phase | Analytical Column | Detector | Retention Time |
|---|---|---|---|---|
| PNA | 25% Water<br>75% MeOH<br>Isocratic flow rate: 0.5 mL/min | Agilent Poroshell 120 EC-C18<br>4.6 × 100 mm, 2.7 μm<br>Column temperature: 30 °C | VWD absorbance<br>$\lambda_{UV}$ = 316 nm | 3.19 min |
| hTPA | 75% 10 mM Phosphate buffer<br>25% MeOH<br>Isocratic flow rate: 0.5 mL/min | Agilent Poroshell 120 EC-C18<br>4.6 × 100 mm, 2.7 μm<br>Column temperature: 30 °C | FLD fluorescence<br>$\lambda_{excitation}$ = 250 nm<br>$\lambda_{emission}$ = 410 nm | 3.57 min |
| FFA | 80% 10 mM Phosphate buffer<br>20% MeOH<br>Isocratic flow rate: 0.5 mL/min | Agilent Poroshell 120 EC-C18<br>4.6 × 100 mm, 2.7 μm<br>Column temperature: 30 °C | VWD absorbance<br>$\lambda_{UV}$ = 217 nm | 4.19 min |
| TMP | 30% 10 mM Phosphate buffer<br>70% MeOH<br>Isocratic flow rate: 0.5 mL/min | Agilent Poroshell 120 EC-C18<br>4.6 × 100 mm, 2.7 μm<br>Column temperature: 30 °C | FLD fluorescence<br>$\lambda_{excitation}$ = 230 nm<br>$\lambda_{emission}$ = 325 nm | 4.56 min |
| *t,t*-HDO | 70% Water with 0.05% TFA<br>30% ACN<br>Isocratic flow rate: 0.7 mL/min | Phenomenex Luna C18<br>4.6 × 250 mm, 5 μm<br>Column temperature: 10 °C | VWD absorbance<br>$\lambda_{UV}$ = 230 nm | *c,c*-HDO 13.58 min<br>*c,t*-HDO 14.06 min<br>*t,c*-HDO 14.57 min<br>*t,t*-HDO 15.28 min |

VWD = variable wavelength detection; FLD = fluorescence detection; *c,c*-HDO = *cis,cis*-2,4-hexadien-1-ol; *c,t*-HDO = *cis,trans*-2,4-hexadien-1-ol; *t,c*-HDO = *trans,cis*-2,4-hexadien-1-ol; *t,t*-HDO = *trans,trans*-2,4-hexadien-1-ol. The limit of detection for PNA, hTPA, FFA, TMP, and *t,t*-HDO was 0.04 μM, 0.5 nM, 0.06 μM, 0.01 μM, and 0.02 μM, respectively.

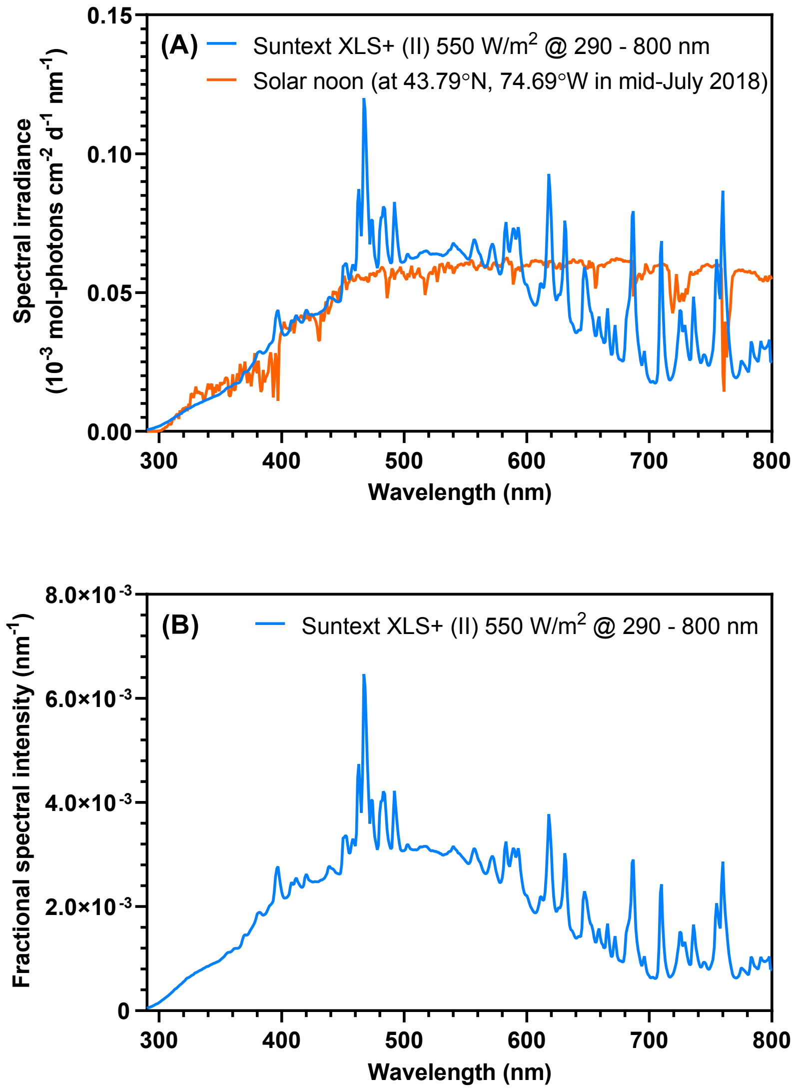


**Figure S2.** (A) Comparison of the xenon arc lamp spectral irradiance produced by the Suntest XLS+(II) solar simulator and the noontime solar spectral irradiance modeled by SMARTS (see Section S12 *Estimations of noontime surface steady-state concentrations of RIs*) for mid-July 2018 (i.e., averaged across July 17-19, 2018) at 43.79º N, 74.69º W (i.e., the averaged latitude and longitude coordinates for Adirondack lakes); (B) Fractional spectral intensity of the xenon arc lamp. Note that the UVA+UVB irradiance in the solar simulator was comparable to the average maximum UVA+UVB irradiance measured over 3 consecutive days (July 17-19, 2018) using a Solar Light PMA2107 data logging radiometer coupled to UVA and UVB Teflon coated photodiode detectors on the roof of Link Hall at Syracuse University.

## 5. *p*-Nitroanisole/pyridine actinometry

The rate of light absorption $R_a$ (mol-photons $L^{-1}$ $s^{-1}$ or Einstein $L^{-1}$ $s^{-1}$) per unit sample volume was calculated following the procedure outlined in previous studies.[46, 48-50] For each set of photolysis experiments, the loss of PNA in 10 μM PNA/5 mM pyr actinometer solutions was monitored in the solar simulator to determine the pseudo-first order rate constant for the loss of PNA, $k_{obs,PNA}$ ($s^{-1}$):[1, 51, 52]

$$\begin{aligned} R_{loss,\,PNA} &= -\frac{d[PNA]}{dt} = k_{obs,\,PNA}[PNA] = \Phi_{PNA}\sum_{\lambda=290\text{ nm}}^{550\text{ nm}} \frac{W_\lambda \varepsilon_\lambda [1-10^{-\alpha_{D(\lambda)}z}]}{z\alpha_\lambda}[PNA] \\ &\approx \Phi_{PNA}\sum_{\lambda=290\text{ nm}}^{550\text{ nm}} \frac{W_\lambda \varepsilon_\lambda (2.303\alpha_{D(\lambda)}z)}{z\alpha_\lambda}[PNA] \approx \Phi_{PNA}\sum_{\lambda=290\text{ nm}}^{550\text{ nm}} 2.303z\frac{W_\lambda}{z}\varepsilon_\lambda [PNA] \qquad \text{(S1)} \\ &= \Phi_{PNA}\sum_{\lambda=290\text{ nm}}^{550\text{ nm}} 2.303zI_\lambda\varepsilon_\lambda [PNA] = 2.303z\Phi_{PNA}\sum_{\lambda=290\text{ nm}}^{550\text{ nm}} I_\lambda\varepsilon_\lambda [PNA] \end{aligned}$$

where $R_{loss,\,PNA}$ (M $s^{-1}$) is the loss rate of PNA, [PNA] is the concentration of PNA, $\Phi_{PNA}$ ($1.74\times10^{-3}$ mol mol-photons$^{-1}$ or mol Einstein$^{-1}$; calculated from $\Phi_{PNA} = 0.29\,[pyr] + 0.00029$) is the quantum yield for the loss of PNA at a given pyridine concentration (i.e., [pyr] = $5\times10^{-3}$ M),[2] $W_\lambda$ ($10^{-3}$ mol-photons $cm^{-2}$ $s^{-1}$ $nm^{-1}$ or milliEinstein $cm^{-2}$ $s^{-1}$ $nm^{-1}$) is the incident light intensity at a given wavelength λ, $\varepsilon_\lambda$ ($M^{-1}$ $cm^{-1}$) is the decadic molar absorption coefficient of PNA at a given wavelength λ,[2] $\alpha_{D(\lambda)}$ ($cm^{-1}$) is the apparent (or diffuse) attenuation coefficient ($\alpha_{D(\lambda)} \approx \alpha_\lambda$ where the distribution function D(λ) is ~1.0 for the quartz test tube [52]), $z$ (1.12 cm) is the optical pathlength for the quartz test tube,[51] $\alpha_\lambda$ ($cm^{-1}$) is the decadic absorption (or attenuation) coefficient (i.e., the absorbance divided by the optical pathlength for the quartz cuvette), and $I_\lambda$ ($10^{-3}$ mol-photons $cm^{-3}$ $s^{-1}$ $nm^{-1}$ or milliEinstein $cm^{-3}$ $s^{-1}$ $nm^{-1}$ or mol-photons $L^{-1}$ $s^{-1}$ $nm^{-1}$) is the incident light intensity at a given wavelength λ per unit volume.

Equation S1 was re-written given that $I_\lambda$ can be approximated by multiplying the fractional spectral intensity of the xenon arc lamp, $\rho_\lambda$ ($nm^{-1}$), with the total incident light intensity from 290 to 550 nm per unit volume, $I_0$ (mol-photons $L^{-1}$ $s^{-1}$; the wavelength range was selected to account for PNA absorbance past 400 nm[53]):[2, 48, 49]

$$k_{obs,\,PNA} = 2.303z\Phi_{PNA}\sum_{\lambda=290\text{ nm}}^{550\text{ nm}} \rho_\lambda I_0 \varepsilon_\lambda = 2.303z\Phi_{PNA}I_0\sum_{\lambda=290\text{ nm}}^{550\text{ nm}} \rho_\lambda\varepsilon_\lambda \qquad \text{(S2)}$$

Equation S2 was further re-arranged to calculate $I_0$, assuming that $I_0$ measured by the PNA/pyr actinometer represented $I_0$ through a given sample:[2, 48, 49]

$$I_0 = \frac{k_{\text{obs, PNA}}}{2.303 z \Phi_{\text{PNA}} \sum_{\lambda = 290\text{ nm}}^{550\text{ nm}} \rho_{\lambda} \varepsilon_{\lambda}} \tag{S3}$$

Equation S3 was used to calculated $R_a$ using the sample-specific $\alpha_{\lambda}$ ($m^{-1}$):[48, 49]

$$R_a = \sum_{\lambda = 290\text{ nm}}^{550\text{ nm}} \frac{W_{\lambda}(1 - 10^{-\alpha_{D,\lambda} z})}{z} \approx \sum_{\lambda = 290\text{ nm}}^{550\text{ nm}} \rho_{\lambda} I_0 (1 - 10^{-\alpha_{\lambda} z}) \tag{S4}$$

For each sample, $R_a$ calculated from Equation S4 was used to determine the apparent quantum yields and quantum yield coefficients of RIs. A summary of $R_a$ is provided in **Table S7**.

**Table S7.** Rates of light absorption (290-550 nm) for native and altered Adirondack lake water samples

| Sample Name | Native | pH 6.5 | pH 4.5 | pH 8.5 | pH 4.5 + Al | pH 8.5 + Fe |
|---|---|---|---|---|---|---|
| | $R_a$ (×$10^{-6}$ mol-photons $L^{-1}$ $s^{-1}$) | $R_a$ (×$10^{-6}$ mol-photons $L^{-1}$ $s^{-1}$) | $R_a$ (×$10^{-6}$ mol-photons $L^{-1}$ $s^{-1}$) | $R_a$ (×$10^{-6}$ mol-photons $L^{-1}$ $s^{-1}$) | $R_a$ (×$10^{-6}$ mol-photons $L^{-1}$ $s^{-1}$) | $R_a$ (×$10^{-6}$ mol-photons $L^{-1}$ $s^{-1}$) |
| Arbutus Lake | 1.83±0.06 | 1.30±0.05 | 1.24±0.04 | 1.81±0.06 | 1.24±0.04 | 2.06±0.07 |
| Big Moose Lake | 2.28±0.08 | 1.41±0.05 | 2.60±0.09 | 1.85±0.06 | 1.65±0.06 | 1.63±0.06 |
| Black Pond | 1.80±0.06 | 1.80±0.06 | 1.59±0.06 | 1.60±0.06 | 1.82±0.06 | 1.50±0.05 |
| Dart Lake | 2.12±0.07 | 1.45±0.05 | 1.23±0.04 | 1.71±0.06 | 1.27±0.04 | 1.32±0.05 |
| G Lake | 0.96±0.03 | 0.96±0.03 | 1.08±0.04 | 0.99±0.03 | 1.10±0.04 | 0.89±0.03 |
| Honnedaga Lake | 1.45±0.05 | 1.45±0.05 | 1.05±0.04 | 1.01±0.04 | 0.94±0.03 | 1.21±0.04 |
| Limekiln Lake | 1.23±0.04 | 1.12±0.04 | 1.14±0.04 | 0.91±0.03 | 0.86±0.03 | 1.07±0.04 |
| Little Hope Pond | 10.57±0.37 | 2.85±0.10 | 2.50±0.09 | 3.03±0.11 | 3.12±0.11 | 2.82±0.10 |
| Moss Lake | 1.93±0.07 | 1.64±0.06 | 2.44±0.08 | 1.56±0.05 | 1.44±0.05 | 1.60±0.06 |
| North Lake | 3.79±0.13 | 2.89±0.10 | 3.38±0.12 | 2.37±0.08 | 2.35±0.08 | 2.38±0.08 |
| Lake Rondaxe | 1.38±0.05 | 1.32±0.05 | 0.53±0.02 | 0.55±0.02 | 0.54±0.02 | 1.75±0.06 |
| Sagamore Lake | 6.81±0.24 | 2.90±0.10 | 2.54±0.09 | 3.01±0.10 | 2.87±0.10 | 3.01±0.10 |
| South Lake | 1.28±0.04 | 1.28±0.04 | 0.74±0.03 | 1.41±0.05 | 1.20±0.04 | 2.20±0.08 |
| Squaw Lake | 1.03±0.04 | 0.64±0.02 | 0.74±0.03 | 1.26±0.04 | 1.13±0.04 | 2.77±0.10 |
| Willis Lake | 2.31±0.08 | 1.56±0.05 | 1.44±0.05 | 1.85±0.06 | 1.45±0.05 | 2.73±0.09 |
| Wolf Lake | 0.67±0.02 | 0.67±0.02 | 0.47±0.02 | 1.20±0.04 | 0.65±0.02 | 1.38±0.05 |

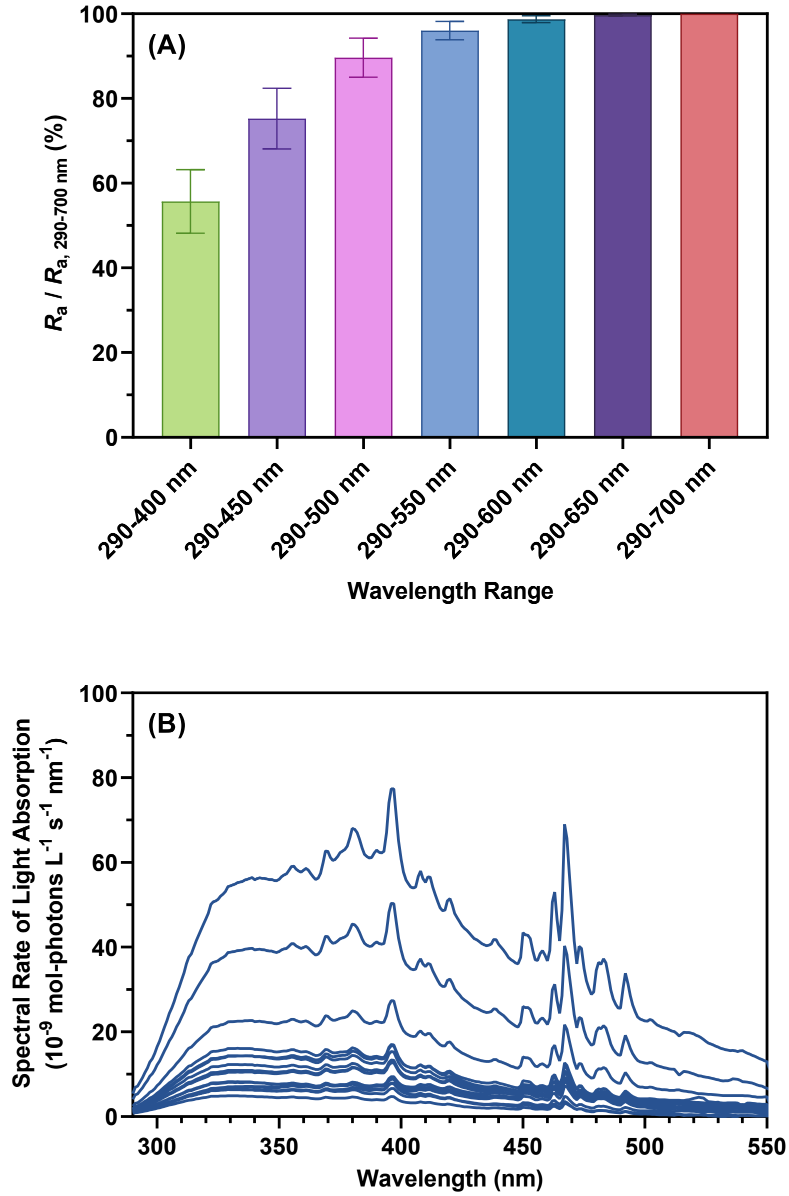


**Figure S3.** Selection of wavelength range for $R_a$ calculations: (A) the percentages of $R_a$ integrated over a specific wavelength range with reference to $R_a$ integrated over the full wavelength range of 290-700 nm. Error bars indicate the standard deviation of $R_a$ measured for native Adirondack lake water samples ($n$=16); (B) the spectral rates of light absorption over the wavelength range of 290-550 nm for native Adirondack lake water samples.

## 6. Terephthalic acid (TPA) as a probe for $^{\bullet}$OH

TPA was spiked into samples to measure the photoproduction of $^{\bullet}$OH, recognizing that both free $^{\bullet}$OH and other lower-energy hydroxylating species[54-57] might contribute to the observed TPA loss. For each sample, the *net* formation of TPA hydroxylation product, hTPA, was monitored by considering the production of hTPA from TPA and the concurrent loss of hTPA via direct photolysis and its negligible reactions with $^{\bullet}$OH and $^1O_2$:[58, 59]

$$R_{\mathrm{f,\ hTPA}} = \frac{\mathrm{d[hTPA]}}{\mathrm{dt}} = R_{\mathrm{prod,\ hTPA}} - R_{\mathrm{loss,\ hTPA}}$$

$$\begin{aligned} &= k_{\mathrm{TPA},\ ^{\bullet}\mathrm{OH}}[\mathrm{TPA}][^{\bullet}\mathrm{OH}]_{\mathrm{ss}} Y_{\mathrm{hTPA}} - k_{\mathrm{direct\ photolysis,\ hTPA}}[\mathrm{hTPA}]SF_{\Sigma\lambda} - k_{\mathrm{hTPA},\ ^{\bullet}\mathrm{OH}}[\mathrm{hTPA}][^{\bullet}\mathrm{OH}]_{\mathrm{ss}} \\ &\quad - k_{\mathrm{hTPA},\ ^1\mathrm{O}_2}[\mathrm{hTPA}][^1\mathrm{O}_2]_{\mathrm{ss}} \\ &\quad \approx k_{\mathrm{TPA},\ ^{\bullet}\mathrm{OH}}[\mathrm{TPA}][^{\bullet}\mathrm{OH}]_{\mathrm{ss}} Y_{\mathrm{hTPA}} - k_{\mathrm{direct\ photolysis,\ hTPA}}[\mathrm{hTPA}]SF_{\Sigma\lambda} \end{aligned} \qquad \text{(S5)}$$

where $R_{\mathrm{f,\ hTPA}}$ (M s$^{-1}$) is the formation rate of hTPA, $R_{\mathrm{prod,\ hTPA}}$ (M s$^{-1}$) is the production rate of hTPA from TPA, $R_{\mathrm{loss,\ hTPA}}$ (M s$^{-1}$) is the loss rate of hTPA, $k_{\mathrm{TPA},\ ^{\bullet}\mathrm{OH}}$ (4.2±(0.3)×10$^9$ M$^{-1}$ s$^{-1}$) is the second-order reaction rate constant of TPA with $^{\bullet}$OH (assuming the doubly dissociated form of TPA prevails over the pH range considered),[58, 60] [TPA] is the initial concentration of TPA (10 μM), $[^{\bullet}\mathrm{OH}]_{\mathrm{ss}}$ is the steady-state concentration of $^{\bullet}$OH, $Y_{\mathrm{hTPA}}$ is the formation yield hTPA from the reaction of TPA with $^{\bullet}$OH, $k_{\mathrm{direct\ photolysis,\ hTPA}}$ (s$^{-1}$) is the experimentally determined direct photolysis rate constant of hTPA, [hTPA] is the concentration of hTPA, $SF_{\Sigma\lambda}$ is the sample-specific light screening factor,[61] $k_{\mathrm{hTPA},\ ^{\bullet}\mathrm{OH}}$ (6.3±(0.1)×10$^9$ M$^{-1}$ s$^{-1}$) is the second-order reaction rate constant of hTPA with $^{\bullet}$OH,[58] $k_{\mathrm{hTPA},\ ^1\mathrm{O}_2}$ (5.0±(0.1)×10$^4$ M$^{-1}$ s$^{-1}$) is the second-order reaction rate constant of hTPA with $^1O_2$,[58] and $[^1\mathrm{O}_2]_{\mathrm{ss}}$ is the steady-state concentration of $^1O_2$ (note that $k_{\mathrm{direct\ photolysis,\ hTPA}}SF_{\Sigma\lambda} \gg k_{\mathrm{hTPA},\ ^{\bullet}\mathrm{OH}}[^{\bullet}\mathrm{OH}]_{\mathrm{ss}} + k_{\mathrm{hTPA},\ ^1\mathrm{O}_2}[^1\mathrm{O}_2]_{\mathrm{ss}}$ assuming typical $[^{\bullet}\mathrm{OH}]_{\mathrm{ss}}$ and $[^1\mathrm{O}_2]_{\mathrm{ss}}$ in sunlit surface waters).[58]

For each sample, a nonlinear least squares regression of hTPA data in the initial rate kinetics regime was performed using Equation S5 (i.e., $dx/dt = a + bx$ where $dx/dt$ = d[hTPA]/dt and $x$ = [hTPA]) to solve for the formation rate of $^{\bullet}$OH, $R_{\mathrm{f},\ ^{\bullet}\mathrm{OH}}$ (M s$^{-1}$):[59, 62]

$$R_{\mathrm{f},\ ^{\bullet}\mathrm{OH}} = \frac{R_{\mathrm{prod,\ hTPA}}}{Y_{\mathrm{hTPA}}} \qquad \text{(S6)}$$

To account for the effects of pH and temperature on $R_{\text{f, hTPA}}$, a pH- and temperature-adjusted $Y_{\text{hTPA}}$ of 0.41±0.01 was derived by averaging the values predicted from $Y_{\text{hTPA}} = [(30 + 0.43 \times \text{pH}) / 100]_{293\text{ K}} \times [(0.0059 \pm 0.0011) \times T - (1.50 \pm 0.31)] / [(0.0059 \pm 0.0011) \times 293\text{ K} - (1.50 \pm 0.31)]$ using $T$ = 303 K (i.e., 30 °C, the chamber temperature of solar simulator was controlled at 30 °C during irradiation) and the pH of Adirondack lake water samples ($n$ = 16).[58, 60, 63-65]

The steady-state concentration of $^{\bullet}$OH in the presence of TPA, $[^{\bullet}\text{OH}]_{\text{ss}}$, was calculated as:[48, 59]

$$[^{\bullet}\text{OH}]_{\text{ss}} = \frac{R_{\text{f, }^{\bullet}\text{OH}}}{k'_{\text{q, }^{\bullet}\text{OH}}} = \frac{R_{\text{prod, hTPA}}}{(k_{^{\bullet}\text{OH, HCO}_3^-}[\text{HCO}_3^-] + k_{^{\bullet}\text{OH, CO}_3^{2-}}[\text{CO}_3^{2-}] + k_{^{\bullet}\text{OH, DOM}}[\text{DOM}] + k_{\text{TPA, }^{\bullet}\text{OH}}[\text{TPA}])Y_{\text{hTPA}}} \approx \frac{R_{\text{prod, hTPA}}}{(k_{^{\bullet}\text{OH, DOM}}[\text{DOM}] + k_{\text{TPA, }^{\bullet}\text{OH}}[\text{TPA}])Y_{\text{hTPA}}} \quad \text{(S7)}$$

where $k'_{\text{q, }^{\bullet}\text{OH}}$ ($\text{s}^{-1}$) is the pseudo-first order rate constant for $^{\bullet}$OH quenching, $k_{^{\bullet}\text{OH, HCO}_3^-}$ ($8.5\times10^6$ $\text{M}^{-1}$ $\text{s}^{-1}$) is the second-order reaction rate constant of $^{\bullet}$OH with $\text{HCO}_3^-$,[66] $[\text{HCO}_3^-]$ is the concentration of $\text{HCO}_3^-$, $k_{^{\bullet}\text{OH, CO}_3^{2-}}$ ($3.9\times10^8$ $\text{M}^{-1}$ $\text{s}^{-1}$) is the second-order reaction rate constant of $^{\bullet}$OH with $\text{CO}_3^{2-}$,[66] $[\text{CO}_3^{2-}]$ is the concentration of $\text{CO}_3^{2-}$, $k_{^{\bullet}\text{OH, DOM}}$ ($2.9(\pm1.5)\times10^4$ $(\text{mg C/L})^{-1}$ $\text{s}^{-1}$ or $3.4(\pm1.8)\times10^8$ $(\text{mol C/L})^{-1}$ $\text{s}^{-1}$) is the average second-order reaction rate constant of $^{\bullet}$OH with DOM compiled from the literature (excluding data for wastewater samples; **Table S8**),[42, 58, 67-76] and [DOM] is the concentration of DOC (note that $k_{^{\bullet}\text{OH, DOM}}[\text{DOM}] + k_{\text{TPA, }^{\bullet}\text{OH}}[\text{TPA}] \gg k_{^{\bullet}\text{OH, HCO}_3^-}[\text{HCO}_3^-] + k_{^{\bullet}\text{OH, CO}_3^{2-}}[\text{CO}_3^{2-}]$ at [TPA] = 10 μM given the low ANC and mildly acidic pH of Adirondack lake water samples and the fact that DOM serves as the principal sink for $^{\bullet}$OH at [DOC] ≥ 0.5 mg C/L[42, 69, 71]).

The apparent quantum yield of $^{\bullet}$OH, $\Phi_{\text{app, }^{\bullet}\text{OH}}$ (mol mol-photons$^{-1}$), was calculated as:[48, 49]

$$\Phi_{\text{app, }^{\bullet}\text{OH}} = \frac{R_{\text{f, }^{\bullet}\text{OH}}}{R_{\text{a}}} = \frac{R_{\text{prod, hTPA}}}{R_{\text{a}}Y_{\text{hTPA}}} \quad \text{(S8)}$$

The quantum yield coefficient of $^{\bullet}$OH with TPA, $f_{\text{TPA}}$ (L mol-photons$^{-1}$), was calculated as:

$$f_{\text{TPA}} = \Phi_{\text{app, }^{\bullet}\text{OH}} \times \frac{k_{\text{TPA, }^{\bullet}\text{OH}}}{k'_{\text{q, }^{\bullet}\text{OH}}} = \frac{R_{\text{prod, hTPA}}k_{\text{TPA, }^{\bullet}\text{OH}}}{R_{\text{a}}Y_{\text{hTPA}}(k_{^{\bullet}\text{OH, DOM}}[\text{DOM}] + k_{\text{TPA, }^{\bullet}\text{OH}}[\text{TPA}])} = \frac{R_{\text{prod, hTPA}}}{R_{\text{a}}Y_{\text{hTPA}}[\text{TPA}]} \quad \text{(S9)}$$

A summary of $\Phi_{\text{app, }^{\bullet}\text{OH}}$ and $f_{\text{TPA}}$ is provided in **Table S9**.

| **Table S8.** Summary of literature $k_{\mathrm{OH,\,DOM}}$ data | | | | | |
|---|---|---|---|---|---|
| Source and Sample ID | $k_{^{\bullet}\mathrm{OH,\,DOM}}$ ($10^4$ mg C/L)$^{-1}$ s$^{-1}$ | $k_{^{\bullet}\mathrm{OH,\,DOM}}$ ($10^8$ mol C/L)$^{-1}$ s$^{-1}$) | Source and Sample ID | $k_{^{\bullet}\mathrm{OH,\,DOM}}$ ($10^4$ mg C/L)$^{-1}$ s$^{-1}$ | $k_{^{\bullet}\mathrm{OH,\,DOM}}$ ($10^8$ mol C/L)$^{-1}$ s$^{-1}$) |
| **Zepp *et al.* (1992)**[67] | | | **Westerhoff *et al.* (1999)**[70] | | |
| Suwanee River Fulvic Acid I | 1.2 | 1.44 | Coal Creek, CO (XAD-8) | 3.58 | 4.3 |
| **Westerhoff *et al.* (1998)**[68] | | | Groundwater near Lake Shingobee, MN (XAD-8) | 2.17 | 2.6 |
| Lake Michigan, IL (XAD-8) | 2.48 | 2.98 | Lake Fryxell, Antarctica (XAD-8) | 2.92 | 3.5 |
| Lake Michigan, IL (1 kDa) | 2.46 | 2.95 | Yakima River at Kiona, WA (XAD-8) | 3.00 | 3.6 |
| California State Project Water, CA (XAD-8) | 3.30 | 3.96 | Lake Michigan, IL (XAD-8) | 2.50 | 3.0 |
| California State Project Water, CA (XAD-4) | 2.61 | 3.13 | Missouri River, IA (XAD-8) | 2.92 | 3.5 |
| California State Project Water, CA (1 kDa) | 2.71 | 3.25 | Ogeechee River, GA (XAD-8) | 3.75 | 4.5 |
| Teays Aquifier, IL (XAD-8) | 3.09 | 3.71 | Ohio River, OH (XAD-8) | 3.42(±0.08) | 4.1(±0.1) |
| Teays Aquifier, IL (1 kDa) | 3.20 | 3.84 | California State Project Water, CA (XAD-4) | 2.58 | 3.1 |
| Mississippi River, MO (1 kDa) | 2.91 | 3.49 | California State Project Water, CA (XAD-8) | 3.33 | 4.0 |
| Silver Lake, CO (XAD-8) | 3.44 | 4.13 | Shingobee River, MN (1992) (XAD-8) | 2.75 | 3.3 |
| Suwanee River Humic Acid I | 6.76 | 8.11 | Shingobee River, MN (1993) (XAD-8) | 3.75 | 4.5 |
| Suwanee River Fulvic Acid I | 3.10 | 3.72 | Lake Shingobee, MN (XAD-8) | 2.83 | 3.4 |
| **Brezonik and Fulkerson-Brekken (1998)**[69] | | | Suwanee River Fulvic Acid I | 3.08 | 3.7 |
| Blue Earth River, MN (Whole Water) | 2.8 | 3.36 | Suwanee River Humic Acid I | 2.58 | 3.1 |
| Mann Creek, WI (Whole Water) | 3.3 | 3.96 | Williams Lake, MN (XAD-8) | 2.92 | 3.5 |
| Lake Minnetonka, MN (Whole Water) | 1.4 | 1.68 | Yakima River at CleElum, WA (XAD-8) | 3.33 | 4.0 |
| Lake Nichols, WI (Whole Water) | 1.8 | 2.16 | **Goldstone *et al.* (2002)**[71] | | |
| Lake Vandercook, WI (Whole Water) | 2.6 | 3.12 | Suwanee River Fulvic Acid I | 2.7(±0.05) | 3.24(±0.06) |
| Blue Earth River, MN (DEAE-cellulose) | 2.9 | 3.48 | Suwanee River Humic Acid I | 1.9(±0.05) | 2.28(±0.06) |
| Mann Creek, WI (DEAE-cellulose) | 1.4 | 1.68 | **Southworth and Voelker (2003)**[72] | | |
| Lake Minnetonka, MN (DEAE-cellulose) | 1.0 | 1.20 | Suwanee River Fulvic Acid I | 4.4(±0.1) | 5.28(±0.12) |
| Lake Nichols, WI (DEAE-cellulose) | 1.5 | 1.80 | | | |
| Lake Vandercook, WI (DEAE-cellulose) | 1.9 | 2.28 | | | |

$k_{^{\bullet}\mathrm{OH,\,DOM}}$ ((mg C/L)$^{-1}$ s$^{-1}$) or (mol C/L)$^{-1}$ s$^{-1}$) = the second-order reaction rate constant of $^{\bullet}$OH with DOM.

**Table S8.** Summary of literature $k_{\text{OH, DOM}}$ data (continued)

| Source and Sample ID | $k_{\cdot\text{OH, DOM}}$ ($10^4$ mg C/L)$^{-1}$ s$^{-1}$ | $k_{\cdot\text{OH, DOM}}$ ($10^8$ mol C/L)$^{-1}$ s$^{-1}$) | Source and Sample ID | $k_{\cdot\text{OH, DOM}}$ ($10^4$ mg C/L)$^{-1}$ s$^{-1}$ | $k_{\cdot\text{OH, DOM}}$ ($10^8$ mol C/L)$^{-1}$ s$^{-1}$) |
|---|---|---|---|---|---|
| **Westerhoff *et al.* (2007)**[73] | | | **Page *et al.* (2010)**[58] | | |
| Suwanee River Fulvic Acid I | 1.16(±0.13) | 1.39(±0.16) | Suwanee River Fulvic Acid I | 2.0±(0.4) | 2.40±(0.48) |
| Suwanee River Fulvic Acid I | 1.56(±0.06) | 1.87(±0.07) | Suwanee River Fulvic Acid I | 1.1±(0.1) | 1.32±(0.12) |
| Suwanee River Fulvic Acid I | 1.29(±0.03) | 1.55(±0.04) | Pony Lake Fulvic Acid | 3.7±(0.5) | 4.44±(0.60) |
| Saguaro Lake, AZ (Hydrophobic Acid) | 1.44(±0.03) | 1.73(±0.04) | Pony Lake Fulvic Acid | 2.0±(0.1) | 2.40±(0.12) |
| Saguaro Lake, AZ (Transphilic Acid) | 1.21(±0.02) | 1.45(±0.02) | **Page *et al.* (2014)**[42] | | |
| Saguaro Lake, AZ (Hydrophobic Neutral) | 1.82(±0.11) | 2.18(±0.13) | Arctic surface waters | 1.73(±0.18) | 3(±2) |
| Nogales Wastewater Treatment Plant, AZ (Hydrophobic Neutral) | 1.43(±0.11) | 1.72(±0.13) | **McKay *et al.* (2014)**[75] | | |
| Nogales Wastewater Treatment Plant, AZ (Transphilic Neutral) | 3.78(±0.45) | 4.53(±0.54) | Suwanee River Fulvic Acid I | 1.73(±0.18) | 2.08(±0.18) |
| Nogales Wastewater Treatment Plant, AZ (Transphilic Acid) | 3.03(±0.26) | 3.63(±0.31) | Elliot Soil Humic Acid | 1.01(±0.12) | 1.21(±0.12) |
| **Rosario-Ortiz *et al.* (2008)**[74] | | | Leonardite Humic Acid | 5.39(±0.26) | 6.47(±0.26) |
| William E. Dunn Water Reclamation Facility, FL (Whole Water) | 9.58(±0.3) | 11.5(±0.3) | Pony Lake Fulvic Acid | 5.75(±0.82) | 6.90(±0.82) |
| Los Angeles County Sanitation District, CA (Whole Water) | 8.83(±1.0) | 10.6(±1.0) | Suwanee River Humic Acid II | 8.63(±0.02) | 10.36(±0.02) |
| Clark County Water Reclamation District, NV (Whole Water) | 3.75(±0.3) | 4.5(±0.3) | **Appiani *et al.* (2014)**[76] | | |
| Clark County Water Reclamation District, NV (Whole Water) | 10.1(±1.7) | 12.1(±1.7) | Fulvic Acids (maximum value) | 3.33 | 4 |
| Metropolitan Water Reclamation District, CO (Whole Water) | 8.50(±1.0) | 10.2(±1.0) | Humic Acids (maximum value) | 7.50 | 9 |
| Metropolitan Water Reclamation District, CO (Whole Water) | 2.25(±0.1) | 2.7(±0.1) | | | |
| 23rd Avenue Wastewater Treatment Plant, AZ (Whole Water) | 8.92(±0.5) | 10.7(±0.5) | | | |
| Cave Creek Water Reclamation Plant, AZ (Whole Water) | 5.67(±0.2) | 6.8(±0.2) | | | |

$k_{\cdot\text{OH, DOM}}$ ((mg C/L)$^{-1}$ s$^{-1}$) or (mol C/L)$^{-1}$ s$^{-1}$) = the second-order reaction rate constant of $^{\cdot}$OH with DOM.

**Table S9.** Summary of •OH data for native and altered Adirondack lake water samples

| Sample Name | Native | pH 6.5 | pH 4.5 | pH 8.5 | pH 4.5 + Al | pH 8.5 + Fe |
|---|---|---|---|---|---|---|
| | $\Phi_{app,\,{}^{\bullet}OH}$ (×10$^{-6}$ mol mol-photons$^{-1}$) | $\Phi_{app,\,{}^{\bullet}OH}$ (×10$^{-6}$ mol mol-photons$^{-1}$) | $\Phi_{app,\,{}^{\bullet}OH}$ (×10$^{-6}$ mol mol-photons$^{-1}$) | $\Phi_{app,\,{}^{\bullet}OH}$ (×10$^{-6}$ mol mol-photons$^{-1}$) | $\Phi_{app,\,{}^{\bullet}OH}$ (×10$^{-6}$ mol mol-photons$^{-1}$) | $\Phi_{app,\,{}^{\bullet}OH}$ (×10$^{-6}$ mol mol-photons$^{-1}$) |
| Arbutus Lake | 4.62±0.97 | 9.67±0.67 | 10.48±0.88 | 6.76±0.60 | 3.14±0.15 | 5.36±0.52 |
| Big Moose Lake | 7.93±0.33 | 4.45±0.16 | 4.31±0.57 | 9.67±1.54 | 2.36±0.12 | 9.64±1.09 |
| Black Pond | 6.42±0.76 | 6.42±0.76 | 10.05±2.16 | 7.31±0.60 | 6.17±0.93 | 7.58±0.79 |
| Dart Lake | 7.95±0.38 | 4.34±0.88 | 14.13±1.97 | 10.33±1.22 | 4.27±0.18 | 12.87±2.31 |
| G Lake | 12.88±1.79 | 12.88±1.79 | 13.51±2.97 | 12.80±1.49 | 11.43±1.50 | 13.09±0.48 |
| Honnedaga Lake | 10.31±1.12 | 10.31±1.12 | 18.66±3.87 | 14.76±1.48 | 13.74±2.69 | 8.74±0.61 |
| Limekiln Lake | 7.69±0.72 | 8.49±0.33 | 9.26±2.55 | 14.35±2.93 | 8.98±0.48 | 12.21±1.18 |
| Little Hope Pond | 1.44±0.07 | 1.30±0.09 | 1.88±0.27 | 6.37±0.48 | 6.51±0.52 | 6.62±0.67 |
| Moss Lake | 5.75±0.89 | 10.24±1.00 | 5.43±0.40 | 8.80±1.33 | 9.89±0.39 | 6.42±0.53 |
| North Lake | 5.13±0.47 | 5.94±0.59 | 8.41±1.15 | 9.04±1.83 | 4.05±0.20 | 12.60±3.04 |
| Lake Rondaxe | 3.02±0.34 | 6.79±2.35 | 18.15±2.48 | 19.00±3.38 | 19.41±2.04 | 6.51±0.59 |
| Sagamore Lake | 3.34±0.81 | 6.73±0.41 | 16.76±1.21 | 7.30±0.68 | 2.92±0.30 | 6.89±1.75 |
| South Lake | 11.97±1.04 | 11.97±1.04 | 21.36±2.79 | 11.43±1.01 | 6.59±0.32 | 6.44±1.50 |
| Squaw Lake | 5.78±1.07 | 17.93±1.40 | 14.54±1.38 | 8.06±0.94 | 8.67±2.50 | 2.49±0.55 |
| Willis Lake | 4.51±1.02 | 6.82±0.24 | 6.95±0.88 | 5.98±0.85 | 2.85±0.66 | 3.52±0.39 |
| Wolf Lake | 9.61±0.89 | 9.61±0.89 | 21.23±1.63 | 7.25±1.03 | 3.80±0.82 | 4.33±0.63 |
| Sample Name | Native | pH 6.5 | pH 4.5 | pH 8.5 | pH 4.5 + Al | pH 8.5 + Fe |
| | $f_{TPA}$ (L mol-photons$^{-1}$) | $f_{TPA}$ (L mol-photons$^{-1}$) | $f_{TPA}$ (L mol-photons$^{-1}$) | $f_{TPA}$ (L mol-photons$^{-1}$) | $f_{TPA}$ (L mol-photons$^{-1}$) | $f_{TPA}$ (L mol-photons$^{-1}$) |
| Arbutus Lake | 0.46±0.10 | 0.97±0.07 | 1.05±0.09 | 0.68±0.06 | 0.31±0.01 | 0.54±0.05 |
| Big Moose Lake | 0.79±0.03 | 0.44±0.02 | 0.43±0.06 | 0.97±0.15 | 0.24±0.01 | 0.96±0.11 |
| Black Pond | 0.64±0.08 | 0.64±0.08 | 1.00±0.22 | 0.73±0.06 | 0.62±0.09 | 0.76±0.08 |
| Dart Lake | 0.80±0.04 | 0.43±0.09 | 1.41±0.20 | 1.03±0.12 | 0.43±0.02 | 1.29±0.23 |
| G Lake | 1.29±0.18 | 1.29±0.18 | 1.35±0.30 | 1.28±0.15 | 1.14±0.15 | 1.31±0.05 |
| Honnedaga Lake | 1.03±0.11 | 1.03±0.11 | 1.87±0.39 | 1.48±0.15 | 1.37±0.27 | 0.87±0.06 |
| Limekiln Lake | 0.77±0.07 | 0.85±0.03 | 0.93±0.26 | 1.44±0.29 | 0.90±0.05 | 1.22±0.12 |
| Little Hope Pond | 0.14±0.01 | 0.13±0.01 | 0.19±0.03 | 0.64±0.05 | 0.65±0.05 | 0.66±0.07 |
| Moss Lake | 0.57±0.09 | 1.02±0.10 | 0.54±0.04 | 0.88±0.13 | 0.99±0.04 | 0.64±0.05 |
| North Lake | 0.51±0.05 | 0.59±0.06 | 0.84±0.12 | 0.90±0.18 | 0.40±0.02 | 1.26±0.30 |
| Lake Rondaxe | 0.30±0.03 | 0.68±0.23 | 1.81±0.25 | 1.90±0.34 | 1.94±0.20 | 0.65±0.06 |
| Sagamore Lake | 0.33±0.08 | 0.67±0.04 | 1.68±0.12 | 0.73±0.07 | 0.29±0.03 | 0.69±0.17 |
| South Lake | 1.20±0.10 | 1.20±0.10 | 2.14±0.28 | 1.14±0.10 | 0.66±0.03 | 0.64±0.15 |
| Squaw Lake | 0.58±0.11 | 1.79±0.14 | 1.45±0.14 | 0.81±0.09 | 0.87±0.25 | 0.25±0.06 |
| Willis Lake | 0.45±0.10 | 0.68±0.02 | 0.69±0.09 | 0.60±0.09 | 0.29±0.07 | 0.35±0.04 |
| Wolf Lake | 0.96±0.09 | 0.96±0.09 | 2.12±0.16 | 0.72±0.10 | 0.38±0.08 | 0.43±0.06 |

Errors represent one standard deviation from duplicate or triplicate measurements.

**7. Furfuryl alcohol (FFA) as a probe for $^1O_2$**

FFA was spiked into samples to measure the photoproduction of $^1O_2$. For each sample, the loss of FFA was monitored to determine the pseudo-first order rate constant for the photodegradation of FFA, $k_{obs,\ FFA}$ ($s^{-1}$), with the contributions from *apparent* direct photolysis of FFA caused by impurities[43] (12.9±3.0%) and the reaction of FFA with $^{\bullet}OH$ (8.6±1.4%):[77, 78]

$$R_{loss,\ FFA} = -\frac{d[FFA]}{dt} = k_{obs,\ FFA}[FFA]$$
$$= k_{FFA,\ ^1O_2}[FFA][^1O_2]_{ss} + k_{direct\ photolysis,\ FFA}[FFA]SF_{\Sigma\lambda} + k_{FFA,\ ^{\bullet}OH}[FFA][^{\bullet}OH]_{ss} \quad \text{(S10)}$$

where $R_{loss,\ FFA}$ ($M\ s^{-1}$) is the loss rate of FFA, [FFA] is the initial concentration of FFA (10 μM), $k_{FFA,\ ^1O_2}$ ($M^{-1}\ s^{-1}$) is the second-order reaction rate constant of FFA with $^1O_2$, and $[^1O_2]_{ss}$ is the steady-state concentration of $^1O_2$, $k_{direct\ photolysis,\ FFA}$ ($s^{-1}$) is the experimentally determined *apparent* direct photolysis rate constant of FFA, $SF_{\Sigma\lambda}$ is the sample-specific light screening factor, $k_{FFA,\ ^{\bullet}OH}$ ($1.5\times10^{10}\ M^{-1}\ s^{-1}$) is the second-order reaction rate constant of FFA with $^{\bullet}OH$,[66] and $[^{\bullet}OH]_{ss}$ is the steady-state concentration of $^{\bullet}OH$ measured by TPA.

To account for the potential effect of temperature on the $^1O_2$ reaction kinetics of FFA, a temperature-adjusted $k_{FFA,\ ^1O_2}$ of $1.17(\pm0.09)\times10^8\ M^{-1}\ s^{-1}$ was derived by substituting $T$ = 30 °C into $k_{FFA,\ ^1O_2} = (1.00 \pm 0.04) \times 10^8\ M^{-1}\ s^{-1} + [(2.1 \pm 0.3) \times 10^6\ M^{-1}\ s^{-1}\ °C^{-1}] \times (T - 22\ °C)$.[44] No attempt was made to correct for the pH or ionic strength dependence of $k_{FFA,\ ^1O_2}$ given the narrow pH range and low specific conductance of Adirondack lake water samples.

For each sample, the steady-state concentration of $^1O_2$, $[^1O_2]_{ss}$, was calculated as:[43, 44, 48, 79]

$$[^1O_2]_{ss} = \frac{R_{f,\ ^1O_2}}{k_d^{\Delta}} = \frac{(k_{obs,\ FFA} - k_{direct\ photolysis,\ FFA}SF_{\Sigma\lambda} - k_{FFA,\ ^{\bullet}OH}[^{\bullet}OH]_{ss})(k_d^{\Delta} + k_{FFA,\ ^1O_2}[FFA])}{k_d^{\Delta}k_{FFA,\ ^1O_2}}$$
$$\approx \frac{(k_{obs,\ FFA} - k_{direct\ photolysis,\ FFA}SF_{\Sigma\lambda} - k_{FFA,\ ^{\bullet}OH}[^{\bullet}OH]_{ss})}{k_{FFA,\ ^1O_2}} \quad \text{(S11)}$$

where $R_{f,\,^1O_2}$ (M s$^{-1}$) is the formation rate of $^1O_2$ and $k_d^{\Delta}$ (2.90(±0.05)×10$^5$ s$^{-1}$; temperature-adjusted for $T$ = 30 °C[44]) is the pseudo-first order deactivation rate constant of $^1O_2$ by water (note that $k_d^{\Delta} \gg k_{FFA,\,^1O_2}$[FFA] with a maximum value of 1.17(±0.09)×10$^3$ s$^{-1}$ at [FFA] = 10 μM).

The formation rate of $^1O_2$, $R_{f,\,^1O_2}$ (M s$^{-1}$), was calculated as:

$$R_{f,\,^1O_2} = [^1O_2]_{ss} k_d^{\Delta} \tag{S12}$$

The apparent quantum yield of $^1O_2$, $\Phi_{app,\,^1O_2}$ (mol mol-photons$^{-1}$), was calculated as:[48, 79]

$$\Phi_{app,\,^1O_2} = \frac{R_{f,\,^1O_2}}{R_a} = \frac{(k_d^{\Delta} + k_{FFA,\,^1O_2}[FFA])[^1O_2]_{ss}}{R_a} \approx \frac{k_d^{\Delta}[^1O_2]_{ss}}{R_a} \tag{S13}$$

The quantum yield coefficient of $^1O_2$ with FFA, $f_{FFA}$ (L mol-photons$^{-1}$), was calculated as:[80]

$$f_{FFA} = \Phi_{app,\,^1O_2} \times \frac{k_{FFA,\,^1O_2}}{k_d^{\Delta}} = \frac{k_{obs,\,FFA}^{corr}}{R_a} \tag{S14}$$

A summary $\Phi_{app,\,^1O_2}$ and $f_{FFA}$ is provided in **Table S10**.

| **Table S10.** Summary of $^{1}O_2$ data for native and altered Adirondack lake water samples | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sample Name | Native | Native + *t,t*-HDO | pH 6.5 | pH 4.5 | pH 8.5 | pH 4.5 + Al | pH 8.5 + Fe |
| | $\Phi_{app,\,^1O_2}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\,^1O_2}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\,^1O_2}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\,^1O_2}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\,^1O_2}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\,^1O_2}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\,^1O_2}$ (×10$^{-2}$ mol mol-photons$^{-1}$) |
| Arbutus Lake | 2.65±0.25 | 2.07±0.16 | 3.17±0.22 | 3.12±0.03 | 2.15±0.19 | 2.29±0.03 | 2.07±0.05 |
| Big Moose Lake | 2.62±0.05 | 1.99±0.08 | 3.09±0.17 | 1.81±0.08 | 2.28±0.03 | 2.03±0.18 | 2.63±0.18 |
| Black Pond | 1.89±0.18 | 1.47±0.09 | 1.89±0.17 | 2.18±0.25 | 2.09±0.17 | 1.49±0.06 | 2.72±0.01 |
| Dart Lake | 2.58±0.21 | 1.83±0.16 | 2.84±0.27 | 3.39±0.28 | 2.15±0.20 | 2.47±0.21 | 3.62±0.01 |
| G Lake | 2.34±0.27 | 1.74±0.09 | 2.34±0.25 | 2.53±0.01 | 2.42±0.15 | 1.66±0.13 | 3.31±0.25 |
| Honnedaga Lake | 1.90±0.17 | 1.50±0.10 | 1.90±0.16 | 2.35±0.27 | 2.38±0.12 | 1.80±0.09 | 2.21±0.01 |
| Limekiln Lake | 2.12±0.04 | 1.53±0.07 | 2.32±0.05 | 2.10±0.28 | 2.46±0.18 | 2.55±0.09 | 2.91±0.20 |
| Little Hope Pond | 1.53±0.13 | 1.20±0.05 | 1.64±0.17 | 1.78±0.17 | 1.39±0.11 | 0.92±0.07 | 1.43±0.08 |
| Moss Lake | 1.88±0.21 | 1.34±0.04 | 2.02±0.21 | 1.44±0.06 | 2.06±0.04 | 1.99±0.08 | 2.63±0.11 |
| North Lake | 1.96±0.19 | 1.43±0.06 | 1.75±0.06 | 1.67±0.08 | 1.90±0.03 | 1.71±0.06 | 2.09±0.27 |
| Lake Rondaxe | 2.08±0.20 | 1.57±0.11 | 2.27±0.11 | 4.55±0.40 | 3.94±0.24 | 3.46±0.27 | 1.93±0.05 |
| Sagamore Lake | 1.63±0.12 | 1.29±0.09 | 1.66±0.08 | 2.01±0.19 | 1.47±0.13 | 1.39±0.10 | 1.58±0.01 |
| South Lake | 2.30±0.07 | 1.76±0.06 | 2.30±0.05 | 4.80±0.40 | 2.06±0.13 | 1.98±0.15 | 1.63±0.12 |
| Squaw Lake | 2.88±0.22 | 2.13±0.21 | 4.50±0.32 | 3.65±0.31 | 2.57±0.17 | 2.40±0.27 | 1.29±0.07 |
| Willis Lake | 2.17±0.16 | 1.62±0.11 | 2.49±0.08 | 2.34±0.06 | 1.77±0.09 | 1.78±0.16 | 1.30±0.07 |
| Wolf Lake | 3.31±0.35 | 2.49±0.22 | 3.31±0.31 | 5.15±0.37 | 1.95±0.03 | 2.44±0.14 | 1.86±0.14 |
| Sample Name | Native | Native + *t,t*-HDO | pH 6.5 | pH 4.5 | pH 8.5 | pH 4.5 + Al | pH 8.5 + Fe |
| | $f_{FFA}$ (L mol-photons$^{-1}$) | $f_{FFA}$ (L mol-photons$^{-1}$) | $f_{FFA}$ (L mol-photons$^{-1}$) | $f_{FFA}$ (L mol-photons$^{-1}$) | $f_{FFA}$ (L mol-photons$^{-1}$) | $f_{FFA}$ (L mol-photons$^{-1}$) | $f_{FFA}$ (L mol-photons$^{-1}$) |
| Arbutus Lake | 10.63±0.10 | 8.32±0.06 | 12.75±0.18 | 12.59±1.19 | 8.62±0.05 | 9.23±0.65 | 8.35±0.50 |
| Big Moose Lake | 10.56±0.68 | 8.02±0.35 | 12.49±1.76 | 7.29±0.94 | 9.20±0.65 | 8.16±0.02 | 10.55±0.15 |
| Black Pond | 7.58±0.09 | 5.93±0.14 | 7.58±0.04 | 8.76±0.28 | 8.38±0.02 | 6.00±0.28 | 10.95±0.96 |
| Dart Lake | 10.37±0.05 | 7.34±0.01 | 11.39±0.11 | 13.61±0.04 | 8.61±0.10 | 9.93±0.01 | 14.58±1.23 |
| G Lake | 9.37±0.29 | 6.99±0.22 | 9.37±0.20 | 10.20±0.91 | 9.74±0.23 | 6.68±0.03 | 13.30±0.13 |
| Honnedaga Lake | 7.61±0.04 | 6.02±0.11 | 7.62±0.02 | 9.43±0.29 | 9.58±0.33 | 7.23±0.27 | 8.89±0.74 |
| Limekiln Lake | 8.53±0.58 | 6.15±0.22 | 9.35±0.59 | 8.41±0.42 | 9.88±0.11 | 10.24±0.51 | 11.71±0.20 |
| Little Hope Pond | 6.13±0.01 | 4.84±0.20 | 6.63±1.24 | 7.13±0.07 | 5.57±0.03 | 3.70±0.04 | 5.76±0.17 |
| Moss Lake | 7.56±0.19 | 5.41±0.28 | 8.09±0.17 | 5.79±0.26 | 8.28±0.55 | 8.00±0.36 | 10.59±0.45 |
| North Lake | 7.87±0.10 | 5.77±0.26 | 7.05±0.85 | 6.70±0.26 | 7.65±0.51 | 6.88±0.33 | 8.37±0.38 |
| Lake Rondaxe | 8.34±0.08 | 6.29±0.09 | 9.13±0.34 | 18.27±0.07 | 15.83±0.36 | 13.88±0.09 | 7.79±0.45 |
| Sagamore Lake | 6.55±0.08 | 5.18±0.08 | 6.66±0.26 | 8.07±0.07 | 5.90±0.02 | 5.58±0.08 | 6.36±0.49 |
| South Lake | 9.28±0.50 | 7.10±0.35 | 9.28±0.57 | 19.27±0.01 | 8.27±0.19 | 7.97±0.06 | 6.54±0.06 |
| Squaw Lake | 11.57±0.08 | 8.56±0.12 | 18.07±0.25 | 14.65±0.02 | 10.33±0.18 | 9.61±0.27 | 5.18±0.17 |
| Willis Lake | 8.71±0.11 | 6.52±0.10 | 10.01±0.54 | 9.44±0.55 | 7.12±0.25 | 7.16±0.03 | 5.25±0.16 |
| Wolf Lake | 13.27±0.28 | 9.98±0.03 | 13.28±0.14 | 20.69±0.24 | 7.85±0.78 | 9.79±0.26 | 7.45±0.06 |

Errors represent one standard deviation from duplicate or triplicate measurements. "Native + *t,t*-HDO" represents native Adirondack lake water samples spiked with 2 mM of *t,t*-HDO (see Section S10 *Effect of t,t-HDO on the formation of* $^{1}O_2$ *and* $^{3}DOM^{*}$).

## 8. 2,4,6-Trimethylphenol (TMP) as an electron transfer probe for $^3DOM^*$

TMP was spiked into samples to measure the photoproduction of $^3DOM^*_{TMP}$. For each sample, the loss of TMP was monitored to determine the pseudo-first order rate constant for the photodegradation of TMP, $k_{obs,\ TMP}$ ($s^{-1}$), with the contributions from direct photolysis of TMP[81] (negligible except for Al- and Fe-spiked samples 7.5±2.5%) and its limited reactions with $^{\bullet}OH$ (1.6±0.6%) and $^1O_2$ (6.0±1.2%):[45, 50, 82-89]

$$R_{loss,\ TMP} = -\frac{d[TMP]}{dt} = k_{obs,\ TMP}[TMP]$$

$$= k_{TMP,\ ^3DOM^*_{TMP}}[TMP][^3DOM^*_{TMP}]_{ss} + k_{direct\ photolysis,\ TMP}[TMP]SF_{\Sigma\lambda} + k_{TMP,\ ^1O_2}[TMP][^1O_2]_{ss} + k_{TMP,\ ^{\bullet}OH}[TMP][^{\bullet}OH]_{ss} \quad (S15)$$

where $R_{loss,\ TMP}$ (M $s^{-1}$) is the loss rate of TMP, [TMP] is the initial concentration of TMP (10 μM), $k_{TMP,\ ^3DOM^*_{TMP}}$ ($M^{-1}$ $s^{-1}$) is the second-order reaction rate constant of TMP with $^3DOM^*_{TMP}$, $[^3DOM^*_{TMP}]_{ss}$ is the steady-state concentration of $^3DOM^*_{TMP}$, $k_{direct\ photolysis,\ TMP}$ ($s^{-1}$) is the experimentally determined direct photolysis rate constant of TMP, $SF_{\Sigma\lambda}$ is the sample-specific light screening factor, $k_{TMP,\ ^1O_2}$ ($5.1(\pm0.2)\times10^7$ $M^{-1}$ $s^{-1}$) is the second-order reaction rate constant of TMP with $^1O_2$,[90] $[^1O_2]_{ss}$ is the steady-state concentration of $^1O_2$ measured by FFA, $k_{TMP,\ ^{\bullet}OH}$ ($1.6(\pm0.1)\times10^{10}$ $M^{-1}$ $s^{-1}$) is the second-order reaction rate constant of TMP with $^{\bullet}OH$ estimated by averaging the values measured for phenol and substituted phenols,[66, 91] and $[^{\bullet}OH]_{ss}$ is the steady-state concentration of $^{\bullet}OH$ measured by TPA.

To account for the inhibition of TMP loss by reduced moieties in DOM,[92-96] the pseudo-first order rate constant for the loss of TMP attributable to $^3DOM^*$ was further corrected for DOM-induced inhibition:[46, 50]

$$k^{corr}_{obs,\ TMP} = \frac{(k_{obs,\ TMP} - k_{direct\ photolysis,\ TMP}SF_{\Sigma\lambda} - k_{TMP,\ ^1O_2}[^1O_2]_{ss} - k_{TMP,\ ^{\bullet}OH}[^{\bullet}OH]_{ss})}{IF_{TMP}} \quad (S16)$$

where $k^{corr}_{obs,\ TMP}$ ($s^{-1}$) is the pseudo-first order rate constant for the loss of TMP attributable to $^3DOM^*$ corrected for inhibition and $IF_{TMP}$ is the sample-specific inhibition factor predicted from $1/IF_{TMP} = 0.021[DOC] + 0.965$ [46] using [DOC] for Adirondack lake water samples ($n$ = 16).

For each sample, the steady-state concentration of $^3DOM^*_{TMP}$, $[^3DOM^*_{TMP}]_{ss}$, was calculated as:[50, 80]

$$[{}^3\mathrm{DOM}^*_{\mathrm{TMP}}]_{\mathrm{ss}} = \frac{R_{\mathrm{f,\ ^3DOM^*_{TMP}}}}{k'_{\mathrm{q,\ ^3DOM^*_{TMP}}}} = \frac{k^{\mathrm{corr}}_{\mathrm{obs,\ TMP}}(k'_{\mathrm{q,\ ^3DOM^*_{TMP}}} + k_{\mathrm{TMP,\ ^3DOM^*_{TMP}}}[\mathrm{TMP}])}{k'_{\mathrm{q,\ ^3DOM^*_{TMP}}} k_{\mathrm{TMP,\ ^3DOM^*_{TMP}}}} \approx \frac{k^{\mathrm{corr}}_{\mathrm{obs,\ TMP}}}{k_{\mathrm{TMP,\ ^3DOM^*_{TMP}}}} \quad \text{(S17)}$$

where $R_{\mathrm{f,\ ^3DOM^*_{TMP}}}$ (M $s^{-1}$) is the formation rate of ${}^3\mathrm{DOM}^*_{\mathrm{TMP}}$, $k'_{\mathrm{q,\ ^3DOM^*_{TMP}}}$ ($3.0(\pm0.6)\times10^5$ $s^{-1}$; note that $k'_{\mathrm{q,\ ^3DOM^*_{TMP}}} \gg k_{\mathrm{TMP,\ ^3DOM^*_{TMP}}}[\mathrm{TMP}]$ with a maximum value of $8.5(\pm0.8)\times10^3$ $s^{-1}$ at [TMP] = 10 μM) is the sum of pseudo-first order rate constants for ${}^3\mathrm{DOM}^*_{\mathrm{TMP}}$ quenching via energy transfer to dissolved $O_2$ ($2.1(\pm0.2)\times10^5$ $s^{-1}$ calculated from $k_{O_2}[O_{2(aq)}]$ where $k_{O_2} = 8.9(\pm0.6)\times10^8$ $M^{-1}$ $s^{-1}$ and $[O_{2(aq)}]$ = ~236 μM at $T$ = 30 °C[97]) and via other non-$O_2$ dependent nonradiative relaxation pathways ($k^{\mathrm{T}}_{\mathrm{d}} = 9.0(\pm2.8)\times10^4$ $s^{-1}$).[95, 96]

To solve for $k_{\mathrm{TMP,\ ^3DOM^*_{TMP}}}$ (**Table S11**), a linear regression of [TMP] (at varying concentrations of 2, 5, 10, 20, and 50 μM) and $k^{\mathrm{corr}}_{\mathrm{obs,\ TMP}}$ data was performed using the linearized form of Equation S18 (i.e., $y = ax + b$ where $y = 1/k^{\mathrm{corr,IF}}_{\mathrm{obs,\ TMP}}$ and $x$ = [TMP]):[46, 50, 53, 98, 99]

$$\frac{1}{k^{\mathrm{corr}}_{\mathrm{obs,\ TMP}}} = \frac{[\mathrm{TMP}]}{R_{\mathrm{f,\ ^3DOM^*_{TMP}}}} + \frac{k'_{\mathrm{q,\ ^3DOM^*_{TMP}}}}{R_{\mathrm{f,\ ^3DOM^*_{TMP}}} k_{\mathrm{TMP,\ ^3DOM^*_{TMP}}}} \quad \text{(S18)}$$

The formation rate of ${}^3\mathrm{DOM}^*_{\mathrm{TMP}}$ (at [TMP] = 10 μM), $R_{\mathrm{f,\ ^3DOM^*_{TMP}}}$ (M $s^{-1}$), was calculated as:

$$R_{\mathrm{f,\ ^3DOM^*_{TMP}}} = [{}^3\mathrm{DOM}^*_{\mathrm{TMP}}]_{\mathrm{ss}} k'_{\mathrm{q,\ ^3DOM^*_{TMP}}} \quad \text{(S19)}$$

The apparent quantum yield of ${}^3\mathrm{DOM}^*_{\mathrm{TMP}}$, $\Phi_{\mathrm{app,\ ^3DOM^*_{TMP}}}$ (mol mol-photons$^{-1}$), was calculated as:[46, 50, 53, 100]

$$\Phi_{\mathrm{app,\ ^3DOM^*_{TMP}}} = \frac{R_{\mathrm{f,\ ^3DOM^*_{TMP}}}}{R_{\mathrm{a}}} \approx \frac{[{}^3\mathrm{DOM}^*_{\mathrm{TMP}}]_{\mathrm{ss}} k'_{\mathrm{q,\ ^3DOM^*_{TMP}}}}{R_{\mathrm{a}}} \quad \text{(S20)}$$

The quantum yield coefficient of ${}^3\mathrm{DOM}^*_{\mathrm{TMP}}$ with TMP, $f_{\mathrm{TMP}}$ (L mol-photons$^{-1}$), was calculated as:[48, 49, 80, 82, 87, 100-106]

$$f_{\mathrm{TMP}} = \Phi_{\mathrm{app,\ ^3DOM^*_{TMP}}} \times \frac{k_{\mathrm{TMP,\ ^3DOM^*_{TMP}}}}{k'_{\mathrm{q,\ ^3DOM^*_{TMP}}}} = \frac{k^{\mathrm{corr}}_{\mathrm{obs,\ TMP}}}{R_{\mathrm{a}}} \quad \text{(S21)}$$

A summary of $\Phi_{\mathrm{app,\ ^3DOM^*_{TMP}}}$ and $f_{\mathrm{TMP}}$ is provided in **Table S12**.

**Table S11.** Summary of $k_{TMP, {}^3DOM^*_{TMP}}$ data for native Adirondack lake water samples

| Sample Name | $k_{TMP, {}^3DOM^*_{TMP}}$ ($\times 10^{-8}$ $M^{-1}$ $s^{-1}$) |
|---|---|
| Arbutus Lake | 8.21±0.20 |
| Big Moose Lake | 7.91±0.72 |
| Black Pond | 8.85±0.33 |
| Dart Lake | 8.62±0.53 |
| G Lake | 9.20±0.92 |
| Honnedaga Lake | 9.09±0.91 |
| Limekiln Lake | 8.72±1.03 |
| Little Hope Pond | 7.21±0.85 |
| Moss Lake | 8.77±1.09 |
| North Lake | 7.16±0.98 |
| Lake Rondaxe | 9.76±1.98 |
| Sagamore Lake | 7.74±0.34 |
| South Lake | 9.28±1.98 |
| Squaw Lake | 9.27±2.98 |
| Willis Lake | 8.22±0.97 |
| Wolf Lake | 8.44±0.66 |
| **Average** | **8.53±0.75** |

Errors represent the 95% confidence intervals.

**Table S12.** Summary of $^3DOM^*_{TMP}$ data for native and altered Adirondack lake water samples

| Sample Name | Native | Native + *t,t*-HDO | pH 6.5 | pH 4.5 | pH 8.5 | pH 4.5 + Al | pH 8.5 + Fe |
|---|---|---|---|---|---|---|---|
| | $\Phi_{app,\ ^3DOM^*_{TMP}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) |
| Arbutus Lake | 3.43±0.13 | 1.78±0.12 | 3.30±0.06 | 2.78±0.33 | 2.04±0.19 | 2.29±0.11 | 2.68±0.18 |
| Big Moose Lake | 3.17±0.30 | 1.40±0.11 | 3.02±0.02 | 0.88±0.10 | 2.68±0.27 | 1.49±0.14 | 3.49±0.22 |
| Black Pond | 2.37±0.14 | 1.12±0.10 | 2.37±0.15 | 1.00±0.15 | 2.73±0.28 | 1.14±0.02 | 3.68±0.20 |
| Dart Lake | 2.98±0.10 | 1.25±0.08 | 2.31±0.18 | 3.02±0.29 | 2.72±0.31 | 1.84±0.01 | 3.76±0.22 |
| G Lake | 2.85±0.08 | 1.33±0.06 | 2.85±0.07 | 1.79±0.08 | 2.68±0.12 | 1.46±0.18 | 4.46±0.11 |
| Honnedaga Lake | 2.36±0.27 | 1.08±0.12 | 2.36±0.27 | 1.66±0.21 | 2.66±0.14 | 1.14±0.11 | 2.13±0.25 |
| Limekiln Lake | 3.02±0.28 | 1.31±0.09 | 3.53±0.29 | 2.03±0.15 | 3.19±0.24 | 1.92±0.13 | 3.52±0.25 |
| Little Hope Pond | 1.32±0.16 | 0.45±0.05 | 0.88±0.09 | 1.34±0.13 | 1.15±0.12 | 0.60±0.07 | 1.28±0.04 |
| Moss Lake | 2.53±0.30 | 1.02±0.05 | 2.06±0.13 | 1.15±0.12 | 2.75±0.33 | 1.76±0.10 | 3.27±0.32 |
| North Lake | 2.00±0.21 | 0.79±0.06 | 1.37±0.08 | 0.87±0.06 | 2.16±0.20 | 1.39±0.16 | 2.52±0.09 |
| Lake Rondaxe | 2.36±0.13 | 1.10±0.05 | 2.38±0.18 | 5.90±0.04 | 5.04±0.77 | 3.24±0.25 | 2.70±0.23 |
| Sagamore Lake | 1.43±0.16 | 0.55±0.05 | 1.37±0.09 | 1.29±0.08 | 1.31±0.09 | 1.07±0.09 | 1.61±0.09 |
| South Lake | 3.05±0.12 | 1.56±0.15 | 3.05±0.13 | 5.32±0.65 | 3.13±0.20 | 1.96±0.11 | 2.01±0.12 |
| Squaw Lake | 3.84±0.28 | 2.29±0.18 | 6.43±0.60 | 4.89±0.45 | 3.25±0.30 | 2.10±0.10 | 1.73±0.09 |
| Willis Lake | 2.68±0.06 | 1.12±0.09 | 2.29±0.17 | 1.19±0.12 | 2.23±0.08 | 1.44±0.17 | 1.70±0.21 |
| Wolf Lake | 4.75±0.49 | 2.99±0.07 | 4.75±0.49 | 6.85±0.61 | 3.07±0.43 | 2.55±0.24 | 2.95±0.18 |
| Sample Name | Native | Native + *t,t*-HDO | pH 6.5 | pH 4.5 | pH 8.5 | pH 4.5 + Al | pH 8.5 + Fe |
| | $f_{TMP}$ (L mol-photons$^{-1}$) | $f_{TMP}$ (L mol-photons$^{-1}$) | $f_{TMP}$ (L mol-photons$^{-1}$) | $f_{TMP}$ (L mol-photons$^{-1}$) | $f_{TMP}$ (L mol-photons$^{-1}$) | $f_{TMP}$ (L mol-photons$^{-1}$) | $f_{TMP}$ (L mol-photons$^{-1}$) |
| Arbutus Lake | 97.32±8.48 | 50.41±2.92 | 93.79±9.92 | 78.40±0.52 | 57.69±1.93 | 65.02±4.98 | 75.89±4.43 |
| Big Moose Lake | 89.62±2.77 | 39.68±1.82 | 85.88±10.02 | 24.84±0.37 | 75.65±1.93 | 42.11±1.30 | 98.92±6.15 |
| Black Pond | 67.23±4.27 | 31.59±1.05 | 67.22±4.25 | 28.04±0.70 | 77.20±1.72 | 32.36±3.35 | 104.15±7.38 |
| Dart Lake | 84.54±7.66 | 35.38±2.22 | 65.26±3.08 | 85.22±2.35 | 76.82±0.91 | 52.16±6.31 | 106.39±7.05 |
| G Lake | 81.07±12.21 | 37.59±3.01 | 81.07±12.17 | 50.82±4.14 | 76.05±5.97 | 41.13±0.01 | 126.53±12.5 |
| Honnedaga Lake | 66.66±0.74 | 30.36±0.37 | 66.65±0.71 | 46.89±0.23 | 75.24±5.37 | 32.28±0.81 | 60.14±0.49 |
| Limekiln Lake | 85.45±2.62 | 37.09±2.13 | 99.91±4.15 | 57.40±2.98 | 90.24±4.34 | 54.43±3.14 | 99.63±5.29 |
| Little Hope Pond | 37.18±0.16 | 12.62±0.20 | 24.98±0.70 | 37.90±0.93 | 32.44±0.71 | 16.86±0.02 | 36.45±3.52 |
| Moss Lake | 71.30±0.28 | 28.86±2.06 | 58.40±3.51 | 32.50±0.70 | 77.49±0.34 | 49.85±3.45 | 92.40±2.59 |
| North Lake | 56.54±1.18 | 22.39±1.01 | 38.86±2.45 | 24.65±1.25 | 60.97±1.94 | 39.31±0.48 | 71.37±6.47 |
| Lake Rondaxe | 66.98±4.57 | 31.18±2.44 | 67.25±3.19 | 167.67±22.0 | 142.01±4.17 | 91.74±4.49 | 76.24±2.93 |
| Sagamore Lake | 40.50±0.61 | 15.61±0.62 | 38.80±2.24 | 36.63±2.38 | 36.95±2.01 | 30.21±1.30 | 45.71±3.08 |
| South Lake | 86.38±7.23 | 44.05±1.38 | 86.38±7.20 | 150.03±0.46 | 88.59±5.29 | 55.64±3.79 | 56.95±3.56 |
| Squaw Lake | 108.66±5.68 | 64.76±3.04 | 181.78±5.81 | 138.21±4.54 | 91.85±3.00 | 59.61±4.55 | 49.14±3.57 |
| Willis Lake | 76.03±7.86 | 31.67±1.53 | 64.90±3.38 | 33.66±0.78 | 63.21±5.62 | 40.69±0.24 | 48.02±0.07 |
| Wolf Lake | 134.08±2.93 | 84.77±8.43 | 134.08±2.87 | 193.61±6.86 | 86.51±1.24 | 72.03±2.29 | 83.54±5.44 |

Errors represent one standard deviation from duplicate or triplicate measurements. "Native + *t,t*-HDO" represents native Adirondack lake water samples spiked with 2 mM of *t,t*-HDO (see Section S10 *Effect of t,t-HDO on the formation of* $^1O_2$ *and* $^3DOM^*$).

**9. *trans,trans*-2,4-Hexadien-1-ol (*t,t*-HDO) as an energy transfer probe for $^{3}DOM^{*}$**

*t,t*-HDO (i.e., sorbic alcohol) was spiked into samples to measure the photoproduction of $^{3}DOM^{*}_{HDO}$. Unlike the other commonly used conjugated diene probe *trans,trans*-hexadienoic acid (i.e., sorbic acid),[80, 107-110] *t,t*-HDO undergoes negligible direct photoisomerization under full spectrum sunlight conditions.[47, 105] Only native lake water samples were analyzed for $^{3}DOM^{*}_{HDO}$ due to limited sample volume. For each sample, the formation of three *t,t*-HDO isomers (i.e., *c,c*-HDO, *c,t*-HDO, and *t,c*-HDO) and the loss of *t,t*-HDO were monitored to derive the overall production rate of four isomers, $R_{\text{prod, HDO}}$ ($\text{M s}^{-1}$), for each initial *t,t*-HDO concentration:[47, 107]

$$\begin{aligned} R_{\text{prod, HDO}} &= \frac{\text{d[HDO]}}{\text{dt}} = R_{\text{f, }c,t\text{-HDO}} + R_{\text{f, }c,c\text{-HDO}} + R_{\text{f, }t,c\text{-HDO}} + R_{\text{f, }t,t\text{-HDO}} \\ &= \frac{\text{d}[c,t\text{-HDO}]}{\text{dt}} + \frac{\text{d}[c,c\text{-HDO}]}{\text{dt}} + \frac{\text{d}[t,c\text{-HDO}]}{\text{dt}} + \frac{\text{d}[t,t\text{-HDO}]}{\text{dt}} \end{aligned} \tag{S22}$$

where $R_{\text{f, }c,t\text{-HDO}}$ ($\text{M s}^{-1}$) is the formation rate of *c,t*-HDO, $R_{\text{f, }c,c\text{-HDO}}$ ($\text{M s}^{-1}$) is the formation rate of *c,c*-HDO, $R_{\text{f, }t,c\text{-HDO}}$ ($\text{M s}^{-1}$) is the formation rate of *t,c*-HDO, and $R_{\text{f, }t,t\text{-HDO}}$ ($\text{M s}^{-1}$) is the *reformation* rate of *t,t*-HDO upon the relaxation of the excited triplet state of *t,t*-HDO (i.e., *t,t*-HDO$^{*}$).

To determine the rate constant for *t,t*-HDO reformation relative to that of *c,t*-HDO, a multiple linear regression of the *t,t*-HDO and *c,t*-HDO data in the initial rate kinetics regime was performed using Equation S23 (i.e., $y = ax_1 + bx_2$ where $y = \text{d}[t,t\text{-HDO}]/\text{dt}$, $x_1 = \text{d}[c,t\text{-HDO}]/\text{dt}$, and $x_2 = [t,t\text{-HDO}]$):[47, 107]

$$\frac{\text{d}[t,t\text{-HDO}]}{\text{dt}} = \frac{k_{t,t\text{-HDO}}}{k_{c,t\text{-HDO}}}\frac{\text{d}[c,t\text{-HDO}]}{\text{dt}} - k'_{t,t\text{-HDO}}[t,t\text{-HDO}] \tag{S23}$$

where $k_{t,t\text{-HDO}}$ ($\text{s}^{-1}$) is the pseudo-first order rate constant for *t,t*-HDO reformation from *t,t*-HDO$^{*}$, $k_{c,t\text{-HDO}}$ ($\text{s}^{-1}$) is the pseudo-first order rate constant for *c,t*-HDO formation from *t,t*-HDO$^{*}$, $k'_{t,t\text{-HDO}}$ ($\text{s}^{-1}$) is the sum of pseudo-first-order rate constants for the reaction of *t,t*-HDO with $^{3}DOM^{*}$ to form *t,t*-HDO$^{*}$ and reactions of *t,t*-HDO with other scavengers under steady-state conditions (e.g., $^{\bullet}OH$ and $^{1}O_2$[47]), and [*t,t*-HDO] is the initial concentration of *t,t*-HDO.

To approximate the sample-specific *t,t*-HDO reformation, a representative relative rate constant (i.e., $k_{t,t\text{-HDO}}/k_{c,t\text{-HDO}}$) of 2.74±0.36 was derived by regressing Equation S20 with data from all Adirondack lake water samples. This relative rate constant was close to that (2.88±0.90) determined for a Suwannee river natural organic matter solution (5 mg C/L at pH 7) under similar irradiation conditions.

For each sample, the steady-state concentration of $^3DOM^*$ in the *presence* of *t,t*-HDO, $[^3DOM^*_{HDO}]_{ss}$, was calculated by considering the formation of $^3DOM^*_{HDO}$ and the simultaneous quenching by *t,t*-HDO and other deactivation processes:[47]

$$[^3\mathrm{DOM}^*_{\mathrm{HDO}}]_{\mathrm{ss}} = \frac{R_{\mathrm{f},\,^3\mathrm{DOM}^*_{\mathrm{HDO}}}}{k_{t,t\text{-HDO},\,^3\mathrm{DOM}^*_{\mathrm{HDO}}}[t,t\text{-HDO}] + k'_{\mathrm{q},\,^3\mathrm{DOM}^*_{\mathrm{HDO}}}} \quad \text{(S24)}$$

where $R_{f,\,^3DOM^*_{HDO}}$ ($M\ s^{-1}$) is the formation rate of $^3DOM^*_{HDO}$, $k_{t,t\text{-HDO},\,^3DOM^*_{HDO}}$ ($M^{-1}\ s^{-1}$) is the second-order reaction rate constant of *t,t*-HDO with $^3DOM^*_{HDO}$, and $k'_{q,\,^3DOM^*_{HDO}}$ ($3.0(\pm0.6)\times10^5\ s^{-1}$) is the sum of pseudo-first order rate constants for $^3DOM^*_{HDO}$ quenching via energy transfer to dissolved $O_2$ ($2.1(\pm0.2)\times10^5\ s^{-1}$ calculated from $k_{O_2}[O_{2(aq)}]$ where $k_{O_2} = 8.9(\pm0.6)\times10^8\ M^{-1}\ s^{-1}$ and $[O_{2(aq)}] = \sim236\ \mu M$ at $T = 30$ °C[97]) and via other non-$O_2$ dependent nonradiative relaxation pathways ($k_d^T = 9.0(\pm2.8)\times10^4\ s^{-1}$).[90, 105]

To solve for $k_{t,t\text{-HDO},\,^3DOM^*_{HDO}}$ (**Table S13**), a linear regression of [*t,t*-HDO] (at varying concentrations of 50, 100, 250, 500, 1000, and 2500 μM) and $R_{p,\ HDO}$ data was performed with the linearized form of Equation S25 (i.e., $y = ax + b$ where $y = [t,t\text{-HDO}]/R_{p,\ HDO}$ and $x = [t,t\text{-HDO}]$):[47]

$$\frac{[t,t\text{-HDO}]}{R_{\mathrm{p,\ HDO}}} = \frac{[t,t\text{-HDO}]}{R_{\mathrm{f},\,^3\mathrm{DOM}^*_{\mathrm{HDO}}}} + \frac{k'_{\mathrm{q},\,^3\mathrm{DOM}^*_{\mathrm{HDO}}}}{R_{\mathrm{f},\,^3\mathrm{DOM}^*_{\mathrm{HDO}}} k_{t,t\text{-HDO},\,^3\mathrm{DOM}^*_{\mathrm{HDO}}}} \quad \text{(S25)}$$

The formation rate of $^3DOM^*_{HDO}$, $R_{f,\,^3DOM^*_{HDO}}$ ($M\ s^{-1}$), was calculated as:

$$R_{\mathrm{f},\,^3\mathrm{DOM}^*_{\mathrm{HDO}}} = \frac{1}{\mathrm{slope}} \quad \text{(S26)}$$

For each sample, the steady-state concentration of $^3DOM^*$ in the *absence* of *t,t*-HDO, $[^3DOM^*_{HDO}]_{ss}$, was calculated as:

$$[^3\mathrm{DOM}^*_{\mathrm{HDO}}]_{\mathrm{ss}} = \frac{R_{\mathrm{f},\,^3\mathrm{DOM}^*_{\mathrm{HDO}}}}{k'_{\mathrm{q},\,^3\mathrm{DOM}^*_{\mathrm{HDO}}}} = \frac{1}{k'_{\mathrm{q},\,^3\mathrm{DOM}^*_{\mathrm{HDO}}}}\frac{1}{\mathrm{slope}} \quad \text{(S27)}$$

The apparent quantum yield of $^3DOM^*_{HDO}$, $\Phi_{app,\ ^3DOM^*_{HDO}}$ (mol mol-photons$^{-1}$), was calculated as:[47]

$$\Phi_{app,\ ^3DOM^*_{HDO}} = \frac{R_{f,\ ^3DOM^*_{HDO}}}{R_a} = \frac{1}{R_a}\frac{1}{slope} \tag{S28}$$

The quantum yield coefficient of $^3DOM^*_{HDO}$ with *t,t*-HDO, $f_{HDO}$ (L mol-photons$^{-1}$), was calculated as:

$$f_{HDO} = \Phi_{app,\ ^3DOM^*_{HDO}} \times \frac{k_{t,t\text{-HDO},\ ^3DOM^*_{HDO}}}{k'_{q,\ ^3DOM^*_{HDO}}} = \frac{1}{R_a intercept} \tag{S29}$$

A summary of $\Phi_{app,\ ^3DOM^*_{HDO}}$ and $f_{HDO}$ is provided in **Table S14**.

**Table S13.** Summary of $k_{t,t\text{-HDO},\ ^3DOM^*_{HDO}}$ data for native Adirondack lake water samples

| Sample Name | $k_{t,t\text{-HDO},\ ^3DOM^*_{HDO}}$ ($\times 10^{-8}$ M$^{-1}$ s$^{-1}$) |
|---|---|
| Arbutus Lake | 7.14±1.21 |
| Big Moose Lake | 6.53±1.07 |
| Black Pond | 8.95±1.50 |
| Dart Lake | 7.61±1.27 |
| G Lake | 9.08±1.50 |
| Honnedaga Lake | 8.70±1.56 |
| Limekiln Lake | 8.05±1.45 |
| Little Hope Pond | 5.91±0.96 |
| Moss Lake | 7.90±1.33 |
| North Lake | 5.88±0.96 |
| Lake Rondaxe | 9.91±1.62 |
| Sagamore Lake | 6.52±1.09 |
| South Lake | 9.86±1.63 |
| Squaw Lake | 9.78±1.59 |
| Willis Lake | 7.02±1.15 |
| Wolf Lake | 9.63±1.76 |
| **Average** | **8.03±1.43** |

Errors represent the 95% confidence intervals.

**Table S14.** Summary of $^3DOM^*_{HDO}$ data for native Adirondack lake water samples

| Sample Name | $\Phi_{app,\ ^3DOM^*_{HDO}}$ ($\times 10^{-2}$ mol mol-photons$^{-1}$) | $f_{HDO}$ (L mol-photons$^{-1}$) |
|---|---|---|
| Arbutus Lake | 0.91±0.01 | 22.18±1.49 |
| Big Moose Lake | 1.00±0.01 | 22.19±1.00 |
| Black Pond | 0.58±0.03 | 17.71±0.42 |
| Dart Lake | 0.94±0.01 | 23.58±1.04 |
| G Lake | 0.94±0.01 | 29.07±1.32 |
| Honnedaga Lake | 0.57±0.02 | 17.25±1.47 |
| Limekiln Lake | 0.84±0.01 | 21.78±2.06 |
| Little Hope Pond | 0.39±0.01 | 7.71±0.14 |
| Moss Lake | 0.68±0.01 | 17.54±0.78 |
| North Lake | 0.68±0.02 | 13.26±0.36 |
| Lake Rondaxe | 0.74±0.03 | 24.40±1.04 |
| Sagamore Lake | 0.43±0.02 | 9.57±0.22 |
| South Lake | 0.83±0.01 | 27.09±0.71 |
| Squaw Lake | 1.04±0.01 | 34.05±0.12 |
| Willis Lake | 0.71±0.02 | 16.47±0.58 |
| Wolf Lake | 1.22±0.05 | 40.92±3.51 |

Errors represent one standard deviation from duplicate measurements.

## 10. Effect of *t,t*-HDO on the formation of $^1O_2$ and $^3DOM^*$

*t,t*-HDO (2 mM) was spiked into FFA- or TMP-containing (10 μM) native Adirondack lake water samples to preferentially quench high-energy $^3DOM^*$ (i.e., $^3DOM^*$ with $E_T \geq 250$ kJ mol$^{-1}$)[111] such that the contribution of $^3DOM^*$ capable of sensitizing the isomerization of *t,t*-HDO to the formation of $^3DOM^*$ capable of oxidizing TMP and/or producing $^1O_2$ could be determined (**Table S15**).[105] The percentage contribution of $^3DOM^*_{HDO}$ to $\Phi_{app,\ ^1O_2}$, the percentage contribution of $^3DOM^*_{HDO}$ to $\Phi_{app,\ ^3DOM^*_{TMP}}$, and the yield of $^1O_2$ from the $O_2$-dependent quenching of $^3DOM^*_{HDO}$ were calculated as:[105]

$$\%\Phi_{app,\ ^1O_2\_^3DOM^*_{HDO}} = \frac{(\Phi_{app,\ ^1O_2} - \Phi_{app,\ ^1O_2,\ HDO})}{\Phi_{app,\ ^1O_2}} \times 100\% \qquad (S30)$$

$$\%\Phi_{app,\ ^3DOM^*_{TMP}\_^3DOM^*_{HDO}} = \frac{(\Phi_{app,\ ^3DOM^*_{TMP}} - \Phi_{app,\ ^3DOM^*_{TMP},\ HDO})}{\Phi_{app,\ ^3DOM^*_{TMP}}} \times 100\% \qquad (S31)$$

$$f_{^1O_2\_^3DOM^*_{HDO}} = \frac{\Phi_{app,\ ^1O_2}(k_{O_2}[O_{2(aq)}] + k_d^T)}{\Phi_{app,\ ^3DOM^*_{HDO}} k_{O_2}[O_{2(aq)}]} \qquad (S32)$$

**Table S15.** Summary of *t,t*-HDO quenching data for native Adirondack lake water samples

| Sample Name | $\%\Phi_{app,\ ^1O_2\_^3DOM^*_{HDO}}$ | $\%\Phi_{app,\ ^3DOM^*_{TMP}\_^3DOM^*_{HDO}}$ | $f_{^1O_2\_^3DOM^*_{HDO}}$ |
|---|---|---|---|
| Arbutus Lake | 22.0±2.9 | 48.2±2.5 | 0.91±0.02 |
| Big Moose Lake | 24.0±0.7 | 56.3±7.5 | 0.90±0.01 |
| Black Pond | 22.1±3.0 | 53.1±4.6 | 1.02±0.07 |
| Dart Lake | 29.4±3.3 | 58.1±2.8 | 1.15±0.01 |
| G Lake | 25.9±4.2 | 53.5±2.0 | 0.91±0.02 |
| Honnedaga Lake | 21.2±2.7 | 55.2±8.8 | 1.00±0.05 |
| Limekiln Lake | 27.8±0.7 | 57.2±7.6 | 1.00±0.01 |
| Little Hope Pond | 21.2±2.5 | 67.1±11.4 | 1.18±0.01 |
| Moss Lake | 29.0±4.5 | 60.6±10.3 | 1.14±0.01 |
| North Lake | 27.1±3.7 | 61.1±9.0 | 1.11±0.04 |
| Lake Rondaxe | 24.9±3.3 | 53.6±4.3 | 0.99±0.06 |
| Sagamore Lake | 21.1±2.2 | 62.3±9.6 | 1.13±0.07 |
| South Lake | 23.4±1.0 | 48.9±2.8 | 0.93±0.01 |
| Squaw Lake | 26.1±2.9 | 40.6±4.1 | 1.03±0.02 |
| Willis Lake | 25.3±2.6 | 58.2±1.7 | 1.11±0.04 |
| Wolf Lake | 25.2±3.7 | 37.5±5.4 | 0.97±0.06 |
| **Average** | **24.7±2.8** | **54.5±7.7** | **1.03±0.10** |

Errors represent one standard deviation from duplicate measurements.

## 11. Summary of literature data on the apparent quantum yields of RIs

**Table S16.** Summary of literature $\Phi_{app,RI}$ data

| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^{\bullet}OH}$ ($\times10^{-6}$ mol mol-photons$^{-1}$) |
|---|---|---|---|---|---|---|---|
| Ref 87 | Hockanum River upstream | Whole Water (River) | 365 or 300-400 | 2.27 | 1.80 | NA | NA |
| | Hockanum downstream wastewater treatment plant | Whole Water (WWTP-River) | 365 or 300-400 | 2.27 | 2.20 | NA | NA |
| | Hockanum upstream | PPL Extract (River) | 365 or 300-400 | 1.49 | 3.05 | NA | NA |
| | Hockanum downstream wastewater treatment plant | PPL Extract (WWTP-River) | 365 or 300-400 | 1.85 | 3.46 | NA | NA |
| | Hockanum 2012 upstream | PPL Extract (River) | 365 or 300-400 | 3.47 | 4.40 | NA | NA |
| | Hockanum 2012 effluent organic matter (EfOM) | PPL Extract (WWTP Effluent) | 365 or 300-400 | 12.73 | 9.76 | NA | NA |
| | East Fork Little (EFL) Miami upstream | Whole Water (River) | 365 or 300-400 | 3.74 | 3.36 | NA | NA |
| | EFL Miami downstream wastewater treatment plant | Whole Water (WWTP-River) | 365 or 300-400 | 3.75 | 3.40 | NA | NA |
| | EFL Miami upstream | PPL Extract (River) | 365 or 300-400 | 2.30 | 3.99 | NA | NA |
| | EFL Miami downstream wastewater treatment plant | PPL Extract (WWTP-River) | 365 or 300-400 | 2.03 | 4.04 | NA | NA |
| | EFL Miami 2012 upstream | PPL Extract (River) | 365 or 300-400 | 2.29 | 2.47 | NA | NA |
| | EFL Miami 2012 EfOM | PPL Extract (WWTP Effluent) | 365 or 300-400 | 2.20 | 3.08 | NA | NA |
| | Pomperaug upstream | Whole Water (River) | 365 or 300-400 | 2.93 | 2.30 | NA | NA |
| | Pomperaug downstream wastewater treatment plant | Whole Water (WWTP-River) | 365 or 300-400 | 1.53 | 2.81 | NA | NA |
| | Pomperaug upstream | PPL Extract (River) | 365 or 300-400 | 1.32 | 2.74 | NA | NA |
| | Pomperaug downstream wastewater treatment plant | PPL Extract (WWTP-River) | 365 or 300-400 | 1.12 | 2.21 | NA | NA |
| | Pomperaug 2013 upstream | PPL Extract (River) | 365 or 300-400 | 1.80 | 3.00 | NA | NA |
| | Pomperaug 2013 EfOM | PPL Extract (WWTP Effluent) | 365 or 300-400 | 4.84 | 5.00 | NA | NA |
| | Pomperaug 2012 upstream | PPL Extract (River) | 365 or 300-400 | 3.31 | 3.60 | NA | NA |
| | Pomperaug 2011 upstream | PPL Extract (River) | 365 or 300-400 | 1.40 | 2.80 | NA | NA |
| | Pony Lake fulvic acid (PLFA) | IHSS Isolate (PLFA) | 365 or 300-400 | 1.03 | 2.65 | NA | NA |
| | Suwannee River natural organic matter (SRNOM) | IHSS Isolate (SRNOM) | 365 or 300-400 | 1.28 | 1.97 | NA | NA |
| | Suwannee River fulvic acid (SRFA) | IHSS Isolate (SRFA) | 365 or 300-400 | 1.46 | 2.43 | NA | NA |
| | Suwannee River humic acid (SRHA) | IHSS Isolate (SRHA) | 365 or 300-400 | 0.74 | 1.72 | NA | NA |
| | Nordic aquatic fulvic acid (NFA) | IHSS Isolate (NFA) | 365 or 300-400 | 0.80 | 1.07 | NA | NA |
| | Nordic aquatic humic acid (NHA) | IHSS Isolate (NHA) | 365 or 300-400 | 0.40 | 1.41 | NA | NA |
| | Wakish Peat humic acid (WPHA) | IHSS Isolate (WPHA) | 365 or 300-400 | 0.38 | 1.15 | NA | NA |
| Ref 82 | SRFA | IHSS Isolate (SRFA) | 313 | 4.00 | NA | NA | NA |
| | Fluka Humic Acid (Fluka HA) | XAD Fraction (Soil) | 313 | 2.81 | NA | NA | NA |
| | Greifensee | Whole Water (Lake) | 313 | 11.96 | NA | NA | NA |
| | SRFA | IHSS Isolate (SRFA) | 366 | 0.80 | NA | NA | NA |
| | Fluka HA | XAD Fraction (Soil) | 366 | 1.33 | NA | NA | NA |
| | Greifensee | Whole Water (Lake) | 366 | 3.85 | NA | NA | NA |
| Ref 112 | SRNOM | IHSS Isolate (SRNOM) | 290-400 | NA | 2.87 | NA | 12.5 |
| | SRNOM hydrophobic acid (HPOA) | XAD Fraction (River) | 290-400 | NA | 2.74 | NA | 9.5 |
| | SRNOM transphilic acid (TPIA) | XAD Fraction (River) | 290-400 | NA | 6.54 | NA | 16.5 |
| Ref 113 | Lake Bemidji | Whole Water (Lake) | 275-600 | 1.88 | 3.14 | NA | 17.2 |
| | Blandin Reservoir | Whole Water (Lake) | 275-600 | 0.75 | 1.98 | NA | NA |
| | Burntside Lake | Whole Water (Lake) | 275-600 | 0.75 | 1.70 | NA | NA |

| **Table S16.** Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^{\bullet}OH}$ (×10$^{-6}$ mol mol-photons$^{-1}$) |
| Ref 113 | Gull Lake | Whole Water (Lake) | 275-600 | 1.51 | 2.73 | NA | 15.6 |
| | Island Lake | Whole Water (Lake) | 275-600 | 1.08 | 2.37 | NA | NA |
| | Lake Itasca | Whole Water (Lake) | 275-600 | 1.36 | 2.91 | NA | NA |
| | Mille Lacs Lake | Whole Water (Lake) | 275-600 | 1.13 | 1.91 | NA | NA |
| | Rainy Lake | Whole Water (Lake) | 275-600 | 0.75 | 1.59 | NA | 16.8 |
| | Shagawa Lake | Whole Water (Lake) | 275-600 | 0.76 | 1.87 | NA | 14.4 |
| | South Sturgeon Lake | Whole Water (Lake) | 275-600 | 0.19 | 0.95 | NA | 9.4 |
| | Sturgeon Lake | Whole Water (Lake) | 275-600 | 0.92 | 1.99 | NA | 15.6 |
| | Lake Vermilion (Big Bay) | Whole Water (Lake) | 275-600 | 0.86 | 2.06 | NA | 16.6 |
| | Lake Vermilion (Pike Bay) | Whole Water (Lake) | 275-600 | 0.36 | 1.20 | NA | 17.5 |
| | White Iron Lake - South | Whole Water (Lake) | 275-600 | 0.39 | 1.18 | NA | 14.8 |
| | Lake Winnibigosh | Whole Water (Lake) | 275-600 | 1.46 | 2.28 | NA | NA |
| | Upper Red Lake #1 | Whole Water (Lake) | 275-600 | 1.95 | 3.18 | NA | 19.1 |
| | Upper Red Lake #2 | Whole Water (Lake) | 275-600 | 0.36 | 1.25 | NA | 26.8 |
| | Lake of the Woods (Muskeg Bay) | Whole Water (Lake) | 275-600 | 0.73 | 1.94 | NA | 19.3 |
| | Lake of the Woods (Fourmile Bay) | Whole Water (Lake) | 275-600 | 0.45 | 1.15 | NA | 16.7 |
| | Crystal Lake | Whole Water (Lake) | 275-600 | 1.33 | 2.42 | NA | 13.7 |
| | Detroit Lake | Whole Water (Lake) | 275-600 | 1.90 | 2.99 | NA | 15.8 |
| | Mississippi River | Whole Water (River) | 275-600 | 0.96 | 2.35 | NA | 23.3 |
| | Vadnais Lake | Whole Water (Lake) | 275-600 | 1.29 | 2.78 | NA | 7.2 |
| | Lake Saint Croix | Whole Water (Lake) | 275-600 | 0.65 | 1.87 | NA | 16.1 |
| Ref 114 | SRNOM pH 4.3 | IHSS Isolate (SRNOM) | 365 | NA | 1.00 | NA | NA |
| | SRNOM pH 5.0 | IHSS Isolate (SRNOM) | 365 | NA | 0.97 | NA | NA |
| | SRNOM pH 6.1 | IHSS Isolate (SRNOM) | 365 | NA | 0.88 | NA | NA |
| | SRNOM pH 7.6 | IHSS Isolate (SRNOM) | 365 | NA | 0.77 | NA | NA |
| Ref 115 | SRFA | IHSS Isolate (SRFA) | 350 | NA | 0.47 | NA | NA |
| | PLFA | IHSS Isolate (PLFA) | 350 | NA | 0.69 | NA | NA |
| Ref 79 | Pony Lake tangential flow ultrafiltration (TFUF) | UF Fraction (Lake) | 365 | NA | 0.59 | NA | NA |
| | NHA | IHSS Isolate (NHA) | 365 | NA | 1.18 | NA | NA |
| | Lake Toolik TFUF | UF Fraction (Lake) | 365 | NA | 1.26 | NA | NA |
| | SRNOM | IHSS Isolate (SRNOM) | 365 | NA | 1.53 | NA | NA |
| | SRNOM | IHSS Isolate (SRNOM) | 365 | NA | 1.81 | NA | NA |
| | SRNOM | IHSS Isolate (SRNOM) | 365 | NA | 1.82 | NA | NA |
| | NFA | IHSS Isolate (NFA) | 365 | NA | 2.03 | NA | NA |
| | SRNOM | IHSS Isolate (SRNOM) | 365 | NA | 2.38 | NA | NA |
| | Nordic Lake natural organic matter (NLNOM) | IHSS Isolate (NLNOM) | 365 | NA | 2.48 | NA | NA |
| | Lake Anna XAD (LAX) HOPA | XAD Fraction (Lake) | 365 | NA | 2.81 | NA | NA |
| | Pony Lake XAD HOPA | XAD Fraction (Lake) | 365 | NA | 3.01 | NA | NA |
| | Rappahannock River XAD (RR5X) HOPA | XAD Fraction (River) | 365 | NA | 3.24 | NA | NA |
| | Rappahannock River XAD (RR3X) HOPA | XAD Fraction (River) | 365 | NA | 3.25 | NA | NA |
| | Rappahannock River UF (RR5UFR) | UF Fraction (River) | 365 | NA | 3.34 | NA | NA |
| | Lake Anna UF (LAUFR) | UF Fraction (Lake) | 365 | NA | 4.02 | NA | NA |

| Table S16. Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app, ^3DOM^*_{TMP}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app, ^1O_2}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app, ^3DOM^*_{Sorbate}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app, ^{\cdot}OH}$ (×10$^{-6}$ mol mol-photons$^{-1}$) |
| Ref 79 | Lake Toolik XAD HOPA | XAD Fraction (Lake) | 365 | NA | 4.14 | NA | NA |
| | Rappahannock River XAD (RR3X) HOPA | XAD Fraction (River) | 365 | NA | 3.65 | NA | NA |
| | Rappahannock River XAD (RR5X) HOPA | XAD Fraction (River) | 365 | NA | 4.50 | NA | NA |
| Ref 116 | Lago Nero | Whole Water (Lake) | 300-500 | 0.35 | NA | NA | NA |
| | Lago Verde | Whole Water (Lake) | 300-500 | 0.91 | NA | NA | NA |
| | Lago della Foppa | Whole Water (Lake) | 300-500 | 2.00 | NA | NA | NA |
| | Lago Nivolet | Whole Water (Lake) | 300-500 | 0.60 | NA | NA | NA |
| | Lago Rosset | Whole Water (Lake) | 300-500 | 0.50 | NA | NA | NA |
| | Lago Soprano | Whole Water (Lake) | 300-500 | 0.36 | NA | NA | NA |
| | Lago Sottano | Whole Water (Lake) | 300-500 | 0.31 | NA | NA | NA |
| | Lago Rouen | Whole Water (Lake) | 300-500 | NA | NA | NA | NA |
| Ref 117 | II-10B | Whole Water (Lake) | 295-600 | 26.00 | NA | NA | NA |
| | II-10B_2 | Whole Water (Lake) | 295-600 | 19.00 | 0.42 | NA | NA |
| | EP-14 | Whole Water (Lake) | 295-600 | 6.50 | 6.60 | NA | 180.0 |
| | EP-15A | Whole Water (Lake) | 295-600 | 11.00 | 0.46 | NA | 207.0 |
| | TF-20_1 | Whole Water (Lake) | 295-600 | 2.70 | 0.76 | NA | 130.0 |
| | TF-20_2 | Whole Water (Lake) | 295-600 | 20.00 | 7.02 | NA | 613.0 |
| | GW lake | Whole Water (Lake) | 295-600 | 4.80 | 0.71 | NA | 141.0 |
| | CA lake | Whole Water (Lake) | 300-500 | 9.70 | NA | NA | 34.0 |
| Ref 118 | WW A | Whole Water (WWTP Effluent) | 290-400 | NA | NA | NA | 60.6 |
| | WW B | Whole Water (WWTP Effluent) | 290-400 | NA | NA | NA | 97.8 |
| | WW C | Whole Water (WWTP Effluent) | 290-400 | NA | NA | NA | 80.6 |
| | SRNOM | IHSS Isolate (SRNOM) | 290-400 | NA | NA | NA | 42.4 |
| | SRFA | IHSS Isolate (SRFA) | 290-400 | NA | NA | NA | 38.4 |
| | SRHA | IHSS Isolate (SRHA) | 290-400 | NA | NA | NA | 29.9 |
| | PLFA | IHSS Isolate (PLFA) | 290-400 | NA | NA | NA | 45.6 |
| Ref 119 | BAN 13 (FA) Bansee lake | XAD Fraction (Lake) | 366 | NA | 3.00 | NA | NA |
| | BAN 13 (FA) | XAD Fraction (Lake) | 366 | NA | 2.10 | NA | NA |
| | BAN 13 (FA) | XAD Fraction (Lake) | 366 | NA | 1.50 | NA | NA |
| | BAN 13 (HA) | XAD Fraction (Lake) | 366 | NA | 2.00 | NA | NA |
| | BM 4 (FA) Brunnensee bog lake | XAD Fraction (Lake) | 366 | NA | 1.60 | NA | NA |
| | BM 4 (FA/1) | XAD Fraction (Lake) | 366 | NA | 1.60 | NA | NA |
| | BM 7 (FA) | XAD Fraction (Lake) | 366 | NA | 1.00 | NA | NA |
| | ZIL 1 (FA) Zillhamer See lake | XAD Fraction (Lake) | 366 | NA | 2.60 | NA | NA |
| | ZIL 1 (FA) | XAD Fraction (Lake) | 366 | NA | 1.70 | NA | NA |
| | SRFA | IHSS Isolate (SRFA) | 366 | NA | 1.80 | NA | NA |
| | SRFA | IHSS Isolate (SRFA) | 366 | NA | 1.00 | NA | NA |
| | ERD (FA) Soil fulvic acid material | XAD Fraction (Soil) | 366 | NA | 3.00 | NA | NA |
| Ref 120 | SRFA | IHSS Isolate (SRFA) | 366 | 1.89 | NA | NA | NA |
| | Greifensee | Whole Water (Lake) | 366 | 6.85 | NA | NA | NA |
| Ref 99 | SRFA | IHSS Isolate (SRFA) | 190-820 | 2.00 | NA | NA | NA |
| | SRFA reduced | IHSS Isolate (SRFA, $NaBH_4$) | 190-820 | 1.40 | NA | NA | NA |

| Table S16. Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^{\cdot}OH}$ ($\times10^{-6}$ mol mol-photons$^{-1}$) |
| Ref 99 | SRHA | IHSS Isolate (SRHA) | 190-820 | 0.53 | NA | NA | NA |
| | SRHA reduced | IHSS Isolate (SRHA, $NaBH_4$) | 190-820 | 0.60 | NA | NA | NA |
| | Delaware Bay Upper Bay Station (UBS) | C18 Extract (Estuary) | 190-820 | 1.20 | NA | NA | NA |
| | UBS reduced | C18 Extract (Estuary, $NaBH_4$) | 190-820 | 0.95 | NA | NA | NA |
| | Delaware Bay Lower Bay Station (LBS) | C18 Extract (Estuary) | 190-820 | 1.50 | NA | NA | NA |
| | LBS reduced | C18 Extract (Estuary, $NaBH_4$) | 190-820 | 1.60 | NA | NA | NA |
| | Delaware Bay Shelf Station (SS) | C18 Extract (Estuary) | 190-820 | 2.60 | NA | NA | NA |
| | SS reduced | C18 Extract (Estuary, $NaBH_4$) | 190-820 | 2.40 | NA | NA | NA |
| Ref 121 | Fluka HA | XAD Fraction (Soil) | 366 | NA | 0.49 | NA | NA |
| | Fluka HA | XAD Fraction (Soil) | 405 | NA | 0.50 | NA | NA |
| | Fluka HA | XAD Fraction (Soil) | 436 | NA | 0.48 | NA | NA |
| | Fluka HA | XAD Fraction (Soil) | 546 | NA | 0.50 | NA | NA |
| | Black Lake Humic Acid | XAD Fraction (Lake) | 366 | NA | 1.00 | NA | NA |
| | Black Lake Humic Acid | XAD Fraction (Lake) | 405 | NA | 1.30 | NA | NA |
| | Black Lake Humic Acid | XAD Fraction (Lake) | 436 | NA | 1.20 | NA | NA |
| | Black Lake Humic Acid | XAD Fraction (Lake) | 546 | NA | 0.51 | NA | NA |
| | Lake Baldegg DOM Concentrate | RO Isolate (Lake) | 366 | NA | 2.60 | NA | NA |
| | Lake Baldegg DOM Concentrate | RO Isolate (Lake) | 405 | NA | 2.30 | NA | NA |
| | Lake Baldegg DOM Concentrate | RO Isolate (Lake) | 436 | NA | 2.00 | NA | NA |
| | Lake Baldegg DOM Concentrate | RO Isolate (Lake) | 546 | NA | 1.10 | NA | NA |
| Ref 85 | Elliott soil fulvic acid (ESFA) | IHSS Isolate (ESFA) | 320 | NA | 0.14 | NA | NA |
| | ESFA | IHSS Isolate (ESFA) | 340 | NA | 0.14 | NA | NA |
| | ESFA | IHSS Isolate (ESFA) | 375 | NA | 0.18 | NA | NA |
| | ESFA | IHSS Isolate (ESFA) | 400 | NA | 0.24 | NA | NA |
| | ESFA | IHSS Isolate (ESFA) | 425 | NA | 0.24 | NA | NA |
| | ESFA | IHSS Isolate (ESFA) | 450 | NA | 0.20 | NA | NA |
| | ESFA | IHSS Isolate (ESFA) | 500 | NA | 0.05 | NA | NA |
| Ref 122 | SRFA | IHSS Isolate (SRFA) | 265-350 | NA | 5.40 | NA | NA |
| | WPHA | IHSS Isolate (WPHA) | 265-350 | NA | 1.85 | NA | NA |
| | NLNOM | IHSS Isolate (NLNOM) | 265-350 | NA | 5.00 | NA | NA |
| | Aldrich humic acid (Aldrich HA) | XAD Fraction (Soil) | 265-350 | NA | 4.40 | NA | NA |
| Ref 123 | WWTP A Bulk | Whole Water (WWTP Effluent) | 290-400 | NA | NA | NA | 254.0 |
| | WWTP A < 10 kDa | UF Fraction (WWTP Effluent) | 290-400 | NA | NA | NA | 245.0 |
| | WWTP A < 5 kDa | UF Fraction (WWTP Effluent) | 290-400 | NA | NA | NA | 597.0 |
| | WWTP A < 1 kDa | UF Fraction (WWTP Effluent) | 290-400 | NA | NA | NA | 629.0 |
| | WWTP A Non-humic | XAD Fraction (WWTP Effluent) | 290-400 | NA | NA | NA | 84.0 |
| | WWTP B Bulk | Whole Water (WWTP Effluent) | 290-400 | NA | NA | NA | 65.0 |
| | WWTP B < 10 kDa | UF Fraction (WWTP Effluent) | 290-400 | NA | NA | NA | 743.0 |
| | WWTP B < 5 kDa | UF Fraction (WWTP Effluent) | 290-400 | NA | NA | NA | 166.0 |
| | WWTP B < 1 kDa | UF Fraction (WWTP Effluent) | 290-400 | NA | NA | NA | 345.0 |
| | WWTP B Non-humic | XAD Fraction (WWTP Effluent) | 290-400 | NA | NA | NA | 31.0 |
| Ref 124 | PLFA pH 3 ozone 0 mmol $O_3$ mmol C | IHSS Isolate (PLFA) | 290-400 | NA | 2.84 | NA | NA |

| **Table S16.** Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^{\bullet}OH}$ (×10$^{-6}$ mol mol-photons$^{-1}$) |
| Ref 124 | PLFA pH 3 ozone 0.025 mmol $O_3$ mmol C | IHSS Isolate (PLFA, $O_3$) | 290-400 | NA | 5.62 | NA | NA |
| | PLFA pH 3 ozone 0.055 mmol $O_3$ mmol C | IHSS Isolate (PLFA, $O_3$) | 290-400 | NA | 7.09 | NA | NA |
| | PLFA pH 3 ozone 0.1 mmol $O_3$ mmol C | IHSS Isolate (PLFA, $O_3$) | 290-400 | NA | 8.36 | NA | NA |
| | PLFA pH 3 ozone 0.15 mmol $O_3$ mmol C | IHSS Isolate (PLFA, $O_3$) | 290-400 | NA | 8.60 | NA | NA |
| | PLFA pH 3 ozone 0.2 mmol $O_3$ mmol C | IHSS Isolate (PLFA, $O_3$) | 290-400 | NA | 9.46 | NA | NA |
| | PLFA pH 3 ozone 0.25 mmol $O_3$ mmol C | IHSS Isolate (PLFA, $O_3$) | 290-400 | NA | 10.59 | NA | NA |
| | PLFA pH 3 ozone 0.35 mmol $O_3$ mmol C | IHSS Isolate (PLFA, $O_3$) | 290-400 | NA | 12.68 | NA | NA |
| | PLFA pH 3 ozone 0.5 mmol $O_3$ mmol C | IHSS Isolate (PLFA, $O_3$) | 290-400 | NA | 9.81 | NA | NA |
| | PLFA pH 3 ozone 0.75 mmol $O_3$ mmol C | IHSS Isolate (PLFA, $O_3$) | 290-400 | NA | 11.52 | NA | NA |
| | PLFA pH 3 ozone 1 mmol $O_3$ mmol C | IHSS Isolate (PLFA, $O_3$) | 290-400 | NA | 13.08 | NA | NA |
| | PLFA pH 7 ozone 0 mmol $O_3$ mmol C | IHSS Isolate (PLFA) | 290-400 | NA | 2.63 | NA | NA |
| | PLFA pH 7 ozone 0.025 mmol $O_3$ mmol C | IHSS Isolate (PLFA, $O_3$) | 290-400 | NA | 3.15 | NA | NA |
| | PLFA pH 7 ozone 0.055 mmol $O_3$ mmol C | IHSS Isolate (PLFA, $O_3$) | 290-400 | NA | 4.60 | NA | NA |
| | PLFA pH 7 ozone 0.1 mmol $O_3$ mmol C | IHSS Isolate (PLFA, $O_3$) | 290-400 | NA | 5.12 | NA | NA |
| | PLFA pH 7 ozone 0.15 mmol $O_3$ mmol C | IHSS Isolate (PLFA, $O_3$) | 290-400 | NA | 6.45 | NA | NA |
| | PLFA pH 7 ozone 0.2 mmol $O_3$ mmol C | IHSS Isolate (PLFA, $O_3$) | 290-400 | NA | 9.38 | NA | NA |
| | PLFA pH 7 ozone 0.25 mmol $O_3$ mmol C | IHSS Isolate (PLFA, $O_3$) | 290-400 | NA | 12.13 | NA | NA |
| | PLFA pH 7 ozone 0.35 mmol $O_3$ mmol C | IHSS Isolate (PLFA, $O_3$) | 290-400 | NA | 15.83 | NA | NA |
| | PLFA pH 7 ozone 0.5 mmol $O_3$ mmol C | IHSS Isolate (PLFA, $O_3$) | 290-400 | NA | 11.06 | NA | NA |
| | PLFA pH 7 ozone 0.75 mmol $O_3$ mmol C | IHSS Isolate (PLFA, $O_3$) | 290-400 | NA | 13.49 | NA | NA |
| | PLFA pH 7 ozone 1 mmol $O_3$ mmol C | IHSS Isolate (PLFA, $O_3$) | 290-400 | NA | 17.02 | NA | NA |
| | SRFA pH 3 ozone 0 mmol $O_3$ mmol C | IHSS Isolate (SRFA) | 290-400 | NA | 1.85 | NA | NA |
| | SRFA pH 3 ozone 0.025 mmol $O_3$ mmol C | IHSS Isolate (SRFA, $O_3$) | 290-400 | NA | 2.43 | NA | NA |
| | SRFA pH 3 ozone 0.055 mmol $O_3$ mmol C | IHSS Isolate (SRFA, $O_3$) | 290-400 | NA | 3.27 | NA | NA |
| | SRFA pH 3 ozone 0.1 mmol $O_3$ mmol C | IHSS Isolate (SRFA, $O_3$) | 290-400 | NA | 4.20 | NA | NA |
| | SRFA pH 3 ozone 0.15 mmol $O_3$ mmol C | IHSS Isolate (SRFA, $O_3$) | 290-400 | NA | 4.80 | NA | NA |
| | SRFA pH 3 ozone 0.2 mmol $O_3$ mmol C | IHSS Isolate (SRFA, $O_3$) | 290-400 | NA | 4.43 | NA | NA |
| | SRFA pH 3 ozone 0.25 mmol $O_3$ mmol C | IHSS Isolate (SRFA, $O_3$) | 290-400 | NA | 6.05 | NA | NA |
| | SRFA pH 3 ozone 0.35 mmol $O_3$ mmol C | IHSS Isolate (SRFA, $O_3$) | 290-400 | NA | 5.96 | NA | NA |
| | SRFA pH 3 ozone 0.5 mmol $O_3$ mmol C | IHSS Isolate (SRFA, $O_3$) | 290-400 | NA | 7.38 | NA | NA |
| | SRFA pH 3 ozone 0.75 mmol $O_3$ mmol C | IHSS Isolate (SRFA, $O_3$) | 290-400 | NA | 7.76 | NA | NA |
| | SRFA pH 3 ozone 1 mmol $O_3$ mmol C | IHSS Isolate (SRFA, $O_3$) | 290-400 | NA | 6.40 | NA | NA |
| | SRFA pH 7 ozone 0 mmol $O_3$ mmol C | IHSS Isolate (SRFA) | 290-400 | NA | 1.24 | NA | NA |
| | SRFA pH 7 ozone 0.025 mmol $O_3$ mmol C | IHSS Isolate (SRFA, $O_3$) | 290-400 | NA | 1.27 | NA | NA |
| | SRFA pH 7 ozone 0.055 mmol $O_3$ mmol C | IHSS Isolate (SRFA, $O_3$) | 290-400 | NA | 2.03 | NA | NA |
| | SRFA pH 7 ozone 0.1 mmol $O_3$ mmol C | IHSS Isolate (SRFA, $O_3$) | 290-400 | NA | 2.55 | NA | NA |
| | SRFA pH 7 ozone 0.15 mmol $O_3$ mmol C | IHSS Isolate (SRFA, $O_3$) | 290-400 | NA | 3.39 | NA | NA |
| | SRFA pH 7 ozone 0.2 mmol $O_3$ mmol C | IHSS Isolate (SRFA, $O_3$) | 290-400 | NA | 4.40 | NA | NA |
| | SRFA pH 7 ozone 0.25 mmol $O_3$ mmol C | IHSS Isolate (SRFA, $O_3$) | 290-400 | NA | 4.63 | NA | NA |
| | SRFA pH 7 ozone 0.35 mmol $O_3$ mmol C | IHSS Isolate (SRFA, $O_3$) | 290-400 | NA | 6.25 | NA | NA |
| | SRFA pH 7 ozone 0.5 mmol $O_3$ mmol C | IHSS Isolate (SRFA, $O_3$) | 290-400 | NA | 5.96 | NA | NA |
| | SRFA pH 7 ozone 0.75 mmol $O_3$ mmol C | IHSS Isolate (SRFA, $O_3$) | 290-400 | NA | 9.81 | NA | NA |

| **Table S16.** Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^{\bullet}OH}$ ($\times10^{-6}$ mol mol-photons$^{-1}$) |
| Ref 124 | SRFA pH 7 ozone 1 mmol $O_3$ mmol C | IHSS Isolate (SRFA, $O_3$) | 290-400 | NA | 11.40 | NA | NA |
| Ref 103 | PLFA | IHSS Isolate (PLFA) | 365 | 2.55 | 1.90 | 5.72 | NA |
| | PLFA < 3 kDa | UF Fraction (PLFA) | 365 | 5.29 | 3.30 | 10.49 | NA |
| | PLFA 3-5 kDa | UF Fraction (PLFA) | 365 | 3.29 | 2.30 | 8.62 | NA |
| | PLFA 5-10 kDa | UF Fraction (PLFA) | 365 | 1.76 | 1.67 | 6.01 | NA |
| | PLFA > 10 kDa | UF Fraction (PLFA) | 365 | 1.12 | 1.20 | 3.15 | NA |
| | SRFA | IHSS Isolate (SRFA) | 365 | 3.50 | 1.50 | 9.35 | NA |
| | SRFA < 3 kDa | UF Fraction (SRFA) | 365 | 5.06 | 3.10 | 16.42 | NA |
| | SRFA 3-5 kDa | UF Fraction (SRFA) | 365 | 4.72 | 2.80 | 17.05 | NA |
| | SRFA 5-10 kDa | UF Fraction (SRFA) | 365 | 2.83 | 0.80 | 12.10 | NA |
| | SRFA >10 kDa | UF Fraction (SRFA) | 365 | 1.94 | 0.88 | 4.01 | NA |
| Ref 80 | Crystal Bog (CB) | Whole Water (Lake) | 365 | 0.23 | 0.54 | 1.52 | NA |
| | Trout Bog (TB) | Whole Water (Lake) | 365 | 0.20 | 0.55 | 1.05 | NA |
| | Allequash L. (AL) | Whole Water (Lake) | 365 | 1.10 | 0.93 | 1.81 | NA |
| | Big Muskellunge L. (BM) | Whole Water (Lake) | 365 | 2.53 | 1.62 | 4.04 | NA |
| | Crystal L. (CR) | Whole Water (Lake) | 365 | 2.31 | 1.89 | 4.74 | NA |
| | Sparkling L. (SP) | Whole Water (Lake) | 365 | 2.32 | 1.40 | 3.28 | NA |
| | Trout L. (TR) | Whole Water (Lake) | 365 | 1.95 | 1.63 | 3.22 | NA |
| | Big Muskellunge Lake ambient | Whole Water (Lake) | 365 | 2.49 | 1.32 | 1.27 | NA |
| | Sparkling Lake ambient | Whole Water (Lake) | 365 | 2.27 | 1.27 | 1.06 | NA |
| | Allequash Lake ambient | Whole Water (Lake) | 365 | 1.03 | 1.01 | 0.43 | NA |
| | St. Louis River ambient | Whole Water (Lake) | 365 | 0.34 | 1.22 | 0.26 | NA |
| | Toivola Swamp ambient | Whole Water (Lake) | 365 | 0.19 | 1.37 | 0.21 | NA |
| | Trout Bog ambient | Whole Water (Lake) | 365 | 0.25 | 0.74 | 0.37 | NA |
| | WLSSD Wastewater Eff ambient | Whole Water (WWTP Effluent) | 365 | 0.60 | 1.44 | 0.70 | NA |
| | MMSD Wastewater Eff ambient | Whole Water (WWTP Effluent) | 365 | 1.29 | 1.42 | 1.38 | NA |
| | Big Muskellunge Lake standardized | Whole Water (Lake) | 365 | 2.60 | 1.42 | 1.13 | NA |
| | Sparkling Lake standardized | Whole Water (Lake) | 365 | 2.55 | 1.30 | 1.04 | NA |
| | Allequash Lake standardized | Whole Water (Lake) | 365 | 1.40 | 0.98 | 0.49 | NA |
| | St. Louis River standardized | Whole Water (Lake) | 365 | 1.34 | 0.87 | 0.31 | NA |
| | Toivola Swamp standardized | Whole Water (Lake) | 365 | 1.20 | 0.82 | 0.36 | NA |
| | Trout Bog standardized | Whole Water (Lake) | 365 | 0.91 | 0.63 | 0.25 | NA |
| | WLSSD Wastewater Eff standardized | Whole Water (WWTP Effluent) | 365 | 1.79 | 1.63 | 0.92 | NA |
| | MMSD Wastewater Eff standardized | Whole Water (WWTP Effluent) | 365 | 2.04 | 1.58 | 1.61 | NA |
| | Big Muskellunge Lake SPE | PPL Extract (Lake) | 365 | 3.62 | 1.42 | 1.16 | NA |
| | Sparkling Lake SPE | PPL Extract (Lake) | 365 | 3.55 | 1.78 | 1.22 | NA |
| | Allequash Lake SPE | PPL Extract (Lake) | 365 | 1.78 | 1.13 | 0.49 | NA |
| | St. Louis River SPE | PPL Extract (Lake) | 365 | 1.71 | 1.25 | 0.43 | NA |
| | Toivola Swamp SPE | PPL Extract (Lake) | 365 | 1.74 | 1.01 | 0.48 | NA |
| | Trout Bog SPE | PPL Extract (Lake) | 365 | 1.04 | 0.82 | 0.27 | NA |
| | WLSSD Wastewater Eff SPE | PPL Extract (WWTP Effluent) | 365 | 1.81 | 1.87 | 0.84 | NA |
| | MMSD Wastewater Eff SPE | PPL Extract (WWTP Effluent) | 365 | 1.94 | 1.68 | 1.16 | NA |

| Table S16. Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^\bullet OH}$ ($\times10^{-6}$ mol mol-photons$^{-1}$) |
| Ref 125 | Avigliana Grande | Whole Water (Lake) | 313 | 3.21 | 1.09 | NA | 38.5 |
| | Avigliana Grande | Whole Water (Lake) | 365 | 2.12 | 1.07 | NA | 23.6 |
| | Avigliana Grande | Whole Water (Lake) | 420 | 0.58 | 0.83 | NA | 10.5 |
| | Candia | Whole Water (Lake) | 313 | 2.86 | 0.81 | NA | 28.5 |
| | Candia | Whole Water (Lake) | 365 | 1.23 | 0.69 | NA | 10.4 |
| | Candia | Whole Water (Lake) | 420 | 0.46 | 0.62 | NA | 2.5 |
| | Viverone | Whole Water (Lake) | 313 | 3.00 | 0.93 | NA | 36.2 |
| | Viverone | Whole Water (Lake) | 365 | 1.58 | 0.98 | NA | 4.0 |
| | Viverone | Whole Water (Lake) | 420 | 0.36 | 0.46 | NA | 10.7 |
| | Balma | Whole Water (Lake) | 313 | 1.78 | 1.68 | NA | 37.1 |
| | Balma | Whole Water (Lake) | 365 | 0.48 | 0.56 | NA | 14.0 |
| | Balma | Whole Water (Lake) | 420 | 0.19 | 0.40 | NA | 6.5 |
| | Sottano della Sella | Whole Water (Lake) | 313 | 5.72 | 1.16 | NA | 32.9 |
| | Sottano della Sella | Whole Water (Lake) | 365 | 0.72 | 0.69 | NA | 9.0 |
| | Sottano della Sella | Whole Water (Lake) | 420 | 0.13 | NA | NA | 3.8 |
| Ref 49 | P1-July-2012_Semi-permanent | Whole Water (Wetland) | 275-400 | 7.63 | 9.73 | NA | 97.5 |
| | P1-Nov-2012_Semi-permanent | Whole Water (Wetland) | 275-400 | 8.50 | 10.86 | NA | 70.8 |
| | P1-May-2013_Semi-permanent | Whole Water (Wetland) | 275-400 | 6.76 | 8.85 | NA | 92.6 |
| | P1-July-2013_Semi-permanent | Whole Water (Wetland) | 275-400 | 9.15 | 10.45 | NA | 91.6 |
| | P1-Nov-2013_Semi-permanent | Whole Water (Wetland) | 275-400 | 8.50 | 9.81 | NA | 76.7 |
| | P1-May-2014_Semi-permanent | Whole Water (Wetland) | 275-400 | 5.67 | 8.04 | NA | 73.8 |
| | P1-Aug-2014_Semi-permanent | Whole Water (Wetland) | 275-400 | 5.23 | 6.51 | NA | 43.0 |
| | P1-Nov-2014_Semi-permanent | Whole Water (Wetland) | 275-400 | 5.89 | 7.40 | NA | 69.8 |
| | P7-July-2012_Semi-permanent | Whole Water (Wetland) | 275-400 | 5.89 | 7.16 | NA | 63.8 |
| | P7-Nov-2012_Semi-permanent | Whole Water (Wetland) | 275-400 | 6.54 | 9.33 | NA | 82.7 |
| | P7-May-2013_Semi-permanent | Whole Water (Wetland) | 275-400 | 5.89 | 7.64 | NA | 50.0 |
| | P7-July-2013_Semi-permanent | Whole Water (Wetland) | 275-400 | 5.02 | 8.12 | NA | 41.0 |
| | P7-Nov-2013_Semi-permanent | Whole Water (Wetland) | 275-400 | 5.89 | 6.76 | NA | 94.6 |
| | P7-May-2014_Semi-permanent | Whole Water (Wetland) | 275-400 | 5.89 | 7.00 | NA | 22.2 |
| | P7-Aug-2014_Semi-permanent | Whole Water (Wetland) | 275-400 | 5.89 | 7.48 | NA | 49.0 |
| | P7-Nov-2014_Semi-permanent | Whole Water (Wetland) | 275-400 | 6.54 | 8.20 | NA | 63.8 |
| | P8-July-2012_Semi-permanent | Whole Water (Wetland) | 275-400 | 3.27 | 5.95 | NA | 71.8 |
| | P8-Nov-2012_Semi-permanent | Whole Water (Wetland) | 275-400 | 4.58 | 7.24 | NA | 85.7 |
| | P8-May-2013_Semi-permanent | Whole Water (Wetland) | 275-400 | 3.27 | 5.87 | NA | 58.9 |
| | P8-July-2013 _Semi-permanent | Whole Water (Wetland) | 275-400 | 4.58 | 6.43 | NA | 54.9 |
| | P8-Nov-2013_Semi-permanent | Whole Water (Wetland) | 275-400 | 3.93 | 6.35 | NA | 86.6 |
| | P8-May-2014_Semi-permanent | Whole Water (Wetland) | 275-400 | 2.62 | 5.23 | NA | 51.9 |
| | P8-Aug-2014_Semi-permanent | Whole Water (Wetland) | 275-400 | 3.27 | 6.03 | NA | 57.9 |
| | P8-Nov-2014_Semi-permanent | Whole Water (Wetland) | 275-400 | 4.36 | 7.00 | NA | 61.9 |
| | T9-July-2012_Temporary | Whole Water (Wetland) | 275-400 | 3.93 | 5.87 | NA | 69.8 |
| | T9-May-2013_Temporary | Whole Water (Wetland) | 275-400 | 2.53 | 4.91 | NA | 57.9 |
| | T9-July-2013_Temporary | Whole Water (Wetland) | 275-400 | 4.15 | 5.31 | NA | 61.9 |

| Table S16. Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^{\bullet}OH}$ ($\times10^{-6}$ mol mol-photons$^{-1}$) |
| Ref 49 | T9-Nov-2013_Temporary | Whole Water (Wetland) | 275-400 | 3.71 | 6.51 | NA | 51.0 |
| | T9-May-2014_Temporary | Whole Water (Wetland) | 275-400 | 3.06 | 5.31 | NA | 41.0 |
| | T9-Aug-2014_Temporary | Whole Water (Wetland) | 275-400 | 2.51 | 5.15 | NA | 55.9 |
| | T9-Nov-2014_Temporary | Whole Water (Wetland) | 275-400 | 3.49 | 6.84 | NA | 58.9 |
| | R1-May-2013_Temporary | Whole Water (Wetland) | 275-400 | 1.69 | 3.70 | NA | 39.1 |
| | R1-July-2013_Temporary | Whole Water (Wetland) | 275-400 | 2.12 | 4.50 | NA | 36.1 |
| | R1-Nov-2013_Temporary | Whole Water (Wetland) | 275-400 | 3.06 | 5.95 | NA | 62.9 |
| | R1-May-2014_Temporary | Whole Water (Wetland) | 275-400 | 2.25 | 4.91 | NA | 41.0 |
| | R1-Aug-2014_Temporary | Whole Water (Wetland) | 275-400 | 2.08 | 4.34 | NA | 27.2 |
| | R1-Nov-2014_Temporary | Whole Water (Wetland) | 275-400 | 2.58 | 5.55 | NA | 69.8 |
| | R2-May-2013_Temporary | Whole Water (Wetland) | 275-400 | 1.47 | 3.30 | NA | 28.2 |
| | R2-July-2013_Temporary | Whole Water (Wetland) | 275-400 | 2.19 | 4.99 | NA | 45.0 |
| | R2-Nov-2013_Temporary | Whole Water (Wetland) | 275-400 | 1.66 | 4.10 | NA | 44.0 |
| | R2-May-2014_Temporary | Whole Water (Wetland) | 275-400 | 1.58 | 3.86 | NA | 29.1 |
| | R2-Aug-2014_Temporary | Whole Water (Wetland) | 275-400 | 1.73 | 4.67 | NA | 41.0 |
| | D1-Mar-2013_Temporary | Whole Water (Wetland) | 275-400 | 3.71 | 5.95 | NA | 106.5 |
| | D1-Jun-2014_1_Temporary | Whole Water (Wetland) | 275-400 | 3.71 | 7.16 | NA | 29.1 |
| | D1-Jun-2014_2_Temporary | Whole Water (Wetland) | 275-400 | 3.06 | 5.71 | NA | 30.1 |
| Ref 50 | BELT_10/1/2014_Stormflow | Whole Water (Stormwater) | 275-400 | 2.83 | NA | NA | NA |
| | BELT_10/3/2014_Stormflow | Whole Water (Stormwater) | 275-400 | 3.67 | NA | NA | NA |
| | BELT_6/29/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 8.17 | NA | NA | NA |
| | BELT_7/13/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 6.14 | NA | NA | NA |
| | BELT_7/17/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 8.47 | NA | NA | NA |
| | BELT_7/20/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.83 | NA | NA | NA |
| | BELT_7/28/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.06 | NA | NA | NA |
| | BELT_9/24/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 6.72 | NA | NA | NA |
| | BELT_10/26/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 0.72 | NA | NA | NA |
| | KC_5/18/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.81 | NA | NA | NA |
| | KC_7/14/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.58 | NA | NA | NA |
| | KC_7/20/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.19 | NA | NA | NA |
| | KC_8/7/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.47 | NA | NA | NA |
| | KC_8/19/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 7.25 | NA | NA | NA |
| | KC_8/24/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 6.81 | NA | NA | NA |
| | KC_9/2/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.89 | NA | NA | NA |
| | KC_9/8/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.72 | NA | NA | NA |
| | KC_9/18/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.64 | NA | NA | NA |
| | KC_9/24/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.03 | NA | NA | NA |
| | KC_10/27/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 8.06 | NA | NA | NA |
| | TBO_10/2/2014_Stormflow | Whole Water (Stormwater) | 275-400 | 4.64 | NA | NA | NA |
| | TBO_5/26/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.53 | NA | NA | NA |
| | TBO_5/29/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.69 | NA | NA | NA |
| | TBO_7/6/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.44 | NA | NA | NA |

| Table S16. Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^{\bullet}OH}$ ($\times10^{-6}$ mol mol-photons$^{-1}$) |
| Ref 50 | TBO_7/12/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.17 | NA | NA | NA |
| | TBO_7/18/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.42 | NA | NA | NA |
| | TBO_8/18/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.56 | NA | NA | NA |
| | TBO_9/17/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.11 | NA | NA | NA |
| | TBO_10/23/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 1.00 | NA | NA | NA |
| | FC_10/1/2014_Stormflow | Whole Water (Stormwater) | 275-400 | 3.89 | NA | NA | NA |
| | FC_10/6/2014_Stormflow | Whole Water (Stormwater) | 275-400 | 6.44 | NA | NA | NA |
| | FC_5/26/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.25 | NA | NA | NA |
| | FC_7/7/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.42 | NA | NA | NA |
| | FC_7/20/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.22 | NA | NA | NA |
| | FC_8/18/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.39 | NA | NA | NA |
| | FC_8/24/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.14 | NA | NA | NA |
| | ALUM_10/3/2014_Stormflow | Whole Water (Stormwater) | 275-400 | 3.92 | NA | NA | NA |
| | ALUM_5/26/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.89 | NA | NA | NA |
| | ALUM_6/18/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.50 | NA | NA | NA |
| | ALUM_7/29/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.06 | NA | NA | NA |
| | ALUM_9/18/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.47 | NA | NA | NA |
| | EK_5/14/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.78 | NA | NA | NA |
| | EK_5/16/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.67 | NA | NA | NA |
| | EK_5/26/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.28 | NA | NA | NA |
| | EK_7/6/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 6.17 | NA | NA | NA |
| | EK_7/12/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.39 | NA | NA | NA |
| | EK_7/28/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 34.44 | NA | NA | NA |
| | EK_8/18/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.94 | NA | NA | NA |
| | EK_9/17/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.89 | NA | NA | NA |
| | EK_10/23/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 0.50 | NA | NA | NA |
| | TBEB_5/14/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.36 | NA | NA | NA |
| | TBEB_8/18/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.83 | NA | NA | NA |
| | TBEB_9/17/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.75 | NA | NA | NA |
| | TBEB_9/23/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 7.44 | NA | NA | NA |
| | TBEB_10/8/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.58 | NA | NA | NA |
| | TBEB_10/23/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 0.75 | NA | NA | NA |
| | COMO3_5/26/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.83 | NA | NA | NA |
| | COMO3_7/6/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 7.64 | NA | NA | NA |
| | COMO3_7/18/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 7.61 | NA | NA | NA |
| | COMO3_7/28/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.94 | NA | NA | NA |
| | COMO3_8/18/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 7.92 | NA | NA | NA |
| | COMO3_9/17/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 8.72 | NA | NA | NA |
| | COMO3_10/23/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 0.81 | NA | NA | NA |
| | MALL_10/1/2014_Stormflow | Whole Water (Stormwater) | 275-400 | 12.17 | NA | NA | NA |
| | MALL_10/6/2014_Stormflow | Whole Water (Stormwater) | 275-400 | 7.11 | NA | NA | NA |
| | VPO_10/1/2014_Stormflow | Whole Water (Stormwater) | 275-400 | 6.61 | NA | NA | NA |

| Table S16. Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^{\bullet}OH}$ ($\times10^{-6}$ mol mol-photons$^{-1}$) |
| Ref 50 | VPO_7/6/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 6.08 | NA | NA | NA |
| | VPO_7/12/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.36 | NA | NA | NA |
| | VPO_7/18/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.75 | NA | NA | NA |
| | VPO_7/28/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.44 | NA | NA | NA |
| | VPO_8/18/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 6.67 | NA | NA | NA |
| | VPO_9/17/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.92 | NA | NA | NA |
| | VPO_10/23/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.61 | NA | NA | NA |
| | STS3P_9/10/2014_Stormflow | Whole Water (Stormwater) | 275-400 | 4.53 | NA | NA | NA |
| | STS3P_4/13/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 2.50 | NA | NA | NA |
| | STS3P_5/27/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.58 | NA | NA | NA |
| | STS3P_7/6/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 2.78 | NA | NA | NA |
| | STS3P_9/17/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.00 | NA | NA | NA |
| | R5_10/2/2014_Stormflow | Whole Water (Stormwater) | 275-400 | 4.47 | NA | NA | NA |
| | R5_4/9/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 7.06 | NA | NA | NA |
| | R5_5/15/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.78 | NA | NA | NA |
| | R5_7/6/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.14 | NA | NA | NA |
| | R5_7/28/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.56 | NA | NA | NA |
| | R5_8/19/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.75 | NA | NA | NA |
| | R5_9/17/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.19 | NA | NA | NA |
| | R5_10/8/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.11 | NA | NA | NA |
| | C2_10/2/2014_Stormflow | Whole Water (Stormwater) | 275-400 | 5.56 | NA | NA | NA |
| | C2_4/10/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.97 | NA | NA | NA |
| | C2_5/11/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 2.89 | NA | NA | NA |
| | C2_7/28/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.33 | NA | NA | NA |
| | C2_8/19/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.25 | NA | NA | NA |
| | C2_9/17/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.92 | NA | NA | NA |
| | C2_9/24/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.81 | NA | NA | NA |
| | C2_10/8/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.36 | NA | NA | NA |
| | OWS10_10/2/2014_Stormflow | Whole Water (Stormwater) | 275-400 | 6.61 | NA | NA | NA |
| | OWS10_4/10/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 6.28 | NA | NA | NA |
| | OWS10_5/11/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.00 | NA | NA | NA |
| | OWS10_7/28/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 2.81 | NA | NA | NA |
| | OWS10_8/19/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.72 | NA | NA | NA |
| | OWS10_9/24/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.08 | NA | NA | NA |
| | BCDIV_6/7/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.06 | NA | NA | NA |
| | BCDIV_8/18/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.81 | NA | NA | NA |
| | BCDIV_8/22/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.44 | NA | NA | NA |
| | BCDIV_9/3/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.94 | NA | NA | NA |
| | LC_5/29/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.44 | NA | NA | NA |
| | LC_7/6/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.25 | NA | NA | NA |
| | LC_7/13/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.03 | NA | NA | NA |
| | LC_7/18/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.28 | NA | NA | NA |

| Table S16. Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^{\bullet}OH}$ ($\times10^{-6}$ mol mol-photons$^{-1}$) |
| Ref 50 | LC_8/22/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.39 | NA | NA | NA |
| | LC_9/18/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.53 | NA | NA | NA |
| | OC_7/13/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 2.92 | NA | NA | NA |
| | OC_8/22/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.83 | NA | NA | NA |
| | OC_10/28/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 6.81 | NA | NA | NA |
| | FCCD2_9/10/2014_Stormflow | Whole Water (Stormwater) | 275-400 | 6.61 | NA | NA | NA |
| | FCCD2_4/13/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 7.19 | NA | NA | NA |
| | FCCD2_5/27/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 5.56 | NA | NA | NA |
| | FCCD2_7/6/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.92 | NA | NA | NA |
| | FCCD2_9/17/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 4.78 | NA | NA | NA |
| | TBAA_7/6/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 3.72 | NA | NA | NA |
| | TBAA_10/28/2015_Stormflow | Whole Water (Stormwater) | 275-400 | 6.47 | NA | NA | NA |
| | ST14_9/10/2014_Stormflow | Whole Water (Stormwater) | 275-400 | 4.86 | NA | NA | NA |
| | ST14_42107_Stormflow | Whole Water (Stormwater) | 275-400 | 5.33 | NA | NA | NA |
| | ST14_42151_Stormflow | Whole Water (Stormwater) | 275-400 | 3.78 | NA | NA | NA |
| | ST14_42264_Stormflow | Whole Water (Stormwater) | 275-400 | 4.33 | NA | NA | NA |
| | ST5B_41892_Stormflow | Whole Water (Stormwater) | 275-400 | 3.22 | NA | NA | NA |
| | ST5B_42108_Stormflow | Whole Water (Stormwater) | 275-400 | 4.75 | NA | NA | NA |
| | ST5B_42151_Stormflow | Whole Water (Stormwater) | 275-400 | 3.61 | NA | NA | NA |
| | ST5B_42191_Stormflow | Whole Water (Stormwater) | 275-400 | 3.67 | NA | NA | NA |
| | ST5B_42264_Stormflow | Whole Water (Stormwater) | 275-400 | 2.61 | NA | NA | NA |
| | CSI13_42143_Stormflow | Whole Water (Stormwater) | 275-400 | 6.19 | NA | NA | NA |
| | CSI13_42177_Stormflow | Whole Water (Stormwater) | 275-400 | 4.22 | NA | NA | NA |
| | CSI13_42213_Stormflow | Whole Water (Stormwater) | 275-400 | 5.14 | NA | NA | NA |
| | CSI13_42264_Stormflow | Whole Water (Stormwater) | 275-400 | 4.08 | NA | NA | NA |
| | CSI13_42285_Stormflow | Whole Water (Stormwater) | 275-400 | 6.03 | NA | NA | NA |
| | ST19_41892_Stormflow | Whole Water (Stormwater) | 275-400 | 7.08 | NA | NA | NA |
| | ST19_42151_Stormflow | Whole Water (Stormwater) | 275-400 | 5.94 | NA | NA | NA |
| | ST19_42191_Stormflow | Whole Water (Stormwater) | 275-400 | 3.14 | NA | NA | NA |
| | ST19_42264_Stormflow | Whole Water (Stormwater) | 275-400 | 6.11 | NA | NA | NA |
| | H2_41914_Stormflow | Whole Water (Stormwater) | 275-400 | 3.97 | NA | NA | NA |
| | H2_42104_Stormflow | Whole Water (Stormwater) | 275-400 | 3.39 | NA | NA | NA |
| | H2_42135_Stormflow | Whole Water (Stormwater) | 275-400 | 2.86 | NA | NA | NA |
| | H2_42191_Stormflow | Whole Water (Stormwater) | 275-400 | 2.06 | NA | NA | NA |
| | H2_42213_Stormflow | Whole Water (Stormwater) | 275-400 | 2.06 | NA | NA | NA |
| | H2_42235_Stormflow | Whole Water (Stormwater) | 275-400 | 2.83 | NA | NA | NA |
| | H2_42264_Stormflow | Whole Water (Stormwater) | 275-400 | 2.53 | NA | NA | NA |
| | H2_42271_Stormflow | Whole Water (Stormwater) | 275-400 | 2.72 | NA | NA | NA |
| | JD1_41914_Stormflow | Whole Water (Stormwater) | 275-400 | 3.50 | NA | NA | NA |
| | JD1_42104_Stormflow | Whole Water (Stormwater) | 275-400 | 4.06 | NA | NA | NA |
| | JD1_42135_Stormflow | Whole Water (Stormwater) | 275-400 | 2.81 | NA | NA | NA |
| | JD1_42191_Stormflow | Whole Water (Stormwater) | 275-400 | 2.06 | NA | NA | NA |

| Table S16. Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^{\cdot}OH}$ ($\times10^{-6}$ mol mol-photons$^{-1}$) |
| Ref 50 | JD1_42213_Stormflow | Whole Water (Stormwater) | 275-400 | 2.97 | NA | NA | NA |
| | JD1_42271_Stormflow | Whole Water (Stormwater) | 275-400 | 2.64 | NA | NA | NA |
| | CSI05_41913_Stormflow | Whole Water (Stormwater) | 275-400 | 5.31 | NA | NA | NA |
| | CSI05_42143_Stormflow | Whole Water (Stormwater) | 275-400 | 4.69 | NA | NA | NA |
| | CSI05_42177_Stormflow | Whole Water (Stormwater) | 275-400 | 3.19 | NA | NA | NA |
| | CSI05_42213_Stormflow | Whole Water (Stormwater) | 275-400 | 1.97 | NA | NA | NA |
| | CSI05_42285_Stormflow | Whole Water (Stormwater) | 275-400 | 4.19 | NA | NA | NA |
| | CSI05_42300_Stormflow | Whole Water (Stormwater) | 275-400 | 4.25 | NA | NA | NA |
| | BC15_42162_Stormflow | Whole Water (Stormwater) | 275-400 | 2.64 | NA | NA | NA |
| | BC15_42172_Stormflow | Whole Water (Stormwater) | 275-400 | 2.67 | NA | NA | NA |
| | BC15_42191_Stormflow | Whole Water (Stormwater) | 275-400 | 2.08 | NA | NA | NA |
| | BC15_42203_Stormflow | Whole Water (Stormwater) | 275-400 | 2.08 | NA | NA | NA |
| | BC15_42238_Stormflow | Whole Water (Stormwater) | 275-400 | 2.31 | NA | NA | NA |
| | CMH06_41913_Stormflow | Whole Water (Stormwater) | 275-400 | 5.28 | NA | NA | NA |
| | CMH06_42142_Stormflow | Whole Water (Stormwater) | 275-400 | 5.11 | NA | NA | NA |
| | CMH06_42177_Stormflow | Whole Water (Stormwater) | 275-400 | 5.69 | NA | NA | NA |
| | CMH06_42212_Stormflow | Whole Water (Stormwater) | 275-400 | 4.92 | NA | NA | NA |
| | CMH06_42264_Stormflow | Whole Water (Stormwater) | 275-400 | 4.58 | NA | NA | NA |
| | CMH06_42285_Stormflow | Whole Water (Stormwater) | 275-400 | 4.72 | NA | NA | NA |
| | CMH06_42300_Stormflow | Whole Water (Stormwater) | 275-400 | 6.61 | NA | NA | NA |
| | CMH19_41913_Stormflow | Whole Water (Stormwater) | 275-400 | 7.47 | NA | NA | NA |
| | CMH19_42142_Stormflow | Whole Water (Stormwater) | 275-400 | 4.17 | NA | NA | NA |
| | CMH19_42177_Stormflow | Whole Water (Stormwater) | 275-400 | 5.36 | NA | NA | NA |
| | CMH19_42212_Stormflow | Whole Water (Stormwater) | 275-400 | 4.08 | NA | NA | NA |
| | CMH19_42264_Stormflow | Whole Water (Stormwater) | 275-400 | 6.36 | NA | NA | NA |
| | CMH19_42285_Stormflow | Whole Water (Stormwater) | 275-400 | 7.08 | NA | NA | NA |
| | CMH19_42300_Stormflow | Whole Water (Stormwater) | 275-400 | 7.28 | NA | NA | NA |
| | CMH07_41913_Stormflow | Whole Water (Stormwater) | 275-400 | 7.72 | NA | NA | NA |
| | CMH07_42212_Stormflow | Whole Water (Stormwater) | 275-400 | 7.22 | NA | NA | NA |
| | CMH07_42264_Stormflow | Whole Water (Stormwater) | 275-400 | 6.25 | NA | NA | NA |
| | CMH07_42285_Stormflow | Whole Water (Stormwater) | 275-400 | 9.03 | NA | NA | NA |
| | CSI12_41913_Stormflow | Whole Water (Stormwater) | 275-400 | 6.53 | NA | NA | NA |
| | CSI12_42143_Stormflow | Whole Water (Stormwater) | 275-400 | 6.42 | NA | NA | NA |
| | CSI12_42177_Stormflow | Whole Water (Stormwater) | 275-400 | 5.00 | NA | NA | NA |
| | CSI12_42213_Stormflow | Whole Water (Stormwater) | 275-400 | 6.67 | NA | NA | NA |
| | CSI12_42264_Stormflow | Whole Water (Stormwater) | 275-400 | 6.19 | NA | NA | NA |
| | BELT_42075_Snowmelt | Whole Water (Stormwater) | 275-400 | 6.08 | NA | NA | NA |
| | KC_42075_Snowmelt | Whole Water (Stormwater) | 275-400 | 5.64 | NA | NA | NA |
| | FC_42075_Snowmelt | Whole Water (Stormwater) | 275-400 | 6.86 | NA | NA | NA |
| | ALUM_42075_Snowmelt | Whole Water (Stormwater) | 275-400 | 3.64 | NA | NA | NA |
| | R5_42076_Snowmelt | Whole Water (Stormwater) | 275-400 | 6.39 | NA | NA | NA |
| | C2_42086_Snowmelt | Whole Water (Stormwater) | 275-400 | 7.14 | NA | NA | NA |

| Table S16. Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^{\cdot}OH}$ ($\times10^{-6}$ mol mol-photons$^{-1}$) |
| Ref 50 | OWS10_42076_Snowmelt | Whole Water (Stormwater) | 275-400 | 5.56 | NA | NA | NA |
| | LC_42073_Snowmelt | Whole Water (Stormwater) | 275-400 | 3.11 | NA | NA | NA |
| | OC_42074_Snowmelt | Whole Water (Stormwater) | 275-400 | 9.25 | NA | NA | NA |
| | TBAA_42074_Snowmelt | Whole Water (Stormwater) | 275-400 | 5.56 | NA | NA | NA |
| | CSI13_42074_Snowmelt | Whole Water (Stormwater) | 275-400 | 1.75 | NA | NA | NA |
| | H2_42086_Snowmelt | Whole Water (Stormwater) | 275-400 | 4.61 | NA | NA | NA |
| | JD1_42076_Snowmelt | Whole Water (Stormwater) | 275-400 | 5.89 | NA | NA | NA |
| | CSI05_42086_Snowmelt | Whole Water (Stormwater) | 275-400 | 6.00 | NA | NA | NA |
| | BC15_42073_Snowmelt | Whole Water (Stormwater) | 275-400 | 3.17 | NA | NA | NA |
| | CMH06_42074_Snowmelt | Whole Water (Stormwater) | 275-400 | 6.94 | NA | NA | NA |
| | CMH19_42074_Snowmelt | Whole Water (Stormwater) | 275-400 | 6.75 | NA | NA | NA |
| | CMH07_42074_Snowmelt | Whole Water (Stormwater) | 275-400 | 8.06 | NA | NA | NA |
| | BELT_42333_Baseflow | Whole Water (Stormwater) | 275-400 | 8.00 | NA | NA | NA |
| | KC_42332_Baseflow | Whole Water (Stormwater) | 275-400 | 5.06 | NA | NA | NA |
| | TBO_42215_Baseflow | Whole Water (Stormwater) | 275-400 | 10.86 | NA | NA | NA |
| | TBO_42296_Baseflow | Whole Water (Stormwater) | 275-400 | 10.19 | NA | NA | NA |
| | FC_42333_Baseflow | Whole Water (Stormwater) | 275-400 | 6.78 | NA | NA | NA |
| | ALUM_42332_Baseflow | Whole Water (Stormwater) | 275-400 | 9.42 | NA | NA | NA |
| | EK_42296_Baseflow | Whole Water (Stormwater) | 275-400 | 6.14 | NA | NA | NA |
| | TBEB_42136_Baseflow | Whole Water (Stormwater) | 275-400 | 7.64 | NA | NA | NA |
| | TBEB_42296_Baseflow | Whole Water (Stormwater) | 275-400 | 6.94 | NA | NA | NA |
| | VPO_42136_Baseflow | Whole Water (Stormwater) | 275-400 | 5.08 | NA | NA | NA |
| | BCDIV_42122_Baseflow | Whole Water (Stormwater) | 275-400 | 6.42 | NA | NA | NA |
| | BCDIV_42298_Baseflow | Whole Water (Stormwater) | 275-400 | 5.56 | NA | NA | NA |
| | LC_42121_Baseflow | Whole Water (Stormwater) | 275-400 | 6.19 | NA | NA | NA |
| | LC_42299_Baseflow | Whole Water (Stormwater) | 275-400 | 5.22 | NA | NA | NA |
| | OC_42121_Baseflow | Whole Water (Stormwater) | 275-400 | 9.25 | NA | NA | NA |
| | OC_42298_Baseflow | Whole Water (Stormwater) | 275-400 | 11.11 | NA | NA | NA |
| | FCCD2_42095_Baseflow | Whole Water (Stormwater) | 275-400 | 5.61 | NA | NA | NA |
| | TBAA_42121_Baseflow | Whole Water (Stormwater) | 275-400 | 7.64 | NA | NA | NA |
| | TBAA_42298_Baseflow | Whole Water (Stormwater) | 275-400 | 10.19 | NA | NA | NA |
| | ST14_42095_Baseflow | Whole Water (Stormwater) | 275-400 | 6.58 | NA | NA | NA |
| | ST5B_42095_Baseflow | Whole Water (Stormwater) | 275-400 | 6.06 | NA | NA | NA |
| | CSI13_42122_Baseflow | Whole Water (Stormwater) | 275-400 | 5.81 | NA | NA | NA |
| | ST19_42095_Baseflow | Whole Water (Stormwater) | 275-400 | 7.67 | NA | NA | NA |
| | CSI05_42122_Baseflow | Whole Water (Stormwater) | 275-400 | 7.42 | NA | NA | NA |
| | BC15_42122_Baseflow | Whole Water (Stormwater) | 275-400 | 3.44 | NA | NA | NA |
| | BC15_42298_Baseflow | Whole Water (Stormwater) | 275-400 | 4.97 | NA | NA | NA |
| | CMH06_42121_Baseflow | Whole Water (Stormwater) | 275-400 | 7.11 | NA | NA | NA |
| | CMH19_42121_Baseflow | Whole Water (Stormwater) | 275-400 | 5.72 | NA | NA | NA |
| | CSI12_42121_Baseflow | Whole Water (Stormwater) | 275-400 | 6.14 | NA | NA | NA |
| Ref 46 | DNR331_10/23/2014 | Whole Water (Wetland) | 275-400 | 0.60 | NA | NA | NA |

| **Table S16.** Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^{\bullet}OH}$ (×10$^{-6}$ mol mol-photons$^{-1}$) |
| Ref 46 | DNR341_10/23/2014 | Whole Water (Wetland) | 275-400 | 2.24 | NA | NA | NA |
| | DNR327_10/23/2014 | Whole Water (Wetland) | 275-400 | 2.03 | NA | NA | NA |
| | DNR254_10/20/2014 | Whole Water (Wetland) | 275-400 | 3.23 | NA | NA | NA |
| | DNR81_10/20/2014 | Whole Water (Wetland) | 275-400 | 1.28 | NA | NA | NA |
| | DNR85_10/20/2014 | Whole Water (Wetland) | 275-400 | 0.28 | NA | NA | NA |
| | DNR91_10/20/2014 | Whole Water (Wetland) | 275-400 | 3.20 | NA | NA | NA |
| | DNR339_10/22/2014 | Whole Water (Wetland) | 275-400 | 0.99 | NA | NA | NA |
| | DNR342_10/24/2014 | Whole Water (Wetland) | 275-400 | 2.80 | NA | NA | NA |
| | DNR222_10/24/2014 | Whole Water (Wetland) | 275-400 | 0.37 | NA | NA | NA |
| | DNR334_10/20/2014 | Whole Water (Wetland) | 275-400 | 0.27 | NA | NA | NA |
| | DNR337_10/22/2014 | Whole Water (Wetland) | 275-400 | 5.10 | NA | NA | NA |
| | DNR309_10/20/2014 | Whole Water (Wetland) | 275-400 | 3.08 | NA | NA | NA |
| | DNR301_10/22/2014 | Whole Water (Wetland) | 275-400 | 0.92 | NA | NA | NA |
| | DNR338_10/22/2014 | Whole Water (Wetland) | 275-400 | 6.28 | NA | NA | NA |
| | 04Aitk001_8/25/2014 | Whole Water (Wetland) | 275-400 | 4.48 | NA | NA | NA |
| | 04Aitk001_10/2/2014 | Whole Water (Wetland) | 275-400 | 5.00 | NA | NA | NA |
| | 04Aitk001_10/2/2014 | Whole Water (Wetland) | 275-400 | 4.45 | NA | NA | NA |
| | 04Aitk001_4/15/2015 | Whole Water (Wetland) | 275-400 | 3.98 | NA | NA | NA |
| | 04Aitk001_7/27/2015 | Whole Water (Wetland) | 275-400 | 2.90 | NA | NA | NA |
| | 04Aitk001_10/6/2015 | Whole Water (Wetland) | 275-400 | 4.58 | NA | NA | NA |
| | 04Aitk001_10/6/2015 | Whole Water (Wetland) | 275-400 | 4.05 | NA | NA | NA |
| | 04Cass003_7/27/2015 | Whole Water (Wetland) | 275-400 | 2.55 | NA | NA | NA |
| | 04Cass003_7/27/2015 | Whole Water (Wetland) | 275-400 | 2.26 | NA | NA | NA |
| | 04Cass003_10/6/2015 | Whole Water (Wetland) | 275-400 | 2.60 | NA | NA | NA |
| | 04Cass011_8/22/2014 | Whole Water (Wetland) | 275-400 | 1.79 | NA | NA | NA |
| | 04Cass011_10/2/2014 | Whole Water (Wetland) | 275-400 | 1.97 | NA | NA | NA |
| | 04Cass011_4/15/2015 | Whole Water (Wetland) | 275-400 | 2.88 | NA | NA | NA |
| | 04Cass011_7/27/2015 | Whole Water (Wetland) | 275-400 | 2.02 | NA | NA | NA |
| | 04Cass011_10/6/2015 | Whole Water (Wetland) | 275-400 | 1.94 | NA | NA | NA |
| | 09Aitk190_8/25/2014 | Whole Water (Wetland) | 275-400 | 2.65 | NA | NA | NA |
| | 09Aitk190_10/2/2014 | Whole Water (Wetland) | 275-400 | 2.70 | NA | NA | NA |
| | 09Aitk190_4/15/2015 | Whole Water (Wetland) | 275-400 | 3.15 | NA | NA | NA |
| | 09Aitk190_7/27/2015 | Whole Water (Wetland) | 275-400 | 2.50 | NA | NA | NA |
| | 09Aitk190_10/6/2015 | Whole Water (Wetland) | 275-400 | 2.37 | NA | NA | NA |
| | 04Crow001_7/27/2015 | Whole Water (Wetland) | 275-400 | 2.63 | NA | NA | NA |
| | 04Crow001_10/6/2015 | Whole Water (Wetland) | 275-400 | 3.55 | NA | NA | NA |
| | New Prairie_8/22/2014 | Whole Water (Wetland) | 275-400 | 4.48 | NA | NA | NA |
| | New Prairie_10/2/2014 | Whole Water (Wetland) | 275-400 | 5.15 | NA | NA | NA |
| | New Prairie_4/6/2015 | Whole Water (Wetland) | 275-400 | 5.30 | NA | NA | NA |
| | New Prairie_7/30/2015 | Whole Water (Wetland) | 275-400 | 4.45 | NA | NA | NA |

**Table S16.** Summary of literature $\Phi_{app,RI}$ data (continued)

| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\,^3DOM^*_{TMP}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\,^1O_2}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\,^3DOM^*_{Sorbate}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\,^{\bullet}OH}$ (×10$^{-6}$ mol mol-photons$^{-1}$) |
|---|---|---|---|---|---|---|---|
| Ref 46 | New Prairie_10/6/2015 | Whole Water (Wetland) | 275-400 | 7.68 | NA | NA | NA |
| | Glacial_8/22/2014 | Whole Water (Wetland) | 275-400 | 5.10 | NA | NA | NA |
| | Glacial_10/2/2014 | Whole Water (Wetland) | 275-400 | 4.78 | NA | NA | NA |
| | Glacial_4/6/2015 | Whole Water (Wetland) | 275-400 | 4.78 | NA | NA | NA |
| | Glacial_7/30/2015 | Whole Water (Wetland) | 275-400 | 4.28 | NA | NA | NA |
| | Glacial_10/6/2015 | Whole Water (Wetland) | 275-400 | 5.18 | NA | NA | NA |
| | Kerk_8/22/2014 | Whole Water (Wetland) | 275-400 | 3.45 | NA | NA | NA |
| | Kerk_10/2/2014 | Whole Water (Wetland) | 275-400 | 3.58 | NA | NA | NA |
| | Kerk_4/6/2015 | Whole Water (Wetland) | 275-400 | 3.98 | NA | NA | NA |
| | Kerk_7/30/2015 | Whole Water (Wetland) | 275-400 | 5.15 | NA | NA | NA |
| | Kerk_7/30/2015 | Whole Water (Wetland) | 275-400 | 4.63 | NA | NA | NA |
| | Kerk_10/6/2015 | Whole Water (Wetland) | 275-400 | 4.50 | NA | NA | NA |
| | Franco_8/22/2014 | Whole Water (Wetland) | 275-400 | 4.70 | NA | NA | NA |
| | Franco_10/1/2014 | Whole Water (Wetland) | 275-400 | 8.00 | NA | NA | NA |
| | Franco_4/8/2015 | Whole Water (Wetland) | 275-400 | 10.30 | NA | NA | NA |
| | Franco_7/29/2015 | Whole Water (Wetland) | 275-400 | 6.43 | NA | NA | NA |
| | 04Rams085_8/20/2014 | Whole Water (Wetland) | 275-400 | 3.90 | NA | NA | NA |
| | 04Rams085_9/30/2014 | Whole Water (Wetland) | 275-400 | 5.93 | NA | NA | NA |
| | 04Rams085_7/31/2015 | Whole Water (Wetland) | 275-400 | 3.25 | NA | NA | NA |
| | 04Rams085_10/7/2015 | Whole Water (Wetland) | 275-400 | 2.23 | NA | NA | NA |
| | 04Rams015_8/20/2014 | Whole Water (Wetland) | 275-400 | 2.80 | NA | NA | NA |
| | 04Rams015_9/30/2014 | Whole Water (Wetland) | 275-400 | 2.34 | NA | NA | NA |
| | 04Rams015_4/14/2015 | Whole Water (Wetland) | 275-400 | 3.38 | NA | NA | NA |
| | 04Rams015_7/31/2015 | Whole Water (Wetland) | 275-400 | 1.98 | NA | NA | NA |
| | 04Rams015_10/7/2015 | Whole Water (Wetland) | 275-400 | 1.86 | NA | NA | NA |
| | 04Rams064_8/20/2014 | Whole Water (Wetland) | 275-400 | 3.18 | NA | NA | NA |
| | 04Rams064_9/30/2014 | Whole Water (Wetland) | 275-400 | 4.03 | NA | NA | NA |
| | 04Rams064_4/14/2015 | Whole Water (Wetland) | 275-400 | 5.38 | NA | NA | NA |
| | 04Rams064_7/31/2015 | Whole Water (Wetland) | 275-400 | 3.15 | NA | NA | NA |
| | 04Rams064_10/7/2015 | Whole Water (Wetland) | 275-400 | 6.35 | NA | NA | NA |
| | Kipling_8/21/2014 | Whole Water (Wetland) | 275-400 | 5.70 | NA | NA | NA |
| | Kipling_9/30/2014 | Whole Water (Wetland) | 275-400 | 12.08 | NA | NA | NA |
| | Kipling_4/14/2015 | Whole Water (Wetland) | 275-400 | 4.00 | NA | NA | NA |
| | Kipling_7/31/2015 | Whole Water (Wetland) | 275-400 | 4.70 | NA | NA | NA |
| | Kipling_10/7/2015 | Whole Water (Wetland) | 275-400 | 7.88 | NA | NA | NA |
| | 04Rams018_8/20/2014 | Whole Water (Wetland) | 275-400 | 5.90 | NA | NA | NA |
| | 04Rams018_9/30/2014 | Whole Water (Wetland) | 275-400 | 6.83 | NA | NA | NA |
| | 04Rams018_9/30/2014 | Whole Water (Wetland) | 275-400 | 7.45 | NA | NA | NA |
| | 07Dako149_8/20/2014 | Whole Water (Wetland) | 275-400 | 4.93 | NA | NA | NA |
| | 07Dako149_9/30/2014 | Whole Water (Wetland) | 275-400 | 6.35 | NA | NA | NA |

| **Table S16.** Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\,^3DOM^*_{TMP}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\,^1O_2}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\,^3DOM^*_{Sorbate}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\,^{\bullet}OH}$ (×10$^{-6}$ mol mol-photons$^{-1}$) |
| Ref 46 | 14Dako001_8/7/2014 | Whole Water (Wetland) | 275-400 | 4.43 | NA | NA | NA |
| | 14Dako003_8/7/2014 | Whole Water (Wetland) | 275-400 | 3.60 | NA | NA | NA |
| | Breen_8/20/2014 | Whole Water (Wetland) | 275-400 | 2.65 | NA | NA | NA |
| | Breen_9/30/2014 | Whole Water (Wetland) | 275-400 | 3.50 | NA | NA | NA |
| | Breen_4/9/2015 | Whole Water (Wetland) | 275-400 | 2.95 | NA | NA | NA |
| | Breen_7/29/2015 | Whole Water (Wetland) | 275-400 | 1.88 | NA | NA | NA |
| | Breen_10/5/2015 | Whole Water (Wetland) | 275-400 | 2.83 | NA | NA | NA |
| | 05Lyon002_8/21/2014 | Whole Water (Wetland) | 275-400 | 3.10 | NA | NA | NA |
| | 05Lyon002_10/1/2014 | Whole Water (Wetland) | 275-400 | 5.60 | NA | NA | NA |
| | 05Lyon002_4/8/2015 | Whole Water (Wetland) | 275-400 | 8.40 | NA | NA | NA |
| | 05Lyon002_7/29/2015 | Whole Water (Wetland) | 275-400 | 4.43 | NA | NA | NA |
| | 05Lyon002_10/5/2015 | Whole Water (Wetland) | 275-400 | 7.10 | NA | NA | NA |
| | 05Lyon002_10/5/2015 | Whole Water (Wetland) | 275-400 | 6.30 | NA | NA | NA |
| | 03Lyon099_8/21/2014 | Whole Water (Wetland) | 275-400 | 11.05 | NA | NA | NA |
| | 03Lyon099_10/1/2014 | Whole Water (Wetland) | 275-400 | 8.95 | NA | NA | NA |
| | 03Lyon099_4/8/2015 | Whole Water (Wetland) | 275-400 | 9.85 | NA | NA | NA |
| | 03Lyon099_7/29/2015 | Whole Water (Wetland) | 275-400 | 9.35 | NA | NA | NA |
| | 03Lyon099_10/5/2015 | Whole Water (Wetland) | 275-400 | 15.60 | NA | NA | NA |
| | 03Lyon146_8/21/2014 | Whole Water (Wetland) | 275-400 | 7.63 | NA | NA | NA |
| | 03Lyon146_8/21/2014 | Whole Water (Wetland) | 275-400 | 7.55 | NA | NA | NA |
| | 03Lyon146_10/1/2014 | Whole Water (Wetland) | 275-400 | 11.38 | NA | NA | NA |
| | 03Lyon146_4/8/2015 | Whole Water (Wetland) | 275-400 | 10.45 | NA | NA | NA |
| | 03Lyon146_7/29/2015 | Whole Water (Wetland) | 275-400 | 11.73 | NA | NA | NA |
| | 03Lyon146_10/5/2015 | Whole Water (Wetland) | 275-400 | 12.95 | NA | NA | NA |
| | Tyler_8/21/2014 | Whole Water (Wetland) | 275-400 | 7.30 | NA | NA | NA |
| | Tyler_10/1/2014 | Whole Water (Wetland) | 275-400 | 5.80 | NA | NA | NA |
| | Tyler_4/8/2015 | Whole Water (Wetland) | 275-400 | 8.88 | NA | NA | NA |
| | Tyler_7/29/2015 | Whole Water (Wetland) | 275-400 | 5.60 | NA | NA | NA |
| | Tyler_10/5/2015 | Whole Water (Wetland) | 275-400 | 6.63 | NA | NA | NA |
| | 03Murr066_8/21/2014 | Whole Water (Wetland) | 275-400 | 4.30 | NA | NA | NA |
| | 03Murr066_10/1/2014 | Whole Water (Wetland) | 275-400 | 4.50 | NA | NA | NA |
| | 03Murr066_4/9/2015 | Whole Water (Wetland) | 275-400 | 4.35 | NA | NA | NA |
| | 03Murr066_7/29/2015 | Whole Water (Wetland) | 275-400 | 2.20 | NA | NA | NA |
| | 03Murr066_10/5/2015 | Whole Water (Wetland) | 275-400 | 4.33 | NA | NA | NA |
| | 03Murr028_8/21/2014 | Whole Water (Wetland) | 275-400 | 6.33 | NA | NA | NA |
| | 03Murr028_8/21/2014 | Whole Water (Wetland) | 275-400 | 5.30 | NA | NA | NA |
| | 03Murr028_10/1/2014 | Whole Water (Wetland) | 275-400 | 6.98 | NA | NA | NA |
| | 03Murr028_4/8/2015 | Whole Water (Wetland) | 275-400 | 4.68 | NA | NA | NA |
| | 03Murr028_7/29/2015 | Whole Water (Wetland) | 275-400 | 3.43 | NA | NA | NA |
| | 03Murr028_10/5/2015 | Whole Water (Wetland) | 275-400 | 5.93 | NA | NA | NA |

| **Table S16.** Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app, {}^3DOM^*_{TMP}}$ (×10^-2^ mol mol-photons^-1^) | $\Phi_{app, {}^1O_2}$ (×10^-2^ mol mol-photons^-1^) | $\Phi_{app, {}^3DOM^*_{Sorbate}}$ (×10^-2^ mol mol-photons^-1^) | $\Phi_{app, {}^{\bullet}OH}$ (×10^-6^ mol mol-photons^-1^) |
| Ref 101 | Boulder Creek (BC) | Whole Water (WWTP-Stream) | 290-400 | 3.29 | 3.65 | NA | 9.8 |
| | BC base modification | Whole Water (Stream, Base) | 290-400 | 3.01 | 3.82 | NA | 10.0 |
| | Boulder Wastewater (BWW) | Whole Water (WWTP Effluent) | 290-400 | 1.37 | 2.77 | NA | 39.7 |
| | BWW base modification | Whole Water (Effluent, Base) | 290-400 | 2.56 | 3.58 | NA | 48.1 |
| | Orange County Water District (OCWD) | Whole Water (WWTP Effluent) | 290-400 | 4.40 | 2.61 | NA | 262.8 |
| | OCWD base modification | Whole Water (Effluent, Base) | 290-400 | 5.05 | 3.71 | NA | 353.7 |
| | Longmont Wastewater (LM) | Whole Water (WWTP Effluent) | 290-400 | 0.85 | 2.36 | NA | 61.3 |
| | LM Longmont 30 mg alum/L | Whole Water (Effluent, Alum) | 290-400 | 1.06 | 2.78 | NA | 70.2 |
| | LM Longmont 60 mg alum/L | Whole Water (Effluent, Alum) | 290-400 | 1.81 | 3.00 | NA | 82.5 |
| | LM Longmont 90 mg alum/L | Whole Water (Effluent, Alum) | 290-400 | 2.46 | 3.52 | NA | 92.2 |
| | LM Longmont 120 mg alum/L | Whole Water (Effluent, Alum) | 290-400 | 2.93 | 3.63 | NA | 108.5 |
| | SRFA < 5 kDa | UF Fraction (SRFA) | 290-400 | 2.26 | 2.98 | NA | 17.1 |
| | SRFA < 5 kDa reduced | UF Fraction (SRFA, $NaBH_4$) | 290-400 | 1.67 | 2.56 | NA | 28.5 |
| | SRFA | IHSS Isolate (SRFA) | 290-400 | 1.43 | 1.81 | NA | 15.8 |
| | SRFA reduced | IHSS Isolate (SRFA, $NaBH_4$) | 290-400 | 1.39 | 1.64 | NA | 20.2 |
| | SRFA > 5 kDa | UF Fraction (SRFA) | 290-400 | 1.19 | 1.54 | NA | 11.0 |
| | SRFA > 5 kDa reduced | UF Fraction (SRFA, $NaBH_4$) | 290-400 | 0.95 | 1.52 | NA | 19.1 |
| Ref 102 | FB21_Sep Everglades estuary | Whole Water (Estuary) | 290-400 | 10.54 | 8.88 | NA | 47.6 |
| | FB21_Oct Everglades estuary | Whole Water (Estuary) | 290-400 | 11.79 | 10.43 | NA | 41.1 |
| | FB21_Nov Everglades estuary | Whole Water (Estuary) | 290-400 | 9.46 | 7.77 | NA | 40.5 |
| | SRS2_Sep Everglades freshwater marsh | Whole Water (Estuary) | 290-400 | 5.36 | 5.39 | NA | 14.3 |
| | SRS2_Oct Everglades freshwater marsh | Whole Water (Estuary) | 290-400 | 5.04 | 6.21 | NA | 20.7 |
| | SRS2_Nov Everglades freshwater marsh | Whole Water (Estuary) | 290-400 | 5.62 | 7.30 | NA | 21.2 |
| | SRS4_Sep Everglades mangrove estuarine | Whole Water (Estuary) | 290-400 | 2.19 | 3.69 | NA | 13.0 |
| | SRS4_Oct Everglades mangrove estuarine | Whole Water (Estuary) | 290-400 | 2.51 | 4.50 | NA | 16.4 |
| | SRS4_Nov Everglades mangrove estuarine | Whole Water (Estuary) | 290-400 | 3.17 | 4.47 | NA | 17.6 |
| | SRS6_Sep Everglades mangrove estuarine | Whole Water (Estuary) | 290-400 | 1.87 | 3.09 | NA | 17.3 |
| | SRS6_Oct Everglades mangrove estuarine | Whole Water (Estuary) | 290-400 | 2.53 | 3.31 | NA | 15.2 |
| | SRS6_Nov Everglades mangrove estuarine | Whole Water (Estuary) | 290-400 | 2.74 | 3.59 | NA | 16.2 |
| | TS2_Sep Everglades freshwater marsh | Whole Water (Estuary) | 290-400 | 6.84 | 6.80 | NA | 16.9 |
| | TS2_Oct Everglades freshwater marsh | Whole Water (Estuary) | 290-400 | 7.87 | 6.31 | NA | 20.1 |
| | TS2_Nov Everglades freshwater marsh | Whole Water (Estuary) | 290-400 | 7.07 | 7.29 | NA | 15.6 |
| | TS3_Sep Everglades freshwater marsh | Whole Water (Estuary) | 290-400 | 6.46 | 6.07 | NA | 19.8 |
| | TS3_Oct Everglades freshwater marsh | Whole Water (Estuary) | 290-400 | 7.03 | 6.94 | NA | 19.4 |
| | TS3_Nov Everglades freshwater marsh | Whole Water (Estuary) | 290-400 | 7.67 | 6.42 | NA | 23.2 |
| | TS7_Sep Everglades mangrove estuarine | Whole Water (Estuary) | 290-400 | 1.59 | 2.70 | NA | 21.2 |
| | TS7_Oct Everglades mangrove estuarine | Whole Water (Estuary) | 290-400 | 1.30 | 2.49 | NA | 16.2 |
| | TS7_Nov Everglades mangrove estuarine | Whole Water (Estuary) | 290-400 | 9.07 | 4.86 | NA | 21.0 |
| | TS7_Sep Everglades mangrove estuarine SPE | PPL Extract (Estuary) | 290-400 | 1.54 | 3.31 | NA | 19.5 |
| | SRS6_Nov Everglades mangrove estuarine SPE | PPL Extract (Estuary) | 290-400 | 2.36 | 4.07 | NA | 17.8 |

| Table S16. Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app, {}^3DOM^*_{TMP}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app, {}^1O_2}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app, {}^3DOM^*_{Sorbate}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app, {}^{\bullet}OH}$ (×10$^{-6}$ mol mol-photons$^{-1}$) |
| Ref 102 | SRS6_Oct Everglades mangrove estuarine SPE | PPL Extract (Estuary) | 290-400 | 2.78 | 4.92 | NA | 20.5 |
| | SRS4_Nov Everglades mangrove estuarine SPE | PPL Extract (Estuary) | 290-400 | 2.96 | 5.54 | NA | 21.0 |
| | SRS2_Nov Everglades freshwater marsh SPE | PPL Extract (Estuary) | 290-400 | 5.55 | 7.75 | NA | 24.4 |
| | TS3_Oct Everglades freshwater marsh SPE | PPL Extract (Estuary) | 290-400 | 7.58 | 7.63 | NA | 22.6 |
| | TS2_Oct Everglades freshwater marsh SPE | PPL Extract (Estuary) | 290-400 | 7.68 | 8.16 | NA | 25.7 |
| | FB21_Oct Everglades estuary SPE | PPL Extract (Estuary) | 290-400 | 8.49 | 8.11 | NA | 46.2 |
| | SRNOM | IHSS Isolate (SRNOM) | 290-400 | NA | 2.66 | NA | 23.7 |
| Ref 78 | SRNOM | IHSS Isolate (SRNOM) | 290-400 | NA | 2.02 | NA | NA |
| | PLFA | IHSS Isolate (PLFA) | 290-400 | NA | 2.04 | NA | NA |
| | SRFA | IHSS Isolate (SRFA) | 290-400 | NA | 2.11 | NA | NA |
| | SRHA | IHSS Isolate (SRHA) | 290-400 | NA | 1.60 | NA | NA |
| | Louisville (LWW)-UV disinfection (eff) | Whole Water (WWTP Effluent) | 290-400 | NA | 2.77 | NA | NA |
| | LWW-eff < 10 kDa | UF Fraction (WWTP Effluent) | 290-400 | NA | 2.79 | NA | NA |
| | LWW-eff < 1 kDa | UF Fraction (WWTP Effluent) | 290-400 | NA | 3.88 | NA | NA |
| | LWW + 0.14 mM Cl2 | UF Fraction (Effluent, HOCl) | 290-400 | NA | 4.53 | NA | NA |
| | LWW + 0.28 mM Cl2 | UF Fraction (Effluent, HOCl) | 290-400 | NA | 6.11 | NA | NA |
| | LWW + 0.42 mM Cl2 | UF Fraction (Effluent, HOCl) | 290-400 | NA | 6.52 | NA | NA |
| | LWW + 0.56 mM Cl2 | UF Fraction (Effluent, HOCl) | 290-400 | NA | 8.01 | NA | NA |
| | Boulder (BWW)-secondary clarification (2C) | Whole Water (WWTP Effluent) | 290-400 | NA | 3.18 | NA | NA |
| | BWW-2C < 10 kDa | UF Fraction (WWTP Effluent) | 290-400 | NA | 3.91 | NA | NA |
| | BWW-2C < 1 kDa | UF Fraction (WWTP Effluent) | 290-400 | NA | 5.78 | NA | NA |
| | BWW-final chlorination (eff) | Whole Water (WWTP Effluent) | 290-400 | NA | 4.66 | NA | NA |
| | BWW-eff < 10 kDa | UF Fraction (WWTP Effluent) | 290-400 | NA | 5.62 | NA | NA |
| | BWW-eff < 1 kDa | UF Fraction (WWTP Effluent) | 290-400 | NA | 8.59 | NA | NA |
| | BWW-2C + 0.07 mM $Cl_2$ | Whole Water (Effluent, HOCl) | 290-400 | NA | 3.82 | NA | NA |
| | BWW-2C + 0.14 mM $Cl_2$ | Whole Water (Effluent, HOCl) | 290-400 | NA | 5.09 | NA | NA |
| | BWW-2C + 0.21 mM $Cl_2$ | Whole Water (Effluent, HOCl) | 290-400 | NA | 6.67 | NA | NA |
| | BWW-2C + 0.28 mM $Cl_2$ | Whole Water (Effluent, HOCl) | 290-400 | NA | 7.13 | NA | NA |
| | BWW-2C + 0.42 mM $Cl_2$ | Whole Water (Effluent, HOCl) | 290-400 | NA | 7.36 | NA | NA |
| | BWW-2C + 0.56 mM $Cl_2$ | Whole Water (Effluent, HOCl) | 290-400 | NA | 5.74 | NA | NA |
| | BWW-2C + 0.044 mM $O_3$ | Whole Water (Effluent, $O_3$) | 290-400 | NA | 4.38 | NA | NA |
| | BWW-2C + 0.088 mM $O_3$ | Whole Water (Effluent, $O_3$) | 290-400 | NA | 5.18 | NA | NA |
| | BWW-2C + 0.132 mM $O_3$ | Whole Water (Effluent, $O_3$) | 290-400 | NA | 7.91 | NA | NA |
| | BWW-2C + 0.176 mM $O_3$ | Whole Water (Effluent, $O_3$) | 290-400 | NA | 9.32 | NA | NA |
| Ref 126 | SRNOM | IHSS Isolate (SRNOM) | 290-400 | NA | 1.85 | NA | 41.0 |
| | SRNOM > 10 kDa | UF Fraction (SRNOM) | 290-400 | NA | 0.44 | NA | 35.0 |
| | SRNOM 1-10 kDa | UF Fraction (SRNOM) | 290-400 | NA | 1.44 | NA | 28.0 |
| | SRNOM < 1 kDa | UF Fraction (SRNOM) | 290-400 | NA | 4.39 | NA | 68.0 |
| | Boulder Wastewater (BWW) | Whole Water (WWTP Effluent) | 290-400 | NA | 3.29 | NA | 32.0 |
| | BWW >10 kDa | UF Fraction (WWTP Effluent) | 290-400 | NA | 1.15 | NA | 18.0 |

| Table S16. Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ (×10⁻² mol mol-photons⁻¹) | $\Phi_{app,\ ^1O_2}$ (×10⁻² mol mol-photons⁻¹) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ (×10⁻² mol mol-photons⁻¹) | $\Phi_{app,\ ^{\bullet}OH}$ (×10⁻⁶ mol mol-photons⁻¹) |
| Ref 126 | BWW 1-10 kDa | UF Fraction (WWTP Effluent) | 290-400 | NA | 1.91 | NA | 16.0 |
| | BWW <1 kDa | UF Fraction (WWTP Effluent) | 290-400 | NA | 6.18 | NA | 497.0 |
| Ref 53 | 1_Santa Cruz River | Whole Water (WWTP-River) | 275-600 | 2.18 | NA | NA | NA |
| | 2_Santa Cruz River | Whole Water (WWTP-River) | 275-600 | 2.97 | NA | NA | NA |
| | 3_Santa Ana River | Whole Water (WWTP-River) | 275-600 | 11.16 | NA | NA | NA |
| | 5_Santa Cruz River | Whole Water (WWTP-River) | 275-600 | 1.67 | 3.29 | NA | NA |
| | 6_Santa Cruz River | Whole Water (WWTP-River) | 275-600 | 3.54 | NA | NA | NA |
| | 7_Empire | Whole Water (WWTP Effluent) | 275-600 | 2.28 | NA | NA | NA |
| | 8_Blue Lake | Whole Water (WWTP Effluent) | 275-600 | 2.56 | NA | NA | NA |
| | 9_Seneca | Whole Water (WWTP Effluent) | 275-600 | 2.92 | NA | NA | NA |
| | 10_Metro | Whole Water (WWTP Effluent) | 275-600 | 2.80 | 1.95 | NA | NA |
| | 11_St. Croix Valley | Whole Water (WWTP Effluent) | 275-600 | 1.15 | NA | NA | NA |
| | 12_Metro | Whole Water (WWTP Effluent) | 275-600 | 2.14 | 2.00 | NA | NA |
| | 13_St. Croix Valley | Whole Water (WWTP Effluent) | 275-600 | 2.12 | NA | NA | NA |
| | 14_Empire | Whole Water (WWTP Effluent) | 275-600 | 1.45 | NA | NA | NA |
| | 15_Blue Lake | Whole Water (WWTP Effluent) | 275-600 | 1.99 | NA | NA | NA |
| | 16_Seneca | Whole Water (WWTP Effluent) | 275-600 | 1.14 | NA | NA | NA |
| | 17_Santa Ana River | Whole Water (WWTP-River) | 275-600 | 5.09 | 3.53 | NA | NA |
| | 18_Blue Lake | Whole Water (WWTP Effluent) | 275-600 | 2.34 | 1.88 | NA | NA |
| | 19_St. Croix Valley | Whole Water (WWTP Effluent) | 275-600 | 1.58 | 1.69 | NA | NA |
| | 20_Empire | Whole Water (WWTP Effluent) | 275-600 | 1.46 | 1.40 | NA | NA |
| | 21_Seneca | Whole Water (WWTP Effluent) | 275-600 | 0.81 | NA | NA | NA |
| | 22_Metro | Whole Water (WWTP Effluent) | 275-600 | 2.62 | NA | NA | NA |
| | 23_Faribault | Whole Water (WWTP Effluent) | 275-600 | 3.17 | NA | NA | NA |
| | 24_Owatonna | Whole Water (WWTP Effluent) | 275-600 | 1.80 | NA | NA | NA |
| | 25_Northfield | Whole Water (WWTP Effluent) | 275-600 | 1.69 | NA | NA | NA |
| | 26_Cannon Falls | Whole Water (WWTP Effluent) | 275-600 | 6.06 | 2.83 | NA | NA |
| | 27_Zumbrota | Whole Water (WWTP Effluent) | 275-600 | 1.67 | NA | NA | NA |
| | 28_Rochester | Whole Water (WWTP Effluent) | 275-600 | 1.36 | NA | NA | NA |
| | 29_Wanamingo | Whole Water (WWTP Effluent) | 275-600 | 2.98 | NA | NA | NA |
| | 30_Kasson | Whole Water (WWTP Effluent) | 275-600 | 3.79 | NA | NA | NA |
| | 31_Big Lake | Whole Water (WWTP Effluent) | 275-600 | 1.74 | 1.54 | NA | NA |
| | 33_St. Cloud | Whole Water (WWTP Effluent) | 275-600 | 2.86 | NA | NA | NA |
| | 34_Santa Cruz River | Whole Water (WWTP-River) | 275-600 | 1.56 | NA | NA | NA |
| | 35_Santa Cruz River | Whole Water (WWTP-River) | 275-600 | 2.47 | NA | NA | NA |
| | 36_Rochester | Whole Water (WWTP Effluent) | 275-600 | 1.63 | NA | NA | NA |
| | 37_Cannon Falls | Whole Water (WWTP Effluent) | 275-600 | 1.06 | 0.86 | NA | NA |
| | 38_Northfield | Whole Water (WWTP Effluent) | 275-600 | 1.67 | NA | NA | NA |
| | 39_Faribault | Whole Water (WWTP Effluent) | 275-600 | 2.50 | NA | NA | NA |
| | 40_Zumbrota | Whole Water (WWTP Effluent) | 275-600 | 11.38 | 6.30 | NA | NA |

| Table S16. Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ (×$10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ (×$10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ (×$10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^{\bullet}OH}$ (×$10^{-6}$ mol mol-photons$^{-1}$) |
| Ref 53 | 41_Kasson | Whole Water (WWTP Effluent) | 275-600 | 1.83 | 1.47 | NA | NA |
| | 42_Owatonna | Whole Water (WWTP Effluent) | 275-600 | 2.73 | 2.49 | NA | NA |
| | 43_Santa Cruz River | Whole Water (WWTP-River) | 275-600 | 1.62 | NA | NA | NA |
| | 44_Santa Cruz River | Whole Water (WWTP-River) | 275-600 | 2.45 | NA | NA | NA |
| | 45_Becker (combined stream) | Whole Water (WWTP Effluent) | 275-600 | 0.16 | NA | NA | NA |
| | 46_St. Cloud | Whole Water (WWTP Effluent) | 275-600 | 1.31 | NA | NA | NA |
| | 47_Wanamingo | Whole Water (WWTP Effluent) | 275-600 | 3.91 | 1.47 | NA | NA |
| | 48_Blue Lake | Whole Water (WWTP Effluent) | 275-600 | 1.88 | NA | NA | NA |
| | 49_Empire | Whole Water (WWTP Effluent) | 275-600 | 0.97 | NA | NA | NA |
| | 50_St. Croix | Whole Water (WWTP Effluent) | 275-600 | 0.78 | 0.80 | NA | NA |
| | 51_Becker (combined stream) | Whole Water (WWTP Effluent) | 275-600 | 0.13 | 0.90 | NA | NA |
| | 52_St. Cloud | Whole Water (WWTP Effluent) | 275-600 | 1.61 | NA | NA | NA |
| | 53_Seneca | Whole Water (WWTP Effluent) | 275-600 | 0.71 | NA | NA | NA |
| | 54_Northfield | Whole Water (WWTP Effluent) | 275-600 | 0.63 | 0.47 | NA | NA |
| | 55_Faribault | Whole Water (WWTP Effluent) | 275-600 | 1.77 | NA | NA | NA |
| | 56_Owatonna | Whole Water (WWTP Effluent) | 275-600 | 1.15 | NA | NA | NA |
| | 57_Metro | Whole Water (WWTP Effluent) | 275-600 | 1.39 | NA | NA | NA |
| | 58_Cannon Falls | Whole Water (WWTP Effluent) | 275-600 | 0.59 | NA | NA | NA |
| | 59_Wanamingo | Whole Water (WWTP Effluent) | 275-600 | 2.90 | NA | NA | NA |
| | 60_Zumbrota | Whole Water (WWTP Effluent) | 275-600 | 6.44 | 3.04 | NA | NA |
| | 61_Rochester | Whole Water (WWTP Effluent) | 275-600 | 2.65 | NA | NA | NA |
| | 62_Kasson | Whole Water (WWTP Effluent) | 275-600 | 2.46 | NA | NA | NA |
| | 63_Northfield | Whole Water (WWTP Effluent) | 275-600 | 1.54 | NA | NA | NA |
| | 64_Faribault | Whole Water (WWTP Effluent) | 275-600 | 5.36 | NA | NA | NA |
| | 65_Empire | Whole Water (WWTP Effluent) | 275-600 | 2.21 | NA | NA | NA |
| | 66_Seneca | Whole Water (WWTP Effluent) | 275-600 | 2.23 | NA | NA | NA |
| | 67_Owatonna | Whole Water (WWTP Effluent) | 275-600 | 2.83 | NA | NA | NA |
| | 69_Zumbrota | Whole Water (WWTP Effluent) | 275-600 | 2.76 | NA | NA | NA |
| | 70_Rochester (conventional aeration) | Whole Water (WWTP Effluent) | 275-600 | 1.75 | NA | NA | NA |
| | 71_Kasson | Whole Water (WWTP Effluent) | 275-600 | 2.68 | NA | NA | NA |
| | 72_Wanamingo | Whole Water (WWTP Effluent) | 275-600 | 1.94 | NA | NA | NA |
| | 73_Becker (residential waste stream) | Whole Water (WWTP Effluent) | 275-600 | 0.69 | 1.27 | NA | NA |
| | 74_St. Cloud | Whole Water (WWTP Effluent) | 275-600 | 1.34 | 0.73 | NA | NA |
| | 75_St. Croix | Whole Water (WWTP Effluent) | 275-600 | 1.43 | NA | NA | NA |
| | 76_Blue Lake | Whole Water (WWTP Effluent) | 275-600 | 2.39 | NA | NA | NA |
| | 77_Metro | Whole Water (WWTP Effluent) | 275-600 | 1.48 | NA | NA | NA |
| | 78_Rochester (non-conventional aeration) | Whole Water (WWTP Effluent) | 275-600 | 2.19 | NA | NA | NA |
| | 79_Becker (industrial waste stream) | Whole Water (WWTP Effluent) | 275-600 | 0.09 | NA | NA | NA |
| | 80_Blue Lake | Whole Water (WWTP Effluent) | 275-600 | 2.07 | NA | NA | NA |
| | 81_Northfield | Whole Water (WWTP Effluent) | 275-600 | 1.32 | NA | NA | NA |

| Table S16. Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^\bullet OH}$ ($\times10^{-6}$ mol mol-photons$^{-1}$) |
| Ref 53 | 82_Faribault | Whole Water (WWTP Effluent) | 275-600 | 8.63 | 2.44 | NA | NA |
| | 83_Seneca | Whole Water (WWTP Effluent) | 275-600 | 0.88 | 1.00 | NA | NA |
| | 84_Empire | Whole Water (WWTP Effluent) | 275-600 | 2.62 | NA | NA | NA |
| | 85_St. Croix | Whole Water (WWTP Effluent) | 275-600 | 1.30 | NA | NA | NA |
| | 86_Metro | Whole Water (WWTP Effluent) | 275-600 | 1.62 | NA | NA | NA |
| | 87_Cannon Falls | Whole Water (WWTP Effluent) | 275-600 | 3.91 | NA | NA | NA |
| | 88_Zumbrota | Whole Water (WWTP Effluent) | 275-600 | 1.82 | NA | NA | NA |
| | 89_Wanamingo | Whole Water (WWTP Effluent) | 275-600 | 4.02 | NA | NA | NA |
| | 90_Rochester (conventional aeration) | Whole Water (WWTP Effluent) | 275-600 | 1.19 | NA | NA | NA |
| | 91_Rochester (non-conventional aeration) | Whole Water (WWTP Effluent) | 275-600 | 1.91 | 1.37 | NA | NA |
| | 92_Kasson | Whole Water (WWTP Effluent) | 275-600 | 2.38 | 1.79 | NA | NA |
| | 93_Becker (industrial waste stream) | Whole Water (WWTP Effluent) | 275-600 | 0.13 | NA | NA | NA |
| | 94_Becker (domestic waste stream) | Whole Water (WWTP Effluent) | 275-600 | 1.09 | NA | NA | NA |
| | 95_St. Cloud | Whole Water (WWTP Effluent) | 275-600 | 1.34 | NA | NA | NA |
| Ref 42 | SRFA | IHSS Isolate (SRFA) | 365 | NA | NA | NA | 27.0 |
| | Arctic lake, rivers, and streams (median) | Whole Water (Lake/River) | 340-410 | NA | NA | NA | 37.6 |
| | Arctic Imnavait Creek (median) | Whole Water (River) | 340-410 | NA | NA | NA | 124.0 |
| Ref 127 | SRNOM | IHSS Isolate (SRNOM) | 365 | NA | 1.80 | NA | NA |
| | SRFA | IHSS Isolate (SRFA) | 365 | NA | 1.40 | NA | NA |
| | SRHA | IHSS Isolate (SRHA) | 365 | NA | 0.60 | NA | NA |
| | NLNOM | IHSS Isolate (NLNOM) | 365 | NA | 1.30 | NA | NA |
| | Upper Mississippi River NOM (MRNOM) | IHSS Isolate (MRNOM) | 365 | NA | 2.00 | NA | NA |
| | PLFA | IHSS Isolate (PLFA) | 365 | NA | 2.40 | NA | NA |
| | Pacific Ocean HPOA | XAD Fraction (Seawater) | 365 | NA | 2.60 | NA | NA |
| | Lake Fryxell FA | XAD Fraction (Lake) | 365 | NA | 2.80 | NA | NA |
| | Everglades HPOA | XAD Fraction (Estuary) | 365 | NA | 1.60 | NA | NA |
| | Williams Lake HPOA | XAD Fraction (Lake) | 365 | NA | 2.20 | NA | NA |
| | Everglades TPIA | XAD Fraction (Estuary) | 365 | NA | 2.80 | NA | NA |
| | Williams Lake TPIA | XAD Fraction (Lake) | 365 | NA | 2.10 | NA | NA |
| | Everglades hydrophobic neutral (HPON) | XAD Fraction (Estuary) | 365 | NA | 3.80 | NA | NA |
| | Williams Lake HPON | XAD Fraction (Lake) | 365 | NA | 3.00 | NA | NA |
| | Great Dismal Swamp | Whole Water (Wetland) | 365 | NA | 1.00 | NA | NA |
| | Lake Bradford | Whole Water (Lake) | 365 | NA | 1.40 | NA | NA |
| | Suwannee River | Whole Water (River) | 365 | NA | 1.60 | NA | NA |
| | Étang de la Gruère | Whole Water (Lake) | 365 | NA | 0.80 | NA | NA |
| | SRNOM | IHSS Isolate (SRNOM) | 300 | NA | 2.50 | NA | NA |
| | SRNOM | IHSS Isolate (SRNOM) | 330 | NA | 2.10 | NA | NA |
| | SRNOM | IHSS Isolate (SRNOM) | 400 | NA | 1.30 | NA | NA |
| | SRNOM | IHSS Isolate (SRNOM) | 430 | NA | 0.90 | NA | NA |
| | SRNOM | IHSS Isolate (SRNOM) | 470 | NA | 0.50 | NA | NA |

| Table S16. Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^\bullet OH}$ (×10$^{-6}$ mol mol-photons$^{-1}$) |
| Ref 127 | SRNOM | IHSS Isolate (SRNOM) | 500 | NA | 0.30 | NA | NA |
| | SRNOM | IHSS Isolate (SRNOM) | 540 | NA | 0.20 | NA | NA |
| | SRNOM | IHSS Isolate (SRNOM) | 560 | NA | 0.10 | NA | NA |
| | PLFA | IHSS Isolate (PLFA) | 300 | NA | 4.00 | NA | NA |
| | PLFA | IHSS Isolate (PLFA) | 400 | NA | 1.60 | NA | NA |
| | PLFA | IHSS Isolate (PLFA) | 430 | NA | 1.10 | NA | NA |
| | PLFA | IHSS Isolate (PLFA) | 470 | NA | 0.40 | NA | NA |
| | Suwannee River | Whole Water (River) | 320 | NA | 1.80 | NA | NA |
| | Suwannee River | Whole Water (River) | 400 | NA | 1.50 | NA | NA |
| | Suwannee River | Whole Water (River) | 430 | NA | 1.10 | NA | NA |
| | Étang de la Gruère | Whole Water (Lake) | 300 | NA | 1.10 | NA | NA |
| | Étang de la Gruère | Whole Water (Lake) | 320 | NA | 1.20 | NA | NA |
| | Étang de la Gruère | Whole Water (Lake) | 340 | NA | 0.80 | NA | NA |
| | Étang de la Gruère | Whole Water (Lake) | 380 | NA | 0.60 | NA | NA |
| Ref 128 | Val-f_Valkea-Kotinen NOM (fall 1999) | RO Isolate (Lake) | 480 | NA | 0.16 | NA | NA |
| | Bir-f_Birkenes NOM (fall 1999) | RO Isolate (Stream) | 480 | NA | 0.19 | NA | NA |
| | Lu-'NOM'_Luther Marsh 'NOM' | UF Fraction (Wetland) | 480 | NA | 0.21 | NA | NA |
| | SKJ-f_Skjervatjern NOM (fall 1999) | RO Isolate (Lake) | 480 | NA | 0.22 | NA | NA |
| | SRNOM | IHSS Isolate (SRNOM) | 480 | NA | 0.23 | NA | NA |
| | SVA-f_Svartberget NOM (fall 1999) | RO Isolate (Stream) | 480 | NA | 0.26 | NA | NA |
| | NOR-NOM_Nordic reference NOM | RO Isolate (Lake) | 480 | NA | 0.29 | NA | NA |
| | SKJ-s_Skjervatjern NOM (spring 2000) | RO Isolate (Lake) | 480 | NA | 0.29 | NA | NA |
| | Val-s_Valkea-Kotinen NOM (spring 2000) | RO Isolate (Lake) | 480 | NA | 0.30 | NA | NA |
| | SVA-s_Svartberget NOM (spring 2000) | RO Isolate (Stream) | 480 | NA | 0.30 | NA | NA |
| | SRHA | IHSS Isolate (SRHA) | 480 | NA | 0.31 | NA | NA |
| | Sa-'NOM'_Sanctuary Pond 'NOM' | UF Fraction (Wetland) | 480 | NA | 0.38 | NA | NA |
| | Heo-NOM_Hellrudmyra NOM | RO Isolate (Lake) | 480 | NA | 0.43 | NA | NA |
| | Fuku-NOM_Fuchskuhle NOM | RO Isolate (Lake) | 480 | NA | 0.48 | NA | NA |
| | SRFA | IHSS Isolate (SRFA) | 480 | NA | 0.57 | NA | NA |
| | Hiet-f_Hietajärvi NOM (fall 1999) | RO Isolate (Lake) | 480 | NA | 0.59 | NA | NA |
| | Hiet-s_Hietajärvi NOM (spring 2000) | RO Isolate (Lake) | 480 | NA | 0.86 | NA | NA |
| | Bir-s_Birkenes NOM (spring 2000) | RO Isolate (Stream) | 480 | NA | 0.91 | NA | NA |
| | Bev-'NOM'_Beverly Swamp 'NOM' | UF Fraction (Wetland) | 480 | NA | 0.61 | NA | NA |
| | Peat(R)-HA_Pahokee peat humic acid (PPHA) | IHSS Isolate (PPHA) | 480 | NA | 0.81 | NA | NA |
| | Peat(S)-HA_Pahokee peat humic acid (PPHA) | IHSS Isolate (PPHA) | 480 | NA | 0.83 | NA | NA |
| | Lau-FA_Laurentian fulvic acid | XAD Fraction (Soil) | 480 | NA | 0.26 | NA | NA |
| | Leon-HA_Leonardit humic acid (LHA) | IHSS Isolate (LHA) | 480 | NA | 0.55 | NA | NA |
| | Sum-HA_Summit Hill Soil humic acid (SHSHA) | IHSS Isolate (SHSHA) | 480 | NA | 0.67 | NA | NA |
| | Soil-HAII_ESHA | IHSS Isolate (ESHA) | 480 | NA | 0.75 | NA | NA |
| | Lau-HA_Laurentian humic acid | XAD Fraction (Soil) | 480 | NA | 1.08 | NA | NA |

| Table S16. Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^{\bullet}OH}$ (×10$^{-6}$ mol mol-photons$^{-1}$) |
| Ref 128 | Soil-FAII_ESFA | IHSS Isolate (ESFA) | 480 | NA | 2.69 | NA | NA |
| Ref 129 | SLR_2 Jun 07 | Whole Water (River) | 365 | NA | 1.80 | NA | NA |
| | SLR_5 Sep 07 | Whole Water (River) | 365 | NA | 2.70 | NA | NA |
| | SLR_15 May 08 | Whole Water (River) | 365 | NA | 0.93 | NA | NA |
| | SLB_26 Aug 08 | Whole Water (River) | 365 | NA | 1.40 | NA | NA |
| | HBR_2 Jun 07 | Whole Water (Lake) | 365 | NA | 2.00 | NA | NA |
| | HBR_5 Sep 07 | Whole Water (Lake) | 365 | NA | 2.50 | NA | NA |
| | HBR_15 May 08 | Whole Water (Lake) | 365 | NA | 0.93 | NA | NA |
| | HBR_26 Aug 08 | Whole Water (Lake) | 365 | NA | 1.50 | NA | NA |
| | A_30 May 07 | Whole Water (Lake) | 365 | NA | 2.10 | NA | NA |
| | A_5 Sep 07 | Whole Water (Lake) | 365 | NA | 3.70 | NA | NA |
| | A_13 May 08 | Whole Water (Lake) | 365 | NA | 0.99 | NA | NA |
| | A_26 Aug 08 | Whole Water (Lake) | 365 | NA | 3.20 | NA | NA |
| | AB1_2 Jun 07 | Whole Water (Lake) | 365 | NA | 2.20 | NA | NA |
| | AB1_5 Sep 07 | Whole Water (Lake) | 365 | NA | 4.70 | NA | NA |
| | AB1_13 May 08 | Whole Water (Lake) | 365 | NA | 0.97 | NA | NA |
| | AB1_26 Aug 08 | Whole Water (Lake) | 365 | NA | 2.70 | NA | NA |
| | AB2_2 Jun 07 | Whole Water (Lake) | 365 | NA | 2.30 | NA | NA |
| | AB2_5 Sep 07 | Whole Water (Lake) | 365 | NA | 5.50 | NA | NA |
| | AB2_13 May 08 | Whole Water (Lake) | 365 | NA | 1.70 | NA | NA |
| | AB2_26 Aug 08 | Whole Water (Lake) | 365 | NA | 3.40 | NA | NA |
| | B_30 May 07 | Whole Water (Lake) | 365 | NA | 2.20 | NA | NA |
| | B_5 Sep 07 | Whole Water (Lake) | 365 | NA | 4.40 | NA | NA |
| | B_13 May 08 | Whole Water (Lake) | 365 | NA | 1.90 | NA | NA |
| | B_26 Aug 08 | Whole Water (Lake) | 365 | NA | 2.90 | NA | NA |
| | C_30 May 07 | Whole Water (Lake) | 365 | NA | 2.20 | NA | NA |
| | C_5 Sep 07 | Whole Water (Lake) | 365 | NA | 5.10 | NA | NA |
| | C_13 May 08 | Whole Water (Lake) | 365 | NA | 2.10 | NA | NA |
| | C_26 Aug 08 | Whole Water (Lake) | 365 | NA | 3.40 | NA | NA |
| | D_1 Jun 07 | Whole Water (Lake) | 365 | NA | 2.50 | NA | NA |
| | D_5 Sep 07 | Whole Water (Lake) | 365 | NA | 5.10 | NA | NA |
| | D_13 May 08 | Whole Water (Lake) | 365 | NA | 2.50 | NA | NA |
| | D_26 Aug 08 | Whole Water (Lake) | 365 | NA | 2.40 | NA | NA |
| | F_1 Jun 07 | Whole Water (Lake) | 365 | NA | 2.30 | NA | NA |
| | F_5 Sep 07 | Whole Water (Lake) | 365 | NA | 4.50 | NA | NA |
| | F_13 May 08 | Whole Water (Lake) | 365 | NA | 2.70 | NA | NA |
| | F_26 Aug 08 | Whole Water (Lake) | 365 | NA | 3.90 | NA | NA |
| | G_1 Jun 07 | Whole Water (Lake) | 365 | NA | 3.10 | NA | NA |
| | G_26 Aug 08 | Whole Water (Lake) | 365 | NA | 3.60 | NA | NA |
| | I_1 Jun 07 | Whole Water (Lake) | 365 | NA | 2.80 | NA | NA |

| Table S16. Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^{\bullet}OH}$ ($\times10^{-6}$ mol mol-photons$^{-1}$) |
| Ref 129 | 10/WML_31 May 07 | Whole Water (Lake) | 365 | NA | 2.50 | NA | NA |
| | 10/WML_14 May 08 | Whole Water (Lake) | 365 | NA | 3.20 | NA | NA |
| | 10/WML_20 Jun 09 | Whole Water (Lake) | 365 | NA | 2.10 | NA | NA |
| | CDM_30 May 07 | Whole Water (Lake) | 365 | NA | 2.20 | NA | NA |
| | CDM_5 Sep 07 | Whole Water (Lake) | 365 | NA | 4.20 | NA | NA |
| | EM_13 Jun 09 | Whole Water (Lake) | 365 | NA | 2.80 | NA | NA |
| | SM_14 Jun 09 | Whole Water (Lake) | 365 | NA | 2.50 | NA | NA |
| | CM_15 Jun 09 | Whole Water (Lake) | 365 | NA | 3.30 | NA | NA |
| | NM_16 Jun 09 | Whole Water (Lake) | 365 | NA | 3.20 | NA | NA |
| | Baptism R. (offshore)_16 Jun 09 | Whole Water (Lake) | 365 | NA | 2.60 | NA | NA |
| | Ontonagon R. (offshore)_19 Jun 09 | Whole Water (Lake) | 365 | NA | 2.00 | NA | NA |
| Ref 130 | Station R (20 m) on 5 November 1993 | Whole Water (Seawater) | 290 | NA | NA | NA | 3430.0 |
| | Station R (20 m) on 5 November 1993 | Whole Water (Seawater) | 295 | NA | NA | NA | 567.4 |
| | Station R (20 m) on 5 November 1993 | Whole Water (Seawater) | 300 | NA | NA | NA | 256.9 |
| | Station R (20 m) on 5 November 1993 | Whole Water (Seawater) | 310 | NA | NA | NA | 220.4 |
| | Station R (20 m) on 5 November 1993 | Whole Water (Seawater) | 320 | NA | NA | NA | 208.9 |
| | Station R (20 m) on 5 November 1993 | Whole Water (Seawater) | 330 | NA | NA | NA | 139.9 |
| | Station R (20 m) on 5 November 1993 | Whole Water (Seawater) | 350 | NA | NA | NA | 36.4 |
| Ref 131 | Dissolved black carbon (DBC)_Bamboo | DBC | 290-400 | NA | 4.07 | NA | NA |
| Ref 132 | Dissolved black carbon_Corn | DBC | 290-400 | NA | 3.47 | NA | NA |
| | Dissolved black carbon_Purslane | DBC | 290-400 | NA | 3.56 | NA | NA |
| | Dissolved black carbon_Soybean | DBC | 290-400 | NA | 6.14 | NA | NA |
| | Dissolved black carbon_Rice | DBC | 290-400 | NA | 3.92 | NA | NA |
| | Dissolved black carbon_Sorghum | DBC | 290-400 | NA | 5.81 | NA | NA |
| | Dissolved black carbon_Bamboo | DBC | 290-400 | NA | 5.32 | NA | NA |
| | Dissolved black carbon_Wheat | DBC | 290-400 | NA | 4.27 | NA | NA |
| | Dissolved black carbon_Millet | DBC | 290-400 | NA | 4.31 | NA | NA |
| | Dissolved black carbon_Peanut | DBC | 290-400 | NA | 4.03 | NA | NA |
| | SRFA | IHSS Isolate (SRFA) | 290-400 | NA | 2.15 | NA | NA |
| | NLNOM | IHSS Isolate (NLNOM) | 290-400 | NA | 3.58 | NA | NA |
| | PLFA | IHSS Isolate (PLFA) | 290-400 | NA | 3.12 | NA | NA |
| | MRNOM | IHSS Isolate (MRNOM) | 290-400 | NA | 3.28 | NA | NA |
| | PPHA | IHSS Isolate (PPHA) | 290-400 | NA | 1.81 | NA | NA |
| | SRNOM | IHSS Isolate (SRNOM) | 290-400 | NA | 2.73 | NA | NA |
| | LHA | IHSS Isolate (LHA) | 290-400 | NA | 1.31 | NA | NA |
| | Pahokee peat fulvic acid (PPFA) | IHSS Isolate (PPFA) | 290-400 | NA | 3.40 | NA | NA |
| | NFA | IHSS Isolate (NFA) | 290-400 | NA | 1.28 | NA | NA |
| Ref 133 | Mississippi 1995 T2C > 3 kDa | UF Fraction (River) | 280-380 | NA | 1.70 | NA | NA |
| | Mississippi 1995 T2D> 3 kDa | UF Fraction (River) | 280-380 | NA | 1.70 | NA | NA |
| | Mississippi 1995 T2E > 3 kDa | UF Fraction (River) | 280-380 | NA | 1.70 | NA | NA |

| Table S16. Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^\bullet OH}$ ($\times10^{-6}$ mol mol-photons$^{-1}$) |
| Ref 133 | Atchafalaya 1995 T1A > 3 kDa | UF Fraction (River) | 280-380 | NA | 2.70 | NA | NA |
| | Atchafalaya 1995 T1B > 3 kDa | UF Fraction (River) | 280-380 | NA | 1.90 | NA | NA |
| | Atchafalaya 1995 T1D > 3 kDa | UF Fraction (River) | 280-380 | NA | 2.00 | NA | NA |
| | Atchafalaya 1995 T1E > 3 kDa | UF Fraction (River) | 280-380 | NA | 1.60 | NA | NA |
| | Gulf of Mexico BGOM > 1 kDa | UF Fraction (Estuary) | 280-380 | NA | 3.90 | NA | NA |
| | Mississippi River BMISS > 1 kDa | UF Fraction (River) | 280-380 | NA | 6.10 | NA | NA |
| | Apalachicola River APP > 3 kDa | UF Fraction (River) | 280-380 | NA | 1.40 | NA | NA |
| | Aldrich HA | XAD Fraction (Soil) | 280-380 | NA | 1.00 | NA | NA |
| | Mississippi 1996 MD > 3 kDa | UF Fraction (River) | 280-380 | NA | 2.00 | NA | NA |
| | Mississippi 1996 MC > 3 kDa | UF Fraction (River) | 280-380 | NA | 1.80 | NA | NA |
| | Mississippi 1996 MA > 3 kDa | UF Fraction (River) | 280-380 | NA | 1.70 | NA | NA |
| | Blackwater River BWR | UF Fraction (River) | 280-380 | NA | 3.80 | NA | NA |
| Ref 134 | PLFA | IHSS Isolate (PLFA) | 346 | 6.90 | NA | NA | NA |
| | SRNOM | IHSS Isolate (SRNOM) | 346 | 4.10 | NA | NA | NA |
| | LHA | IHSS Isolate (LHA) | 346 | 4.10 | NA | NA | NA |
| | Lake Bradford | Whole Water (Lake) | 346 | 7.80 | NA | NA | NA |
| | Great Dismal Swamp | Whole Water (Wetland) | 346 | 5.60 | NA | NA | NA |
| Ref 135 | Sharpes Bay water sample, Ontario, Canada | Whole Water (Lake) | 280 | NA | 3.35 | NA | NA |
| | Sharpes Bay water sample, Ontario, Canada | Whole Water (Lake) | 300 | NA | 0.59 | NA | NA |
| | Sharpes Bay water sample, Ontario, Canada | Whole Water (Lake) | 340 | NA | 0.14 | NA | NA |
| | Sharpes Bay water sample, Ontario, Canada | Whole Water (Lake) | 360 | NA | 0.08 | NA | NA |
| | Sharpes Bay water sample, Ontario, Canada | Whole Water (Lake) | 400 | NA | 0.24 | NA | NA |
| Ref 136 | SRNOM | IHSS Isolate (SRNOM) | 370 | NA | 1.40 | NA | NA |
| | SRNOM reduced | IHSS Isolate (SRNOM, $NaBH_4$) | 370 | NA | 1.40 | NA | NA |
| | SRFA | IHSS Isolate (SRFA) | 370 | NA | 1.80 | NA | NA |
| | SRFA reduced | IHSS Isolate (SRFA, $NaBH_4$) | 370 | NA | 1.80 | NA | NA |
| | NLNOM | IHSS Isolate (NLNOM) | 370 | NA | 2.70 | NA | NA |
| | NLNOM reduced | IHSS Isolate (NLNOM, $NaBH_4$) | 370 | NA | 3.20 | NA | NA |
| Ref 48 | SRFA 0 h | IHSS Isolate (SRFA) | 300-500 | 1.24 | 1.80 | NA | 105.6 |
| | SRFA 11 h | IHSS Isolate (SRFA) | 300-500 | 1.19 | 1.92 | NA | 73.9 |
| | SRFA 35 h | IHSS Isolate (SRFA) | 300-500 | 1.12 | 1.96 | NA | 67.2 |
| | SRFA 59 h | IHSS Isolate (SRFA) | 300-500 | 0.89 | 1.99 | NA | 74.6 |
| | NFA 0 h | IHSS Isolate (NFA) | 300-500 | 0.78 | 1.42 | NA | 85.4 |
| | NFA 11 h | IHSS Isolate (NFA) | 300-500 | 0.86 | 1.58 | NA | 58.9 |
| | NFA 35 h | IHSS Isolate (NFA) | 300-500 | 0.62 | 1.67 | NA | 50.8 |
| | NFA 59 h | IHSS Isolate (NFA) | 300-500 | 0.74 | 1.74 | NA | 56.8 |
| | ESHA 0 h | IHSS Isolate (ESHA) | 300-500 | 5.02 | 2.00 | NA | 26.0 |
| | ESHA 11 h | IHSS Isolate (ESHA) | 300-500 | 3.67 | 2.23 | NA | 20.0 |
| | ESHA 35 h | IHSS Isolate (ESHA) | 300-500 | 2.56 | 2.37 | NA | 16.9 |
| | ESHA 59 h | IHSS Isolate (ESHA) | 300-500 | 2.19 | 2.68 | NA | 16.0 |

| **Table S16.** Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^\bullet OH}$ ($\times10^{-6}$ mol mol-photons$^{-1}$) |
| Ref 137 | SRFA | IHSS Isolate (SRFA) | 300 | NA | NA | NA | 36.0 |
| | SRFA (aerobic) | IHSS Isolate (SRFA) | 305 | NA | NA | NA | 56.5 |
| | SRFA (aerobic) | IHSS Isolate (SRFA) | 310 | NA | NA | NA | 96.0 |
| | SRFA (aerobic) | IHSS Isolate (SRFA) | 320 | NA | NA | NA | 86.5 |
| | SRFA (aerobic) | IHSS Isolate (SRFA) | 330 | NA | NA | NA | 62.9 |
| | SRFA (aerobic) | IHSS Isolate (SRFA) | 340 | NA | NA | NA | 42.4 |
| | SRFA (aerobic) | IHSS Isolate (SRFA) | 345 | NA | NA | NA | 57.9 |
| | SRFA (aerobic) | IHSS Isolate (SRFA) | 350 | NA | NA | NA | 41.1 |
| | SRFA (aerobic) | IHSS Isolate (SRFA) | 360 | NA | NA | NA | 23.5 |
| | SRFA (anaerobic) | IHSS Isolate (SRFA) | 295 | NA | NA | NA | 18.3 |
| | SRFA (anaerobic) | IHSS Isolate (SRFA) | 300 | NA | NA | NA | 35.9 |
| | SRFA (anaerobic) | IHSS Isolate (SRFA) | 310 | NA | NA | NA | 45.5 |
| | SRFA (anaerobic) | IHSS Isolate (SRFA) | 320 | NA | NA | NA | 76.5 |
| | SRFA (anaerobic) | IHSS Isolate (SRFA) | 330 | NA | NA | NA | 55.6 |
| | SRFA (anaerobic) | IHSS Isolate (SRFA) | 340 | NA | NA | NA | 49.7 |
| | SRFA (anaerobic) | IHSS Isolate (SRFA) | 343 | NA | NA | NA | 14.5 |
| | SRFA (anaerobic) | IHSS Isolate (SRFA) | 350 | NA | NA | NA | 3.0 |
| | Upper Delaware Bay (aerobic) | Whole Water (Estuary) | 320 | NA | NA | NA | 600.0 |
| | Upper Delaware Bay (aerobic) | Whole Water (Estuary) | 320 | NA | NA | NA | 160.0 |
| | Upper Delaware Bay (aerobic) | Whole Water (Estuary) | 320 | NA | NA | NA | 200.0 |
| | Chesapeake Bay Mouth (anaerobic) | Whole Water (Estuary) | 320 | NA | NA | NA | 110.0 |
| | Upper Delaware Bay (anaerobic) | Whole Water (Estuary) | 320 | NA | NA | NA | 230.0 |
| | Upper Delaware Bay (anaerobic) | Whole Water (Estuary) | 320 | NA | NA | NA | 300.0 |
| | Upper Delaware Bay (aerobic) | Whole Water (Estuary) | 310 | NA | NA | NA | 126.9 |
| | Upper Delaware Bay (aerobic) | Whole Water (Estuary) | 330 | NA | NA | NA | 107.4 |
| | Upper Delaware Bay (anaerobic) | Whole Water (Estuary) | 300 | NA | NA | NA | 315.3 |
| | Upper Delaware Bay (anaerobic) | Whole Water (Estuary) | 310 | NA | NA | NA | 272.2 |
| | Upper Delaware Bay (anaerobic) | Whole Water (Estuary) | 330 | NA | NA | NA | 121.0 |
| | Upper Delaware Bay (anaerobic) | Whole Water (Estuary) | 340 | NA | NA | NA | 101.1 |
| Ref 138 | EfOM Wastewater effluent | C18 Extract (WWTP Effluent) | 300-600 | 4.01 | 3.29 | NA | 66.9 |
| | Henan Changsheng Industrial Fulvic acid | XAD Fraction (Soil) | 300-600 | 2.75 | 2.23 | NA | 4.0 |
| | Aldrich HA | XAD Fraction (Soil) | 300-600 | 2.62 | 2.15 | NA | 11.0 |
| Ref 139 | Dissolved black carbon_Sorghum straw | DBC | 290-400 | 24.58 | 3.71 | 2.62 | NA |
| | Dissolved black carbon_Peanut straw | DBC | 290-400 | 11.27 | 6.68 | 5.69 | NA |
| | Dissolved black carbon_Maize straw | DBC | 290-400 | 17.75 | 3.75 | 3.08 | NA |
| | Dissolved black carbon_Soybean straw | DBC | 290-400 | 14.36 | 4.82 | 4.21 | NA |
| | Dissolved black carbon_Bamboo | DBC | 290-400 | 11.82 | 3.21 | 2.11 | NA |
| | Dissolved black carbon_Rice straw | DBC | 290-400 | 21.27 | 3.08 | 1.86 | NA |
| | NLNOM | IHSS Isolate (NLNOM) | 290-400 | 3.15 | 3.71 | 1.78 | NA |
| | PLFA | IHSS Isolate (PLFA) | 290-400 | 3.87 | 5.29 | 4.32 | NA |

| **Table S16.** Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^\bullet OH}$ (×10$^{-6}$ mol mol-photons$^{-1}$) |
| Ref 139 | SRFA | IHSS Isolate (SRFA) | 290-400 | 3.40 | 2.66 | 1.69 | NA |
| | SRHA | IHSS Isolate (SRHA) | 290-400 | 1.74 | 2.02 | 0.59 | NA |
| | SRNOM | IHSS Isolate (SRNOM) | 290-400 | 2.52 | 2.46 | 1.47 | NA |
| Ref 100 | Wetland influent PPL Isolate | PPL Extract (Wetland) | 300-700 | 0.84 | 2.66 | NA | NA |
| | Wetland influent | Whole Water (Wetland) | 300-700 | 0.66 | 2.27 | NA | NA |
| | Wetland influent PPL discharge | PPL Discharge (Wetland) | 300-700 | 2.43 | NA | NA | NA |
| | Bulrush cell effluent PPL Isolate | PPL Extract (Wetland) | 300-700 | 0.79 | 1.86 | NA | NA |
| | Bulrush cell effluent | Whole Water (Wetland) | 300-700 | 0.77 | 1.95 | NA | NA |
| | Bulrush cell effluent PPL discharge | PPL Discharge (Wetland) | 300-700 | 3.09 | NA | NA | NA |
| | Cattail cell effluent PPL Isolate | PPL Extract (Wetland) | 300-700 | 0.66 | 1.80 | NA | NA |
| | Cattail cell effluent | Whole Water (Wetland) | 300-700 | 0.39 | 2.11 | NA | NA |
| | Cattail cell effluent PPL discharge | PPL Discharge (Wetland) | 300-700 | 2.37 | NA | NA | NA |
| | Open water cell effluent PPL Isolate | PPL Extract (Wetland) | 300-700 | 0.64 | 2.52 | NA | NA |
| | Open water cell effluent | Whole Water (Wetland) | 300-700 | 0.50 | 3.20 | NA | NA |
| | Open water cell effluent PPL discharge | PPL Discharge (Wetland) | 300-700 | 2.34 | NA | NA | NA |
| | SRFA | IHSS Isolate (SRFA) | 300-700 | 1.43 | 1.44 | NA | NA |
| | PLFA | IHSS Isolate (PLFA) | 300-700 | 0.33 | 1.92 | NA | NA |
| Ref 140 | Satilla River water | Whole Water (River) | 300 | NA | NA | NA | 385.6 |
| | Satilla River water | Whole Water (River) | 310 | NA | NA | NA | 1106.7 |
| | Satilla River water | Whole Water (River) | 320 | NA | NA | NA | 218.0 |
| Ref 141 | Lower Yangtze River | Whole Water (River) | 290-400 | NA | NA | NA | 854.0 |
| | Qinhuai River | Whole Water (River) | 290-400 | NA | NA | NA | 625.0 |
| | Middle Yangtze River | Whole Water (River) | 290-400 | NA | NA | NA | 636.0 |
| | Ganjiang | Whole Water (River) | 290-400 | NA | NA | NA | 519.0 |
| | Wangyu River | Whole Water (River) | 290-400 | NA | NA | NA | 668.0 |
| | Jiuli River | Whole Water (River) | 290-400 | NA | NA | NA | 363.0 |
| | Meiliang Bay of Taihu | Whole Water (Lake) | 290-400 | NA | NA | NA | 503.0 |
| | East Taihu Lake | Whole Water (Lake) | 290-400 | NA | NA | NA | 462.0 |
| | Changdang Lake | Whole Water (Lake) | 290-400 | NA | NA | NA | 757.0 |
| | Chaohu Lake | Whole Water (Lake) | 290-400 | NA | NA | NA | 388.0 |
| | Xuanwu Lake | Whole Water (Lake) | 290-400 | NA | NA | NA | 1830.0 |
| Ref 142 | Okefenokee Swamp, Georgia | Whole Water (Wetland) | 366 | NA | 5.60 | NA | NA |
| | Aucilla River, Lamont, Florida | Whole Water (River) | 366 | NA | 2.60 | NA | NA |
| | Econfina River near Perry, Florida | Whole Water (River) | 366 | NA | 3.20 | NA | NA |
| | Fenholloway River, Foley, Florida | Whole Water (River) | 366 | NA | 1.40 | NA | NA |
| | Wakulla River near Wakulla Springs, Florida | Whole Water (River) | 366 | NA | 6.00 | NA | NA |
| | St Marks River, St Marks, FL | Whole Water (River) | 366 | NA | 3.00 | NA | NA |
| | Gulf of Mexico, Shell Point, FL | Whole Water (Estuary) | 366 | NA | 6.00 | NA | NA |
| | Gulf of Mexico, Live Oak Island, FL | Whole Water (Estuary) | 366 | NA | 5.20 | NA | NA |
| | Puddle in peanut field, Sylvester, GA | Whole Water (Puddle) | 366 | NA | 6.50 | NA | NA |
| | Mississippi River, Baton Rouge, Louisiana | Whole Water (River) | 366 | NA | 9.30 | NA | NA |
| | Hickory Hills Pond, Athens, GA | Whole Water (Pond) | 366 | NA | 1.90 | NA | NA |

| **Table S16.** Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ (×10$^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^\bullet OH}$ (×10$^{-6}$ mol mol-photons$^{-1}$) |
| Ref 111 | Aucilla River, Lamont, Florida | Whole Water (River) | 313 | NA | 2.80 | NA | NA |
| | Aucilla River, Lamont, Florida | Whole Water (River) | 366 | NA | 1.10 | NA | NA |
| | Aucilla River, Lamont, Florida | Whole Water (River) | 405 | NA | 0.60 | NA | NA |
| | Ogeechee River near Savannah, GA | Whole Water (River) | 366 | NA | 1.60 | NA | NA |
| | Suwannee River, Suwannee Springs, FL | Whole Water (River) | 313 | NA | 2.40 | NA | NA |
| | Suwannee River, Suwannee Springs, FL | Whole Water (River) | 366 | NA | 1.70 | NA | NA |
| | Wylde Lake humus (Ontario) | XAD Fraction (Lake) | 313 | NA | 1.60 | NA | NA |
| | Wylde Lake humus (Ontario) | XAD Fraction (Lake) | 366 | NA | 0.60 | NA | NA |
| | Wylde Lake humus (Ontario) | XAD Fraction (Lake) | 405 | NA | 0.30 | NA | NA |
| | Fluka HA | XAD Fraction (Soil) | 313 | NA | 1.10 | NA | NA |
| | Fluka HA | XAD Fraction (Soil) | 366 | NA | 0.40 | NA | NA |
| | Fluka HA | XAD Fraction (Soil) | 405 | NA | 0.40 | NA | NA |
| | Aldrich HA | XAD Fraction (Soil) | 313 | NA | 1.30 | NA | NA |
| | Aldrich HA | XAD Fraction (Soil) | 366 | NA | 0.40 | NA | NA |
| | Contech fulvic acid | XAD Fraction (Soil) | 313 | NA | 0.40 | NA | NA |
| | Contech fulvic acid | XAD Fraction (Soil) | 366 | NA | 0.50 | NA | NA |
| Ref 143 | SRHA | IHSS Isolate (SRHA) | 290-400 | NA | 1.38 | NA | 30.1 |
| | SRFA | IHSS Isolate (SRFA) | 290-400 | NA | 1.85 | NA | 42.9 |
| | PLFA | IHSS Isolate (PLFA) | 290-400 | NA | 1.34 | NA | 45.6 |
| | Effluent | Whole Water (WWTP Effluent) | 290-400 | NA | 2.66 | NA | 49.6 |
| | Effluent hydrophobic (HPO) | XAD Fraction (WWTP Effluent) | 290-400 | NA | 3.24 | NA | 79.7 |
| | Effluent transphilic (TPI) | XAD Fraction (WWTP Effluent) | 290-400 | NA | 2.45 | NA | 86.9 |
| | Effluent hydrophilic (HPI) | XAD Fraction (WWTP Effluent) | 290-400 | NA | 8.16 | NA | 28.7 |
| Ref 144 | Effluent1 | Whole Water (WWTP Effluent) | 290-400 | 6.96 | 5.49 | NA | NA |
| | HPO1 | XAD Fraction (WWTP Effluent) | 290-400 | 4.77 | 4.02 | NA | NA |
| | TPI1 | XAD Fraction (WWTP Effluent) | 290-400 | 7.42 | 4.67 | NA | NA |
| | HPI1 | XAD Fraction (WWTP Effluent) | 290-400 | 0.93 | 9.03 | NA | NA |
| | Effluent2 | Whole Water (WWTP Effluent) | 290-400 | 6.80 | 6.11 | NA | NA |
| | HPO2 | XAD Fraction (WWTP Effluent) | 290-400 | 5.63 | 4.00 | NA | NA |
| | TPI2 | XAD Fraction (WWTP Effluent) | 290-400 | 7.07 | 5.29 | NA | NA |
| | HPI2 | XAD Fraction (WWTP Effluent) | 290-400 | 1.12 | 8.61 | NA | NA |
| | SRNOM | IHSS Isolate (SRNOM) | 290-400 | 3.09 | 2.88 | NA | NA |
| | SRHA | IHSS Isolate (SRHA) | 290-400 | 1.97 | 2.05 | NA | NA |
| | SRFA | IHSS Isolate (SRFA) | 290-400 | 4.43 | 3.10 | NA | NA |
| | PLFA | IHSS Isolate (PLFA) | 290-400 | 3.53 | 4.51 | NA | NA |
| Ref 47 | SRNOM λ > 315 nm sorbic acid | IHSS Isolate (SRNOM) | 315-400 | NA | NA | 0.68 | NA |
| | SRNOM λ > 315 nm sorbic alcohol | IHSS Isolate (SRNOM) | 315-400 | NA | NA | 0.75 | NA |
| | SRNOM λ > 315 nm sorbic amine | IHSS Isolate (SRNOM) | 315-400 | NA | NA | 0.75 | NA |
| | SRNOM λ > 290 nm sorbic acid | IHSS Isolate (SRNOM) | 290-400 | NA | NA | 0.96 | NA |
| | SRNOM λ > 290 nm sorbic alcohol | IHSS Isolate (SRNOM) | 290-400 | NA | NA | 0.97 | NA |
| | SRNOM λ > 290 nm sorbic amine | IHSS Isolate (SRNOM) | 290-400 | NA | NA | 0.96 | NA |
| Ref 105 | WWOM 1 Wastewater-impacted lake | PPL Extract (WWTP-Lake) | 290-400 | 10.74 | 7.42 | 7.46 | NA |

| **Table S16.** Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ (×10^-2^ mol mol-photons^-1^) | $\Phi_{app,\ ^1O_2}$ (×10^-2^ mol mol-photons^-1^) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ (×10^-2^ mol mol-photons^-1^) | $\Phi_{app,\ ^\bullet OH}$ (×10^-6^ mol mol-photons^-1^) |
| Ref 105 | WWOM 2 Wastewater-impacted river | PPL Extract (WWTP-River) | 290-400 | 9.56 | 7.95 | 6.78 | NA |
| | WWOM 3 Wastewater-impacted river | PPL Extract (WWTP-River) | 290-400 | 8.89 | 7.46 | 6.72 | NA |
| | WWOM 4 Wastewater-impacted river | PPL Extract (WWTP-River) | 290-400 | 7.44 | 6.47 | 5.75 | NA |
| | WWOM 5 Wastewater-impacted lake | PPL Extract (WWTP-Lake) | 290-400 | 8.07 | 6.14 | 5.33 | NA |
| | WWOM 6 Wastewater-impacted lake | PPL Extract (WWTP-Lake) | 290-400 | 8.15 | 6.11 | 5.72 | NA |
| | WWOM 7 Wastewater-impacted lake | PPL Extract (WWTP-Lake) | 290-400 | 9.11 | 7.18 | 6.62 | NA |
| | WWOM 8 Wastewater-impacted river | PPL Extract (WWTP-River) | 290-400 | 9.85 | 7.30 | 6.84 | NA |
| | EfOM 1 Wastewater Effluent | PPL Extract (WWTP Effluent) | 290-400 | 4.63 | 4.55 | 4.01 | NA |
| | EfOM 2 Wastewater Effluent | PPL Extract (WWTP Effluent) | 290-400 | 5.11 | 5.45 | 4.37 | NA |
| | SRNOM | IHSS Isolate (SRNOM) | 290-400 | 2.52 | 2.46 | 1.47 | NA |
| | SRHA | IHSS Isolate (SRHA) | 290-400 | 1.72 | 2.02 | 0.59 | NA |
| | SRFA | IHSS Isolate (SRFA) | 290-400 | 3.39 | 2.66 | 1.70 | NA |
| | PLFA | IHSS Isolate (PLFA) | 290-400 | 3.86 | 5.29 | 4.32 | NA |
| | NLNOM | IHSS Isolate (NLNOM) | 290-400 | 3.11 | 3.70 | 1.79 | NA |
| | | | | | | | |
| This work | Arbutus Lake | Whole Water (Lake) | 290-550 | 3.43±0.13 | 2.65±0.25 | 0.91±0.01 | 4.62±0.97 |
| | Big Moose Lake | Whole Water (Lake) | 290-550 | 3.17±0.30 | 2.62±0.05 | 1.00±0.01 | 7.93±0.33 |
| | Black Pond | Whole Water (Lake) | 290-550 | 2.37±0.14 | 1.89±0.18 | 0.58±0.03 | 6.42±0.76 |
| | Dart Lake | Whole Water (Lake) | 290-550 | 2.98±0.10 | 2.58±0.21 | 0.94±0.01 | 7.95±0.38 |
| | G Lake | Whole Water (Lake) | 290-550 | 2.85±0.08 | 2.34±0.27 | 0.94±0.01 | 12.88±1.79 |
| | Honnedaga Lake | Whole Water (Lake) | 290-550 | 2.36±0.27 | 1.90±0.17 | 0.57±0.02 | 10.31±1.12 |
| | Limekiln Lake | Whole Water (Lake) | 290-550 | 3.02±0.28 | 2.12±0.04 | 0.84±0.01 | 7.69±0.72 |
| | Little Hope Pond | Whole Water (Lake) | 290-550 | 1.32±0.16 | 1.53±0.13 | 0.39±0.01 | 1.44±0.07 |
| | Moss Lake | Whole Water (Lake) | 290-550 | 2.53±0.30 | 1.88±0.21 | 0.68±0.01 | 5.75±0.89 |
| | North Lake | Whole Water (Lake) | 290-550 | 2.00±0.21 | 1.96±0.19 | 0.68±0.02 | 5.13±0.47 |
| | Lake Rondaxe | Whole Water (Lake) | 290-550 | 2.36±0.13 | 2.08±0.20 | 0.74±0.03 | 3.02±0.34 |
| | Sagamore Lake | Whole Water (Lake) | 290-550 | 1.43±0.16 | 1.63±0.12 | 0.43±0.02 | 3.34±0.81 |
| | South Lake | Whole Water (Lake) | 290-550 | 3.05±0.12 | 2.30±0.07 | 0.83±0.01 | 11.97±1.04 |
| | Squaw Lake | Whole Water (Lake) | 290-550 | 3.84±0.28 | 2.88±0.22 | 1.04±0.01 | 5.78±1.07 |
| | Willis Lake | Whole Water (Lake) | 290-550 | 2.68±0.06 | 2.17±0.16 | 0.71±0.02 | 4.51±1.02 |
| | Wolf Lake | Whole Water (Lake) | 290-550 | 4.75±0.49 | 3.31±0.35 | 1.22±0.05 | 9.61±0.89 |
| | Arbutus Lake - pH 6.5 | Whole Water (Lake) | 290-550 | 3.30±0.06 | 3.17±0.22 | NA | 9.67±0.67 |
| | Big Moose Lake - pH 6.5 | Whole Water (Lake) | 290-550 | 3.02±0.02 | 3.09±0.17 | NA | 4.45±0.16 |
| | Black Pond - pH 6.5 | Whole Water (Lake) | 290-550 | 2.37±0.15 | 1.89±0.17 | NA | 6.42±0.76 |
| | Dart Lake - pH 6.5 | Whole Water (Lake) | 290-550 | 2.31±0.18 | 2.84±0.27 | NA | 4.34±0.88 |
| | G Lake - pH 6.5 | Whole Water (Lake) | 290-550 | 2.85±0.07 | 2.34±0.25 | NA | 12.88±1.79 |
| | Honnedaga Lake - pH 6.5 | Whole Water (Lake) | 290-550 | 2.36±0.27 | 1.90±0.16 | NA | 10.31±1.12 |
| | Limekiln Lake - pH 6.5 | Whole Water (Lake) | 290-550 | 3.53±0.29 | 2.32±0.05 | NA | 8.49±0.33 |
| | Little Hope Pond - pH 6.5 | Whole Water (Lake) | 290-550 | 0.88±0.09 | 1.64±0.17 | NA | 1.30±0.09 |
| | Moss Lake - pH 6.5 | Whole Water (Lake) | 290-550 | 2.06±0.13 | 2.02±0.21 | NA | 10.24±1.00 |
| | North Lake - pH 6.5 | Whole Water (Lake) | 290-550 | 1.37±0.08 | 1.75±0.06 | NA | 5.94±0.59 |
| | Lake Rondaxe - pH 6.5 | Whole Water (Lake) | 290-550 | 2.38±0.18 | 2.27±0.11 | NA | 6.79±2.35 |

| **Table S16.** Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^{\bullet}OH}$ ($\times10^{-6}$ mol mol-photons$^{-1}$) |
| This work | Sagamore Lake - pH 6.5 | Whole Water (Lake) | 290-550 | 1.37±0.09 | 1.66±0.08 | NA | 6.73±0.41 |
| | South Lake - pH 6.5 | Whole Water (Lake) | 290-550 | 3.05±0.13 | 2.30±0.05 | NA | 11.97±1.04 |
| | Squaw Lake - pH 6.5 | Whole Water (Lake) | 290-550 | 6.43±0.60 | 4.50±0.32 | NA | 17.93±1.40 |
| | Willis Lake - pH 6.5 | Whole Water (Lake) | 290-550 | 2.29±0.17 | 2.49±0.08 | NA | 6.82±0.24 |
| | Wolf Lake - pH 6.5 | Whole Water (Lake) | 290-550 | 4.75±0.49 | 3.31±0.31 | NA | 9.61±0.89 |
| | Arbutus Lake - pH 4.5 | Whole Water (Lake) | 290-550 | 2.78±0.33 | 3.12±0.03 | NA | 10.48±0.88 |
| | Big Moose Lake - pH 4.5 | Whole Water (Lake) | 290-550 | 0.88±0.10 | 1.81±0.08 | NA | 4.31±0.57 |
| | Black Pond - pH 4.5 | Whole Water (Lake) | 290-550 | 1.00±0.15 | 2.18±0.25 | NA | 10.05±2.16 |
| | Dart Lake - pH 4.5 | Whole Water (Lake) | 290-550 | 3.02±0.29 | 3.39±0.28 | NA | 14.13±1.97 |
| | G Lake - pH 4.5 | Whole Water (Lake) | 290-550 | 1.79±0.08 | 2.53±0.01 | NA | 13.51±2.97 |
| | Honnedaga Lake - pH 4.5 | Whole Water (Lake) | 290-550 | 1.66±0.21 | 2.35±0.27 | NA | 18.66±3.87 |
| | Limekiln Lake - pH 4.5 | Whole Water (Lake) | 290-550 | 2.03±0.15 | 2.10±0.28 | NA | 9.26±2.55 |
| | Little Hope Pond - pH 4.5 | Whole Water (Lake) | 290-550 | 1.34±0.13 | 1.78±0.17 | NA | 1.88±0.27 |
| | Moss Lake - pH 4.5 | Whole Water (Lake) | 290-550 | 1.15±0.12 | 1.44±0.06 | NA | 5.43±0.40 |
| | North Lake - pH 4.5 | Whole Water (Lake) | 290-550 | 0.87±0.06 | 1.67±0.08 | NA | 8.41±1.15 |
| | Lake Rondaxe - pH 4.5 | Whole Water (Lake) | 290-550 | 5.90±0.04 | 4.55±0.40 | NA | 18.15±2.48 |
| | Sagamore Lake - pH 4.5 | Whole Water (Lake) | 290-550 | 1.29±0.08 | 2.01±0.19 | NA | 16.76±1.21 |
| | South Lake - pH 4.5 | Whole Water (Lake) | 290-550 | 5.32±0.65 | 4.80±0.40 | NA | 21.36±2.79 |
| | Squaw Lake - pH 4.5 | Whole Water (Lake) | 290-550 | 4.89±0.45 | 3.65±0.31 | NA | 14.54±1.38 |
| | Willis Lake - pH 4.5 | Whole Water (Lake) | 290-550 | 1.19±0.12 | 2.34±0.06 | NA | 6.95±0.88 |
| | Wolf Lake - pH 4.5 | Whole Water (Lake) | 290-550 | 6.85±0.61 | 5.15±0.37 | NA | 21.23±1.63 |
| | Arbutus Lake - pH 8.5 | Whole Water (Lake) | 290-550 | 2.04±0.19 | 2.15±0.19 | NA | 6.76±0.60 |
| | Big Moose Lake - pH 8.5 | Whole Water (Lake) | 290-550 | 2.68±0.27 | 2.28±0.03 | NA | 9.67±1.54 |
| | Black Pond - pH 8.5 | Whole Water (Lake) | 290-550 | 2.73±0.28 | 2.09±0.17 | NA | 7.31±0.60 |
| | Dart Lake - pH 8.5 | Whole Water (Lake) | 290-550 | 2.72±0.31 | 2.15±0.20 | NA | 10.33±1.22 |
| | G Lake - pH 8.5 | Whole Water (Lake) | 290-550 | 2.68±0.12 | 2.42±0.15 | NA | 12.80±1.49 |
| | Honnedaga Lake - pH 8.5 | Whole Water (Lake) | 290-550 | 2.66±0.14 | 2.38±0.12 | NA | 14.76±1.48 |
| | Limekiln Lake - pH 8.5 | Whole Water (Lake) | 290-550 | 3.19±0.24 | 2.46±0.18 | NA | 14.35±2.93 |
| | Little Hope Pond - pH 8.5 | Whole Water (Lake) | 290-550 | 1.15±0.12 | 1.39±0.11 | NA | 6.37±0.48 |
| | Moss Lake - pH 8.5 | Whole Water (Lake) | 290-550 | 2.75±0.33 | 2.06±0.04 | NA | 8.80±1.33 |
| | North Lake - pH 8.5 | Whole Water (Lake) | 290-550 | 2.16±0.20 | 1.90±0.03 | NA | 9.04±1.83 |
| | Lake Rondaxe - pH 8.5 | Whole Water (Lake) | 290-550 | 5.04±0.77 | 3.94±0.24 | NA | 19.00±3.38 |
| | Sagamore Lake - pH 8.5 | Whole Water (Lake) | 290-550 | 1.31±0.09 | 1.47±0.13 | NA | 7.30±0.68 |
| | South Lake - pH 8.5 | Whole Water (Lake) | 290-550 | 3.13±0.20 | 2.06±0.13 | NA | 11.43±1.01 |
| | Squaw Lake - pH 8.5 | Whole Water (Lake) | 290-550 | 3.25±0.30 | 2.57±0.17 | NA | 8.06±0.94 |
| | Willis Lake - pH 8.5 | Whole Water (Lake) | 290-550 | 2.23±0.08 | 1.77±0.09 | NA | 5.98±0.85 |
| | Wolf Lake - pH 8.5 | Whole Water (Lake) | 290-550 | 3.07±0.43 | 1.95±0.03 | NA | 7.25±1.03 |
| | Arbutus Lake - pH 4.5 + Al | Whole Water (Lake) | 290-550 | 2.29±0.11 | 2.29±0.03 | NA | 3.14±0.15 |
| | Big Moose Lake - pH 4.5 + Al | Whole Water (Lake) | 290-550 | 1.49±0.14 | 2.03±0.18 | NA | 2.36±0.12 |
| | Black Pond - pH 4.5 + Al | Whole Water (Lake) | 290-550 | 1.14±0.02 | 1.49±0.06 | NA | 6.17±0.93 |
| | Dart Lake - pH 4.5 + Al | Whole Water (Lake) | 290-550 | 1.84±0.01 | 2.47±0.21 | NA | 4.27±0.18 |
| | G Lake - pH 4.5 + Al | Whole Water (Lake) | 290-550 | 1.46±0.18 | 1.66±0.13 | NA | 11.43±1.50 |

| Table S16. Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^{\bullet}OH}$ ($\times10^{-6}$ mol mol-photons$^{-1}$) |
| This work | Honnedaga Lake - pH 4.5 + Al | Whole Water (Lake) | 290-550 | 1.14±0.11 | 1.80±0.09 | NA | 13.74±2.69 |
| | Limekiln Lake - pH 4.5 + Al | Whole Water (Lake) | 290-550 | 1.92±0.13 | 2.55±0.09 | NA | 8.98±0.48 |
| | Little Hope Pond - pH 4.5 + Al | Whole Water (Lake) | 290-550 | 0.60±0.07 | 0.92±0.07 | NA | 6.51±0.52 |
| | Moss Lake - pH 4.5 + Al | Whole Water (Lake) | 290-550 | 1.76±0.10 | 1.99±0.08 | NA | 9.89±0.39 |
| | North Lake - pH 4.5 + Al | Whole Water (Lake) | 290-550 | 1.39±0.16 | 1.71±0.06 | NA | 4.05±0.20 |
| | Lake Rondaxe - pH 4.5 + Al | Whole Water (Lake) | 290-550 | 3.24±0.25 | 3.46±0.27 | NA | 19.41±2.04 |
| | Sagamore Lake - pH 4.5 + Al | Whole Water (Lake) | 290-550 | 1.07±0.09 | 1.39±0.10 | NA | 2.92±0.30 |
| | South Lake - pH 4.5 + Al | Whole Water (Lake) | 290-550 | 1.96±0.11 | 1.98±0.15 | NA | 6.59±0.32 |
| | Squaw Lake - pH 4.5 + Al | Whole Water (Lake) | 290-550 | 2.10±0.10 | 2.40±0.27 | NA | 8.67±2.50 |
| | Willis Lake - pH 4.5 + Al | Whole Water (Lake) | 290-550 | 1.44±0.17 | 1.78±0.16 | NA | 2.85±0.66 |
| | Wolf Lake - ppH 4.5 + Al | Whole Water (Lake) | 290-550 | 2.55±0.24 | 2.44±0.14 | NA | 3.80±0.82 |
| | Arbutus Lake - pH 8.5 + Fe | Whole Water (Lake) | 290-550 | 2.68±0.18 | 2.07±0.05 | NA | 5.36±0.52 |
| | Big Moose Lake - pH 8.5 + Fe | Whole Water (Lake) | 290-550 | 3.49±0.22 | 2.63±0.18 | NA | 9.64±1.09 |
| | Black Pond - pH 8.5 + Fe | Whole Water (Lake) | 290-550 | 3.68±0.20 | 2.72±0.01 | NA | 7.58±0.79 |
| | Dart Lake - pH 8.5 + Fe | Whole Water (Lake) | 290-550 | 3.76±0.22 | 3.62±0.01 | NA | 12.87±2.31 |
| | G Lake - pH 8.5 + Fe | Whole Water (Lake) | 290-550 | 4.46±0.11 | 3.31±0.25 | NA | 13.09±0.48 |
| | Honnedaga Lake - pH 8.5 + Fe | Whole Water (Lake) | 290-550 | 2.13±0.25 | 2.21±0.01 | NA | 8.74±0.61 |
| | Limekiln Lake - pH 8.5 + Fe | Whole Water (Lake) | 290-550 | 3.52±0.25 | 2.91±0.20 | NA | 12.21±1.18 |
| | Little Hope Pond - pH 8.5 + Fe | Whole Water (Lake) | 290-550 | 1.28±0.04 | 1.43±0.08 | NA | 6.62±0.67 |
| | Moss Lake - pH 8.5 + Fe | Whole Water (Lake) | 290-550 | 3.27±0.32 | 2.63±0.11 | NA | 6.42±0.53 |
| | North Lake - pH 8.5 + Fe | Whole Water (Lake) | 290-550 | 2.52±0.09 | 2.09±0.27 | NA | 12.6±3.04 |
| | Lake Rondaxe - pH 8.5 + Fe | Whole Water (Lake) | 290-550 | 2.70±0.23 | 1.93±0.05 | NA | 6.51±0.59 |
| | Sagamore Lake - pH 8.5 + Fe | Whole Water (Lake) | 290-550 | 1.61±0.09 | 1.58±0.01 | NA | 6.89±1.75 |
| | South Lake - pH 8.5 + Fe | Whole Water (Lake) | 290-550 | 2.01±0.12 | 1.63±0.12 | NA | 6.44±1.50 |
| | Squaw Lake - pH 8.5 + Fe | Whole Water (Lake) | 290-550 | 1.73±0.09 | 1.29±0.07 | NA | 2.49±0.55 |
| | Willis Lake - pH 8.5 + Fe | Whole Water (Lake) | 290-550 | 1.70±0.21 | 1.30±0.07 | NA | 3.52±0.39 |
| | Wolf Lake - pH 8.5 + Fe | Whole Water (Lake) | 290-550 | 2.95±0.18 | 1.86±0.14 | NA | 4.33±0.63 |
| | SRNOM | IHSS Isolate (SRNOM) | 290-550 | 2.19±0.08 | 1.96±0.15 | 1.09±0.10 | 21.03±0.78 |
| | SRFA | IHSS Isolate (SRFA) | 290-550 | 2.30±0.10 | 2.07±0.26 | 1.40±0.20 | 23.22±2.29 |
| | SRHA | IHSS Isolate (SRHA) | 290-550 | 1.40±0.03 | 1.14±0.20 | 0.42±0.01 | 12.58±0.53 |
| | Arbutus Lake | Whole Water (Lake) | 290-400 | 5.49±0.21 | 4.24±0.40 | 1.45±0.02 | 7.40±1.55 |
| | Big Moose Lake | Whole Water (Lake) | 290-400 | 4.90±0.46 | 4.05±0.08 | 1.55±0.01 | 12.25±0.50 |
| | Black Pond | Whole Water (Lake) | 290-400 | 4.26±0.26 | 3.39±0.33 | 1.04±0.05 | 11.53±1.36 |
| | Dart Lake | Whole Water (Lake) | 290-400 | 4.79±0.16 | 4.15±0.33 | 1.51±0.01 | 12.79±0.62 |
| | G Lake | Whole Water (Lake) | 290-400 | 4.66±0.12 | 3.82±0.44 | 1.54±0.02 | 21.08±2.92 |
| | Honnedaga Lake | Whole Water (Lake) | 290-400 | 4.98±0.56 | 3.99±0.36 | 1.20±0.04 | 21.73±2.36 |
| | Limekiln Lake | Whole Water (Lake) | 290-400 | 6.08±0.57 | 4.25±0.07 | 1.68±0.01 | 15.44±1.45 |
| | Little Hope Pond | Whole Water (Lake) | 290-400 | 2.53±0.30 | 2.92±0.24 | 0.74±0.01 | 2.75±0.14 |
| | Moss Lake | Whole Water (Lake) | 290-400 | 4.71±0.57 | 3.51±0.38 | 1.26±0.01 | 10.71±1.66 |
| | North Lake | Whole Water (Lake) | 290-400 | 3.52±0.37 | 3.45±0.33 | 1.19±0.03 | 9.02±0.82 |
| | Lake Rondaxe | Whole Water (Lake) | 290-400 | 4.73±0.27 | 4.16±0.39 | 1.48±0.06 | 6.05±0.69 |

| Table S16. Summary of literature $\Phi_{app,RI}$ data (continued) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Source | Sample ID | Sample Classification | Wavelength Range (nm) | $\Phi_{app,\ ^3DOM^*_{TMP}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^1O_2}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^3DOM^*_{Sorbate}}$ ($\times10^{-2}$ mol mol-photons$^{-1}$) | $\Phi_{app,\ ^\bullet OH}$ ($\times10^{-6}$ mol mol-photons$^{-1}$) |
| This work | Sagamore Lake | Whole Water (Lake) | 290-400 | 2.57±0.28 | 2.91±0.21 | 0.77±0.03 | 5.98±1.45 |
| | South Lake | Whole Water (Lake) | 290-400 | 5.24±0.21 | 3.96±0.12 | 1.43±0.01 | 20.58±1.80 |
| | Squaw Lake | Whole Water (Lake) | 290-400 | 5.37±0.39 | 4.03±0.31 | 1.45±0.02 | 8.09±1.49 |
| | Willis Lake | Whole Water (Lake) | 290-400 | 4.57±0.10 | 3.70±0.26 | 1.20±0.03 | 7.70±1.74 |
| | Wolf Lake | Whole Water (Lake) | 290-400 | 7.20±0.74 | 5.01±0.53 | 1.85±0.08 | 14.57±1.35 |
| | Arbutus Lake | Whole Water (Lake) | 290-500 | 3.59±0.13 | 2.77±0.26 | 0.95±0.01 | 4.84±1.01 |
| | Big Moose Lake | Whole Water (Lake) | 290-500 | 3.30±0.31 | 2.73±0.06 | 1.04±0.01 | 8.25±0.34 |
| | Black Pond | Whole Water (Lake) | 290-500 | 2.56±0.16 | 2.04±0.20 | 0.62±0.03 | 6.93±0.82 |
| | Dart Lake | Whole Water (Lake) | 290-500 | 3.14±0.11 | 2.72±0.22 | 0.99±0.01 | 8.39±0.40 |
| | G Lake | Whole Water (Lake) | 290-500 | 3.03±0.08 | 2.48±0.29 | 1.00±0.01 | 13.69±1.90 |
| | Honnedaga Lake | Whole Water (Lake) | 290-500 | 2.65±0.30 | 2.13±0.19 | 0.64±0.02 | 11.59±1.26 |
| | Limekiln Lake | Whole Water (Lake) | 290-500 | 3.39±0.32 | 2.37±0.04 | 0.94±0.01 | 8.61±0.81 |
| | Little Hope Pond | Whole Water (Lake) | 290-500 | 1.44±0.17 | 1.67±0.14 | 0.42±0.01 | 1.57±0.08 |
| | Moss Lake | Whole Water (Lake) | 290-500 | 2.79±0.34 | 2.08±0.23 | 0.75±0.01 | 6.34±0.98 |
| | North Lake | Whole Water (Lake) | 290-500 | 2.16±0.22 | 2.11±0.20 | 0.73±0.02 | 5.53±0.50 |
| | Lake Rondaxe | Whole Water (Lake) | 290-500 | 2.65±0.15 | 2.33±0.22 | 0.83±0.03 | 3.39±0.39 |
| | Sagamore Lake | Whole Water (Lake) | 290-500 | 1.54±0.17 | 1.75±0.13 | 0.46±0.02 | 3.60±0.87 |
| | South Lake | Whole Water (Lake) | 290-500 | 3.23±0.13 | 2.44±0.07 | 0.88±0.01 | 12.68±1.11 |
| | Squaw Lake | Whole Water (Lake) | 290-500 | 3.89±0.28 | 2.92±0.23 | 1.05±0.01 | 5.86±1.08 |
| | Willis Lake | Whole Water (Lake) | 290-500 | 2.86±0.06 | 2.31±0.17 | 0.75±0.02 | 4.82±1.09 |
| | Wolf Lake | Whole Water (Lake) | 290-500 | 4.91±0.50 | 3.42±0.36 | 1.26±0.06 | 9.93±0.92 |
| | Arbutus Lake | Whole Water (Lake) | 290-600 | 3.38±0.13 | 2.61±0.24 | 0.89±0.01 | 4.55±0.95 |
| | Big Moose Lake | Whole Water (Lake) | 290-600 | 3.13±0.29 | 2.59±0.05 | 0.99±0.01 | 7.82±0.32 |
| | Black Pond | Whole Water (Lake) | 290-600 | 2.31±0.14 | 1.84±0.18 | 0.56±0.03 | 6.25±0.74 |
| | Dart Lake | Whole Water (Lake) | 290-600 | 2.91±0.10 | 2.52±0.20 | 0.92±0.01 | 7.77±0.37 |
| | G Lake | Whole Water (Lake) | 290-600 | 2.80±0.07 | 2.30±0.27 | 0.92±0.01 | 12.66±1.76 |
| | Honnedaga Lake | Whole Water (Lake) | 290-600 | 2.26±0.26 | 1.82±0.16 | 0.55±0.02 | 9.88±1.07 |
| | Limekiln Lake | Whole Water (Lake) | 290-600 | 2.86±0.27 | 2.00±0.03 | 0.79±0.01 | 7.27±0.68 |
| | Little Hope Pond | Whole Water (Lake) | 290-600 | 1.27±0.15 | 1.47±0.12 | 0.37±0.01 | 1.38±0.07 |
| | Moss Lake | Whole Water (Lake) | 290-600 | 2.45±0.30 | 1.83±0.20 | 0.66±0.01 | 5.58±0.86 |
| | North Lake | Whole Water (Lake) | 290-600 | 1.94±0.20 | 1.90±0.18 | 0.66±0.01 | 4.98±0.45 |
| | Lake Rondaxe | Whole Water (Lake) | 290-600 | 2.25±0.13 | 1.97±0.19 | 0.70±0.03 | 2.87±0.33 |
| | Sagamore Lake | Whole Water (Lake) | 290-600 | 1.39±0.15 | 1.58±0.11 | 0.42±0.02 | 3.24±0.78 |
| | South Lake | Whole Water (Lake) | 290-600 | 2.97±0.12 | 2.24±0.07 | 0.81±0.01 | 11.66±1.02 |
| | Squaw Lake | Whole Water (Lake) | 290-600 | 3.82±0.28 | 2.87±0.22 | 1.03±0.01 | 5.76±1.06 |
| | Willis Lake | Whole Water (Lake) | 290-600 | 2.62±0.06 | 2.12±0.15 | 0.69±0.02 | 4.41±1.00 |
| | Wolf Lake | Whole Water (Lake) | 290-600 | 4.69±0.48 | 3.27±0.34 | 1.21±0.05 | 9.50±0.88 |

Ref = reference; NA = not available; $\Phi_{app,RI}$ values not directly reported in the references or associated supplementary documents were digitized from raw figures using *Plot Digitizer 2.6.8*. $f_{TMP}$ were converted to $\Phi_{app,\ ^3DOM^*_{TMP}}$ using $k_{TMP,\ ^3DOM^*_{TMP}}$ values reported in Erickson *et al.*[90] when applicable.

**12. Estimations of noontime surface steady-state concentrations of RIs**

Using the apparent quantum yields measured from photochemistry experiments, the noontime surface steady-state concentrations of RIs were predicted on the date a given lake was sampled. For the top 1-cm layer of each lake (i.e., concentrations calculated over $z$ = 1 cm where D(λ) = 1.2[145]), the average rate of light absorption $R_{\text{a, noon}}$ (mol-photons $L^{-1}$ $s^{-1}$ or Einstein $L^{-1}$ $s^{-1}$) per unit volume was approximated as:[129]

$$R_{\text{a, noon}} = \sum_{\lambda\,=\,290\text{ nm}}^{550\text{ nm}} \frac{Z_{\lambda,\text{ noon}}(1-10^{-\alpha_{\text{D},\lambda} z})}{z} SF_{\lambda} = \sum_{\lambda\,=\,290\text{ nm}}^{550\text{ nm}} \frac{Z_{\lambda,\text{ noon}}[1-10^{-1.2\alpha_{\lambda} z}]}{z} \frac{[1-10^{-1.2\alpha_{\lambda} z}]}{(2.303)(1.2)z\alpha_{\lambda}} \tag{S33}$$

where $Z_{\lambda,\text{ noon}}$ is the site-specific solar irradiance at a given wavelength λ ($10^{-3}$ mol-photons $cm^{-2}$ $s^{-1}$ $nm^{-1}$ or milliEinstein $cm^{-2}$ $s^{-1}$ $nm^{-1}$) modeled using the Simple Model of the Atmospheric Radiative Transfer of Sunshine (SMARTS)[146, 147] with adjustments made for reflection off the water's surface and increased pathlength within the water column.[51, 145, 148]

To account for the reflected fraction and the increased pathlength, $Z_{\lambda,\text{ noon}}$ was calculated as:[145, 148]

$$Z_{\lambda,\text{ noon}} = W_{\lambda,\text{ noon, direct}}(1-RF_{\text{direct}})\sec\theta + 1.2\,W_{\lambda,\text{ noon, diffuse}}(1-RF_{\text{diffuse}}) \tag{S34}$$

where $W_{\lambda,\text{ noon, direct}}$ ($10^{-3}$ mol-photons $cm^{-2}$ $s^{-1}$ $nm^{-1}$ or milliEinstein $cm^{-2}$ $s^{-1}$ $nm^{-1}$) is the direct beam irradiance at a given wavelength λ, $RF_{\text{direct}}$ is the reflected fraction of direct sunlight calculated using the Fresnel's law (= $[\sin(\theta-\text{SZA})/\sin(\theta+\text{SZA})]^2$ with the solar zenith angle (SZA) and $\theta$), $\theta$ is the refraction angle calculated using the Snell's law (= $\arcsin(1/1.34\times\sin\text{SZA})$ with the SZA and the refractive index of water set at 1.34), $W_{\lambda,\text{ noon, diffuse}}$ ($10^{-3}$ mol-photons $cm^{-2}$ $s^{-1}$ $nm^{-1}$ or milliEinstein $cm^{-2}$ $s^{-1}$ $nm^{-1}$) is the diffuse (or sky) irradiance at a given wavelength λ, and $RF_{\text{diffuse}}$ (= 0.07) is the average reflected fraction of diffuse sunlight assuming a uniformly bright sky.[145]

To determine $W_{\lambda,\text{ noon, direct}}$ and $W_{\lambda,\text{ noon, diffuse}}$ for each site, SMARTS was configured using the input parameters in **Table S17** with updated measurements for atmospheric species[148] to output the site-specific global, direct, and diffuse horizontal irradiances, respectively, as detailed in **Table S18**.

| Table S17. SMARTS configuration and input parameters | |
|---|---|
| **Card 1:** Adirondack lakes (average longitude, latitude, and altitude for 16 sampling lakes) | **Card 10:** Regional albedo: 0[148] |
| **Card 2:** Site pressure calculated at Altitude: 0.558 km; Height: 0 km; Latitude: +43.7897048 | **Card 10b:** Tilted surface and local albedo: Bypass |
| **Card 3:** Reference atmosphere: MidLatitude Summer | **Card 11:** Spectral range: 280 – 800 nm; Solar constant: 1361 $W/m^2$;[149] Solar constant distance correction factor: 1.0 |
| **Card 4:** Precipitable water: 2.39 cm[150] | **Card 12:** Spectral range to be printed: 280 – 800 nm at 1 nm intervals; Spectral results: Global horizontal irradiance; Direct horizontal irradiance; Diffuse horizontal irradiance ($W\ m^{-2}\ nm^{-1}$) |
| **Card 5:** Ozone vertical column: 0.3 atm-cm (i.e., 300 Dobson units);[148] Altitude of reading: Sea level | **Card 13:** Circumsolar calculations: Bypass |
| **Card 6:** Gaseous Absorption and Pollution: Light Pollution[151] | **Card 14:** Extra scanning/smoothing: Bypass |
| **Card 7:** Carbone dioxide concentration: 407 ppmv[152] | **Card 15:** Extra illuminance and photosynthetically active radiation calculations: Bypass |
| **Card 7a:** Extraterrestrial spectrum: Gueymard 2004[153] | **Card 16:** Extra UV calculations: Bypass |
| **Card 8:** Aerosol model: Shettle & Fenn Rural[154] | **Card 17:** Solar position and air (one set of example variables shown here): Year: 2018; Month: 7; Day: 18; Hour: 12.079; Latitude: +43.789705; Longitude: -74.627852; Time zone: -5 *Note: Parameters in 17 varied as coordinates, dates, and hours.* |
| **Card 9:** Atmospheric turbidity: 0.1 specified as Aerosol Optical Depth at 500 nm[155] | |

For each lake, $R_{\text{a, noontime}}$ calculated from Equation S33 was combined with the apparent quantum yields and pseudo first-order quenching rate constants of RIs to estimate the surface steady-state concentrations of RIs at solar noon on the sampling date. No corrections were made for potential changes in formation efficiencies of RIs due to variation between temperatures *in situ* and under laboratory irradiation conditions. Note that $[\text{RI}]_{\text{ss}}$ only represented concentrations measured in the bulk aqueous phase and did not account for the microheterogeneity of DOM.[156, 157]

$$[^{\bullet}\text{OH}]_{\text{ss, noontime, surface}} = \frac{\Phi_{\text{app, }^{\bullet}\text{OH}} R_{\text{a, noontime}}}{k_{^{\bullet}\text{OH, DOM}}[\text{DOM}]} \quad \text{(S35)}$$

$$[^{1}\text{O}_2]_{\text{ss, noontime, surface}} = \frac{\Phi_{\text{app, }^{1}\text{O}_2} R_{\text{a, noontime}}}{k_{\text{d}}^{\Delta}} \quad \text{(S36)}$$

$$[^{3}\text{DOM}^{*}_{\text{TMP}}]_{\text{ss, noontime, surface}} = \frac{\Phi_{\text{app, }^{3}\text{DOM}^{*}_{\text{TMP}}} R_{\text{a, noontime}}}{k_{\text{O}_2}[\text{O}_{2(\text{aq})}] + k_{\text{d}}^{\text{T}}} \quad \text{(S37)}$$

$$[^{3}\text{DOM}^{*}_{\text{HDO}}]_{\text{ss, noontime, surface}} = \frac{\Phi_{\text{app, }^{3}\text{DOM}^{*}_{\text{HDO}}} R_{\text{a, noontime}}}{k_{\text{O}_2}[\text{O}_{2(\text{aq})}] + k_{\text{d}}^{\text{T}}} \quad \text{(S38)}$$

A summary of the surface steady-state concentrations of RIs at solar noon is provided in **Table S19**.

**Table S18.** Solar noon conditions on Adirondack lakes

| Lake name | Sampling Coordinates | Sampling Date | Elevation (m) | Solar Zenith Angle (°)[a] | Refraction Angle (°)[a] | $RF_{Direct}$[a] | Direct Beam Irradiance (W $m^{-2}$)[a] | Diffuse Irradiance (W $m^{-2}$)[a] | Global Irradiance (W $m^{-2}$)[a] | Clearness Index[a] | $R_{a, noontime}$ (×$10^{-7}$ mol-photons $L^{-1}$ $s^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Arbutus Lake | 43.983350, -74.235737 | 9/19/2018 | 516 | 42.660 | 30.378 | 0.049 | 378.52 | 82.43 | 460.95 | 0.3417 | 6.53±0.23 |
| Big Moose Lake | 43.837263, -74.822176 | 7/23/2018 | 558 | 23.855 | 17.566 | 0.027 | 492.35 | 86.18 | 578.53 | 0.4387 | 8.63±0.30 |
| Black Pond | 44.432591, -74.297836 | 9/16/2018 | 495 | 41.949 | 29.924 | 0.048 | 383.46 | 82.70 | 466.16 | 0.3462 | 7.24±0.25 |
| Dart Lake | 43.799611, -74.853656 | 7/23/2018 | 537 | 23.817 | 17.539 | 0.027 | 492.34 | 86.28 | 578.62 | 0.4388 | 8.69±0.30 |
| G Lake | 43.415344, -74.633610 | 7/9/2018 | 620 | 21.111 | 15.592 | 0.026 | 504.77 | 86.29 | 591.05 | 0.4489 | 5.42±0.19 |
| Honnedaga Lake | 43.531398, -74.853429 | 5/16/2018 | 701 | 24.325 | 17.902 | 0.028 | 495.96 | 86.30 | 582.26 | 0.4374 | 8.27±0.29 |
| Limekiln Lake | 43.717766, -74.790064 | 7/24/2018 | 575 | 23.945 | 17.631 | 0.027 | 492.15 | 86.11 | 578.26 | 0.4384 | 7.18±0.25 |
| Little Hope Pond | 44.516432, -74.125455 | 9/16/2018 | 517 | 42.032 | 29.978 | 0.048 | 382.98 | 82.57 | 465.55 | 0.3457 | 15.86±0.55 |
| Moss Lake | 43.788073, -74.846356 | 7/23/2018 | 536 | 23.806 | 17.531 | 0.027 | 492.39 | 86.28 | 578.67 | 0.4388 | 9.29±0.32 |
| North Lake | 43.528518, -74.938799 | 7/11/2018 | 555 | 21.482 | 15.860 | 0.026 | 589.12 | 86.51 | 589.12 | 0.4474 | 12.89±0.45 |
| Lake Rondaxe | 43.757783, -74.914560 | 7/23/2018 | 524 | 23.775 | 17.509 | 0.027 | 492.43 | 86.34 | 578.77 | 0.4389 | 7.76±0.27 |
| Sagamore Lake | 43.768805, -74.625736 | 7/24/2018 | 580 | 23.996 | 17.667 | 0.027 | 491.95 | 86.07 | 578.02 | 0.4382 | 16.07±0.56 |
| South Lake | 43.514768, -74.906541 | 7/11/2018 | 615 | 21.469 | 15.851 | 0.026 | 503.21 | 86.26 | 589.47 | 0.4476 | 6.79±0.24 |
| Squaw Lake | 43.633669, -74.739336 | 7/24/2018 | 646 | 23.861 | 17.571 | 0.027 | 493.20 | 85.83 | 579.02 | 0.4390 | 4.87±0.17 |
| Willis Lake | 43.371021, -74.241691 | 7/9/2018 | 400 | 21.066 | 15.560 | 0.026 | 502.96 | 87.23 | 590.19 | 0.4482 | 9.73±0.34 |
| Wolf Lake | 44.017985, -74.220643 | 9/19/2018 | 556 | 42.694 | 30.400 | 0.050 | 378.57 | 82.26 | 460.83 | 0.3417 | 3.18±0.11 |

[a] SMARTS output on the given sampling date and time.

| **Table S19.** Estimated noontime surface steady-state concentrations of RIs in Adirondack lakes | | | | |
|---|---|---|---|---|
| Lake Name | $[^{\bullet}OH]_{ss,\ noontime,surface}$ ($\times 10^{-17}$ M) | $[^{1}O_2]_{ss,\ noontime,surface}$ ($\times 10^{-14}$ M) | $[^{3}DOM^{*}_{TMP}]_{ss,\ noontime,surface}$ ($\times 10^{-14}$ M) | $[^{3}DOM^{*}_{HDO}]_{ss,\ noontime,surface}$ ($\times 10^{-14}$ M) |
| Arbutus Lake | 2.45±0.51 | 5.97±0.56 | 7.34±1.70 | 1.93±0.40 |
| Big Moose Lake | 5.48±0.22 | 7.80±0.16 | 9.00±2.57 | 2.82±0.57 |
| Black Pond | 5.38±0.63 | 4.72±0.46 | 5.64±1.43 | 1.38±0.33 |
| Dart Lake | 5.86±0.28 | 7.74±0.61 | 8.47±1.93 | 2.67±0.54 |
| G Lake | 8.81±1.22 | 4.37±0.50 | 5.02±0.85 | 1.66±0.35 |
| Honnedaga Lake | 17.01±1.85 | 5.41±0.49 | 6.44±1.96 | 1.55±0.35 |
| Limekiln Lake | 6.07±0.57 | 5.24±0.09 | 7.15±2.04 | 1.96±0.39 |
| Little Hope Pond | 0.72±0.04 | 8.34±0.70 | 6.90±2.15 | 2.01±0.41 |
| Moss Lake | 5.57±0.86 | 6.03±0.66 | 7.75±2.41 | 2.05±0.40 |
| North Lake | 5.14±0.47 | 8.71±0.84 | 8.50±2.51 | 2.85±0.62 |
| Lake Rondaxe | 2.60±0.30 | 5.56±0.52 | 6.02±1.50 | 1.88±0.44 |
| Sagamore Lake | 2.59±0.63 | 9.03±0.65 | 7.60±2.29 | 2.27±0.54 |
| South Lake | 9.55±0.83 | 5.39±0.16 | 6.77±1.59 | 1.84±0.37 |
| Squaw Lake | 2.87±0.53 | 4.83±0.37 | 6.14±1.63 | 1.65±0.34 |
| Willis Lake | 3.93±0.89 | 7.27±0.52 | 8.51±1.83 | 2.25±0.50 |
| Wolf Lake | 3.79±0.35 | 3.63±0.38 | 4.97±1.46 | 1.27±0.30 |
| Errors represent one standard deviation from duplicate estimations. | | | | |

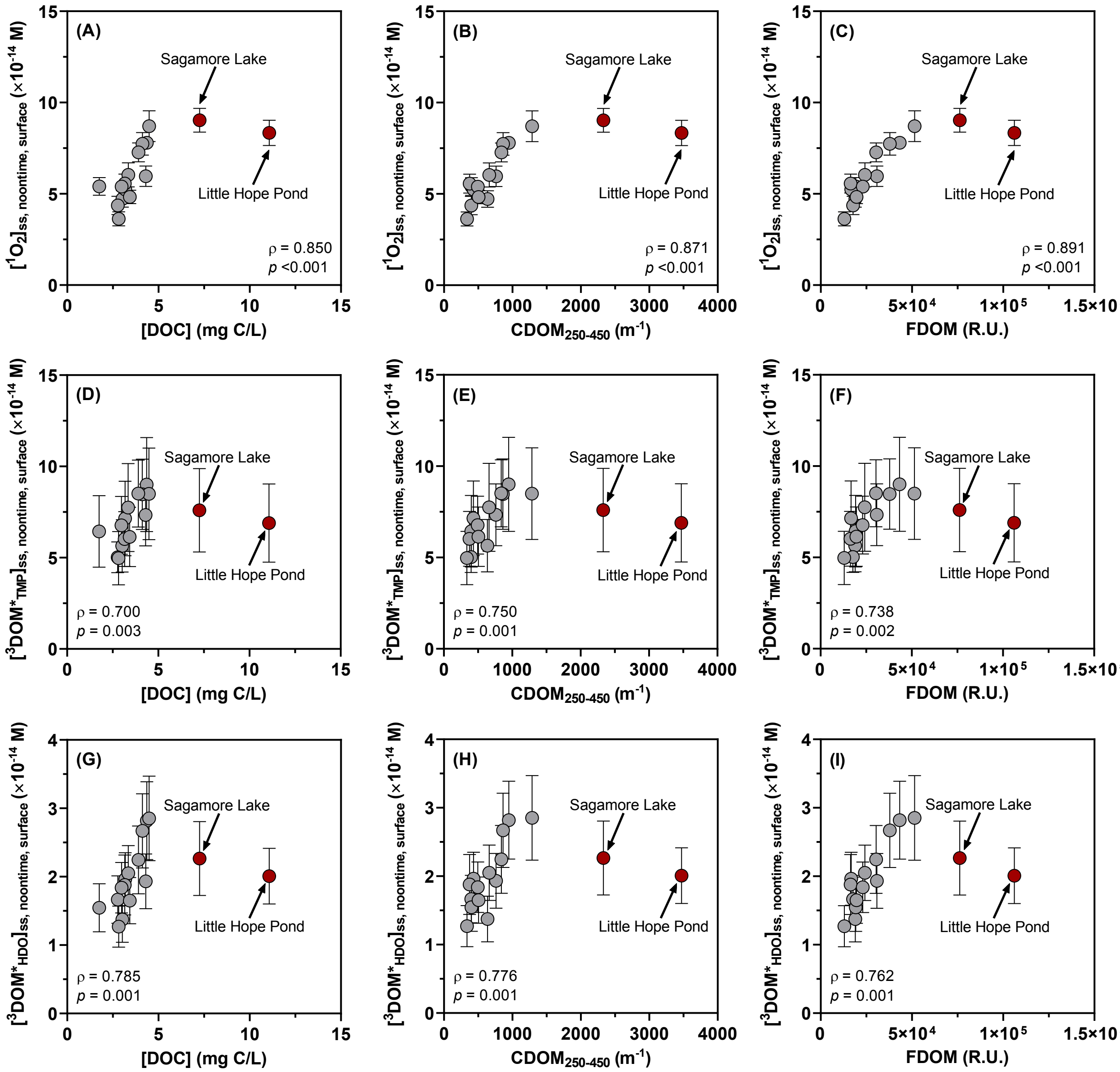


**Figure S4.** Spearman's correlations between estimated noontime surface $[RI]_{ss}$ and DOM quantity measures of native Adirondack lake water samples (*n*=16): (A) Correlation between $[^1O_2]_{ss}$ and [DOC]; (B) Correlation between $[^1O_2]_{ss}$ and CDOM; (C) Correlation between $[^1O_2]_{ss}$ and FDOM; (D) Correlation between $[^3DOM^*_{TMP}]_{ss}$ and [DOC]; (E) Correlation between $[^3DOM^*_{TMP}]_{ss}$ and CDOM; (F) Correlation between $[^3DOM^*_{TMP}]_{ss}$ and FDOM; (G) Correlation between $[^3DOM^*_{HDO}]_{ss}$ and [DOC]; (H) Correlation between $[^3DOM^*_{HDO}]_{ss}$ and CDOM; and (I) Correlation between $[^3DOM^*_{HDO}]_{ss}$ and FDOM. Error bars indicate the standard deviation of duplicate or triplicate measurements. Little Hope Pond and Sagamore lake water samples featured lower $[^3DOM^*]_{ss}$ and $[^1O_2]_{ss}$ than those would have been expected from the monotonic relationships with [DOC], $CDOM_{250\text{-}450}$, or FDOM. Note that Little Hope and Sagamore samples not only contained the highest [DOC] but also the highest concentrations of metals (i.e., [Al]+[Fe]+[Trace Metals]).

For each lake, the indirect photolysis half-lives of atrazine, metolachlor, and diuron were calculated as:

$$t_{1/2} = \frac{\ln 2}{k_{\text{indirect photolysis}}} = \frac{\ln 2}{k_{\text{herbicide}, {}^{\bullet}\text{OH}}[{}^{\bullet}\text{OH}]_{\text{ss}} + k_{\text{herbicide}, {}^{1}\text{O}_2}[{}^{1}\text{O}_2]_{\text{ss}} + k_{\text{herbicide}, {}^{3}\text{DOM}^{*}_{\text{HDO}}}[{}^{3}\text{DOM}^{*}_{\text{HDO}}]_{\text{ss}}} \quad \text{(S39)}$$

where $k_{\text{indirect photolysis}}$ ($s^{-1}$) is the estimated indirect photolysis rate constant of a target herbicide (e.g., atrazine, metolachlor, or diuron), $k_{\text{herbicide}, {}^{\bullet}\text{OH}}$ is the second-order reaction rate constant of a herbicide with $^{\bullet}OH$ (i.e., $2.5(\pm 0.4)\times 10^9$ $M^{-1}$ $s^{-1}$ for atrazine, $7.0(\pm 1.6)\times 10^9$ $M^{-1}$ $s^{-1}$ for metolachlor, and $7.8(\pm 1.7)\times 10^9$ $M^{-1}$ $s^{-1}$ for diuron, respectively),[108] $k_{\text{herbicide}, {}^{1}\text{O}_2}$ is the second-order reaction rate constant of a herbicide with $^1O_2$ (i.e., $2.0(\pm 0.3)\times 10^5$ $M^{-1}$ $s^{-1}$ for atrazine, $4.4(\pm 0.6)\times 10^5$ $M^{-1}$ $s^{-1}$ for metolachlor, and $2.9(\pm 0.6)\times 10^5$ $M^{-1}$ $s^{-1}$ for diuron, respectively),[11] and $k_{\text{herbicide}, {}^{3}\text{DOM}^{*}_{\text{HDO}}}$ is the second-order reaction rate constant of a herbicide with $^3DOM^*_{HDO}$ (i.e., $1.2(\pm 0.2)\times 10^9$ $M^{-1}$ $s^{-1}$ for atrazine, $9.3(\pm 1.9)\times 10^8$ $M^{-1}$ $s^{-1}$ for metolachlor, and $2.7(\pm 3.6)\times 10^8$ $M^{-1}$ $s^{-1}$ for diuron, respectively),[108, 158, 159] considering the relevance of high-energy $^3DOM^*$ for organic micropollutant photodegradation.[160]

For each lake, the exogenous photoinactivation time for 2-log inactivation of MS2 coliphage was calculated as:

$$t_{\text{2-log inactivation}} = \frac{2\ln(10)}{k_{\text{exogenous photoinactivation}}} = \frac{2\ln(10)}{k_{\text{MS2}, {}^{\bullet}\text{OH}}[{}^{\bullet}\text{OH}]_{\text{ss}} + k_{\text{MS2}, {}^{1}\text{O}_2}[{}^{1}\text{O}_2]_{\text{ss}} + k_{\text{MS2}, {}^{3}\text{AQ2S}^{*}}[{}^{3}\text{DOM}^{*}_{\text{HDO}}]_{\text{ss}}} \quad \text{(S40)}$$

where $k_{\text{exogenous photoinactivation}}$ ($s^{-1}$) is the estimated exogenous photoinactivation rate constant of MS2, $k_{\text{MS2}, {}^{\bullet}\text{OH}}$ is the second-order reaction rate constant for MS2 inactivation by $^{\bullet}OH$ (i.e., $7.4(\pm 1.9)\times 10^9$ $M^{-1}$ $s^{-1}$),[161] $k_{\text{MS2}, {}^{1}\text{O}_2}$ is the second-order reaction rate constant for MS2 inactivation by $^1O_2$ (i.e., $3.5(\pm 0.3)\times 10^8$ $M^{-1}$ $s^{-1}$),[161] and $k_{\text{MS2}, {}^{3}\text{AQ2S}^{*}}$ is the second-order reaction rate constant for MS inactivation by the triplet state of anthraquinone-2-sulfonate ($^3AQ2S^*$; $6.5(\pm 1.8)\times 10^8$ $M^{-1}$ $s^{-1}$) as a surrogate for $^3DOM^*$.[161] Note that Equation S40 does not explicitly account for the association of MS2 with DOM[162] or other synergistic effects (e.g., temperature[163]) on virus inactivation.[164]

A summary of the estimated *minimum* indirect photolysis half-lives of atrazine, metolachlor, and diuron and the estimated *minimum* exogenous photoinactivation time for 2-log inactivation of MS2 coliphage at the surface of Adirondack lakes under noontime conditions is provided in **Table S20**.

| **Table S20.** Estimated minimum noontime surface indirect photochemical half-lives of herbicides and exogenous inactivation time for 2-log inactivation of MS2 coliphage in Adirondack lakes | | | | |
|---|---|---|---|---|
| Lake Name | Atrazine (hours) | Metolachlor (hours) | Diuron (hours) | MS2 (hours) |
| Arbutus Lake | 9.2±4.7 | 12.0±6.7 | 37.6±11.4 | 40.4±16.4 |
| Big Moose Lake | 6.3±3.2 | 9.3±2.9 | 25.2±7.3 | 29.0±10.3 |
| Black Pond | 13.1±7.3 | 19.4±6.7 | 50.0±17.8 | 52.6±21.9 |
| Dart Lake | 6.6±3.4 | 9.8±3.1 | 26.4±7.8 | 30.2±12.0 |
| G Lake | 10.6±5.4 | 15.4±4.9 | 39.3±12.6 | 51.4±22.6 |
| Honnedaga Lake | 11.4±6.1 | 16.1±5.3 | 37.4±13.2 | 44.9±18.1 |
| Limekiln Lake | 9.0±4.5 | 13.2±4.1 | 35.0±10.2 | 42.3±15.0 |
| Little Hope Pond | 8.8±4.5 | 13.2±4.2 | 36.9±10.6 | 31.7±11.6 |
| Moss Lake | 8.6±4.3 | 12.7±3.9 | 33.9±10.1 | 39.2±16.4 |
| North Lake | 6.3±3.3 | 9.3±3.0 | 25.2±7.9 | 27.6±11.4 |
| Lake Rondaxe | 9.6±5.2 | 14.4±4.9 | 38.9±13.1 | 42.8±18.1 |
| Sagamore Lake | 8.0±4.4 | 12.0±4.2 | 32.6±11.3 | 28.8±10.8 |
| South Lake | 9.5±4.8 | 13.9±4.3 | 35.5±10.7 | 42.3±15.1 |
| Squaw Lake | 10.8±5.5 | 16.0±5.1 | 43.4±13.2 | 48.6±19.3 |
| Willis Lake | 8.0±4.2 | 11.9±3.9 | 32.1±10.5 | 33.4±13.0 |
| Wolf Lake | 14.2±7.8 | 21.0±7.2 | 55.2±19.0 | 64.6±28.2 |

Errors represent uncertainties derived by Gaussian error propagation. Note that the contribution of $CO_3^{\bullet-}$ to herbicide photodegradation or virus photoinactivation was expected to be minimal given the low ANC of Adirondack lakes.

## 13. Performance statistics of OPLS and MLR models

**Table S21.** Performance statistics of the OPLS model of $\Phi_{\mathrm{app,RI}}$ for native Adirondack lake water samples

| Component | $R^2X$ | Eigenvalue | $R^2$ | $Q^2$ | $R^2Y$ | Eigenvalue $Y$ |
|---|---|---|---|---|---|---|
| Overall Model | 0.768 | | 0.887 | 0.718 | 0.977 | |
| Predictive | 0.509 | | 0.882 | 0.718 | 0.977 | |
| P1 | 0.365 | 5.84 | 0.806 | 0.663 | 0.845 | 3.38 |
| P2 | 0.144 | 2.31 | 0.076 | 0.055 | 0.132 | 0.529 |
| Orthogonal in $X$ | 0.258 | | 0.0054 | | | |
| O1 | 0.258 | 4.13 | 0.0054 | | | |
| $Y$ Variable | | | $R^2VY$ (cum) | $Q^2VY$ (cum) | | |
| $\Phi_{\mathrm{app},\,^{3}\mathrm{DOM}^{*}_{\mathrm{TMP}}}$ | | | 0.954 | 0.890 | | |
| $\Phi_{\mathrm{app},\,^{1}\mathrm{O}_2}$ | | | 0.909 | 0.766 | | |
| $\Phi_{\mathrm{app},\,^{3}\mathrm{DOM}^{*}_{\mathrm{HDO}}}$ | | | 0.876 | 0.680 | | |
| $\Phi_{\mathrm{app},\,^{\bullet}\mathrm{OH}}$ | | | 0.809 | 0.535 | | |
| $X$ Variable | VIP Score (>1.0) | | $X$ Variable | | VIP Score (≤1.0) | |
| $S_{290\text{–}400}$ ($\mu m^{-1}$) | 1.252 | | HIX | | 0.971 | |
| $CDOM_{250\text{-}450}$ ($m^{-1}$) | 1.195 | | $S_R$ | | 0.961 | |
| FDOM (R.U.) | 1.144 | | $S_{300\text{–}600}$ ($\mu m^{-1}$) | | 0.955 | |
| [DOC] (μM) | 1.138 | | FI | | 0.951 | |
| Peak C : Peak M | 1.122 | | [Al] (μM) | | 0.919 | |
| *E2*:*E3* | 1.107 | | [Trace Metals] (μM) | | 0.906 | |
| [Fe] (μM) | 1.096 | | Peak C : Peak A | | 0.906 | |
| $SUVA_{254}$ (L mg $C^{-1}$•$m^{-1}$) | 1.064 | | ANC (μeq/L) | | 0.860 | |
| $\beta{:}\alpha$ | 1.049 | | [$NO_3^-$] (μM) | | 0.856 | |
| Peak C : Peak T | 1.041 | | [Anions] (μM) | | 0.772 | |
| Peak A : Peak T | 1.016 | | [Phenolic] (mg gallic acid/mg C) | | 0.764 | |
| | | | [Base Cations] (μM) | | 0.740 | |

$R^2X$ = the fraction of $X$ variation modeled in the component, using the $X$ model; Eigenvalue = the number of $X$ variables times $R^2X$; $R^2$ = the fraction of $Y$ variation modeled by $X$ in the component, using the $X$ model; $Q^2$ = the overall cross-validated $R^2$ for the component; $R^2Y$ = the fraction of $Y$ variation modeled by $Y$ in the component, using the $Y$ model; Eigenvalue $Y$ = the number of Y variables times $R^2Y$; $R^2VY$ (cum) = the cumulative predicted fraction (cross validation) of the variation of $Y$; $Q^2VY$ (cum) = the cumulative fraction of the variation of the $Y$ variable explained after the selected component; VIP = variable importance in the projection.

**Table S22.** Performance statistics of the linear regression models of $\Phi_{app,RI}$ for native Adirondack lake water samples

| $\Phi_{app,\ ^3DOM^*_{TMP}}$ Model Criterion | | Coefficient | Estimate | Standard Error | VIF | D'Agostino-Pearson $K^2$ Test $p$ Value |
|---|---|---|---|---|---|---|
| Adjusted $R^2$ | 0.890 | β0 (intercept) | -7.546 | 0.899 | - | 0.8049 (pass) |
| RMSE | 0.283 | β1 ($S_{290-400}$ (μm$^{-1}$)) | 0.455 | 0.055 | 1.318 | |
| AICc | -32.11 | β2 ($\beta:\alpha$) | 4.553 | 0.999 | 1.318 | |
| $\Phi_{app,\ ^1O_2}$ Model Criterion | | Coefficient | Estimate | Standard Error | VIF | D'Agostino-Pearson $K^2$ Test $p$ Value |
| Adjusted $R^2$ | 0.824 | β0 (intercept) | -3.255 | 0.659 | - | 0.6800 (pass) |
| RMSE | 0.199 | β1 ($S_{290-400}$ (μm$^{-1}$)) | 0.312 | 0.037 | 1.000 | |
| AICc | -45.85 | | | | | |
| $\Phi_{app,\ ^3DOM^*_{HDO}}$ Model Criterion | | Coefficient | Estimate | Standard Error | VIF | D'Agostino-Pearson $K^2$ Test $p$ Value |
| Adjusted $R^2$ | 0.869 | β0 (intercept) | -1.094 | 0.404 | - | 0.6684 (pass) |
| RMSE | 0.082 | β1 ($S_{290-400}$ (μm$^{-1}$)) | 0.122 | 0.018 | 1.468 | |
| AICc | -71.67 | β2 ($SUVA_{254}$ (L mg C$^{-1}$•m$^{-1}$)) | -0.099 | 0.039 | 1.468 | |
| $\Phi_{app,\ ^{\bullet}OH}$ Model Criterion | | Coefficient | Estimate | Standard Error | VIF | D'Agostino-Pearson $K^2$ Test $p$ Value |
| Adjusted $R^2$ | 0.230 | β0 (intercept) | -14.996 | 8.846 | - | 0.2720 (pass) |
| RMSE | 2.842 | β1 ($S_{290-400}$ (μm$^{-1}$)) | 1.237 | 0.490 | 1.000 | |
| AICc | 39.29 | | | | | |

Adjusted $R^2$ = the adjusted determination coefficient for the model; RMSE = root mean square of the errors; AICc = corrected Akaike information criterion; VIF = variance inflation factor.

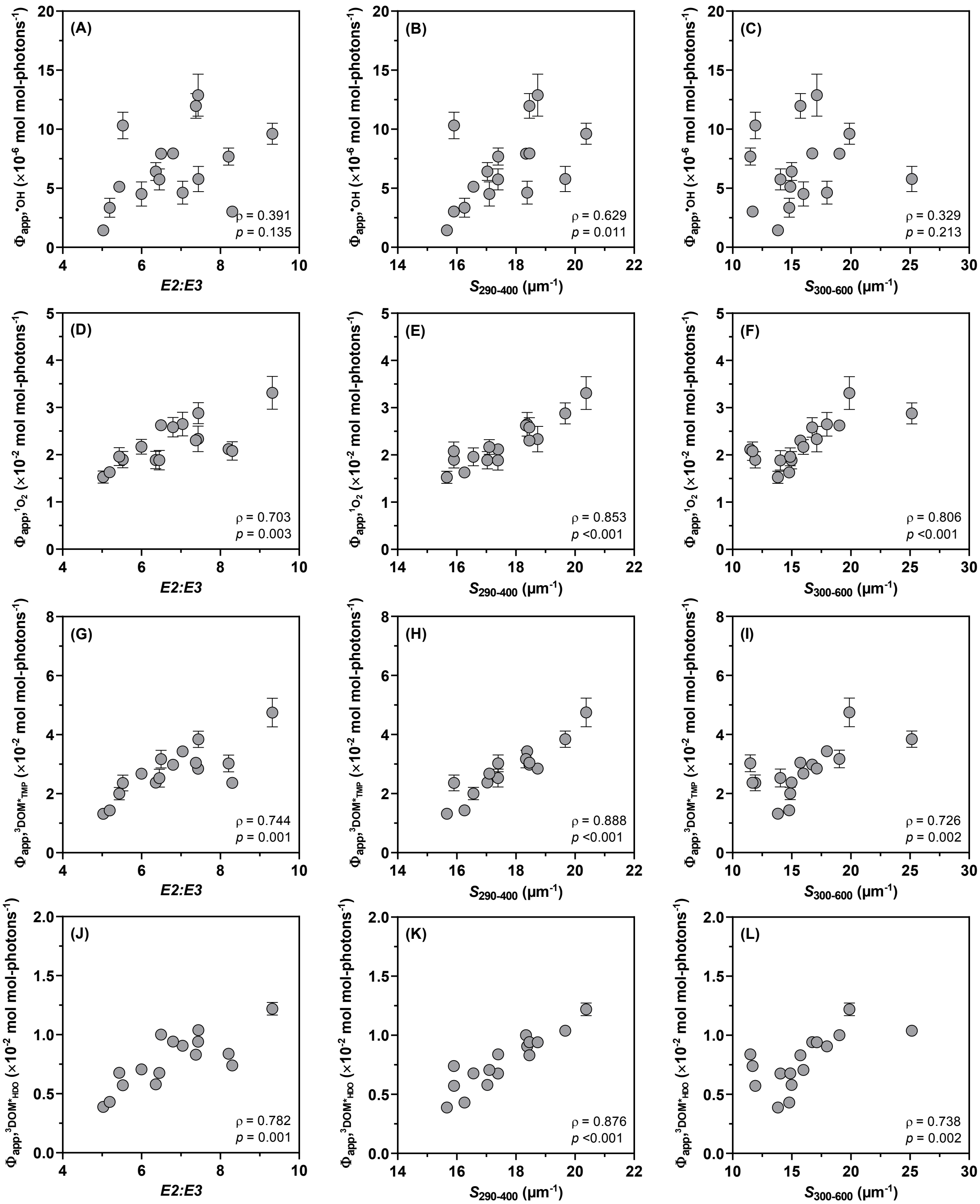


**Figure S5.** Spearman's correlations between $\Phi_{app,RI}$ and *E2:E3*, $S_{290-400}$, and $S_{300-600}$ of native Adirondack lake water samples ($n$=16): (A) Correlation between $\Phi_{app,\,^{\cdot}OH}$ and *E2:E3*; (B) Correlation between $\Phi_{app,\,^{\cdot}OH}$ and $S_{290-400}$; (C) Correlation between $\Phi_{app,\,^{\cdot}OH}$ and $S_{300-600}$; (D) Correlation between $\Phi_{app,\,^1O_2}$ and *E2:E3*; (E) Correlation between $\Phi_{app,\,^1O_2}$ and $S_{290-400}$; (F) Correlation between $\Phi_{app,\,^1O_2}$ and $S_{300-600}$; (G) Correlation between $\Phi_{app,\,^3DOM^*_{TMP}}$ and *E2:E3*; (H) Correlation between $\Phi_{app,\,^3DOM^*_{TMP}}$ and $S_{290-400}$; (I) Correlation between $\Phi_{app,\,^3DOM^*_{TMP}}$ and $S_{300-600}$; (J) Correlation between $\Phi_{app,\,^3DOM^*_{HDO}}$ and *E2:E3*; (K) Correlation between $\Phi_{app,\,^3DOM^*_{HDO}}$ and $S_{290-400}$; and (L) Correlation between $\Phi_{app,\,^3DOM^*_{HDO}}$ and $S_{300-600}$. Error bars indicate the standard deviation of duplicate or triplicate measurements.

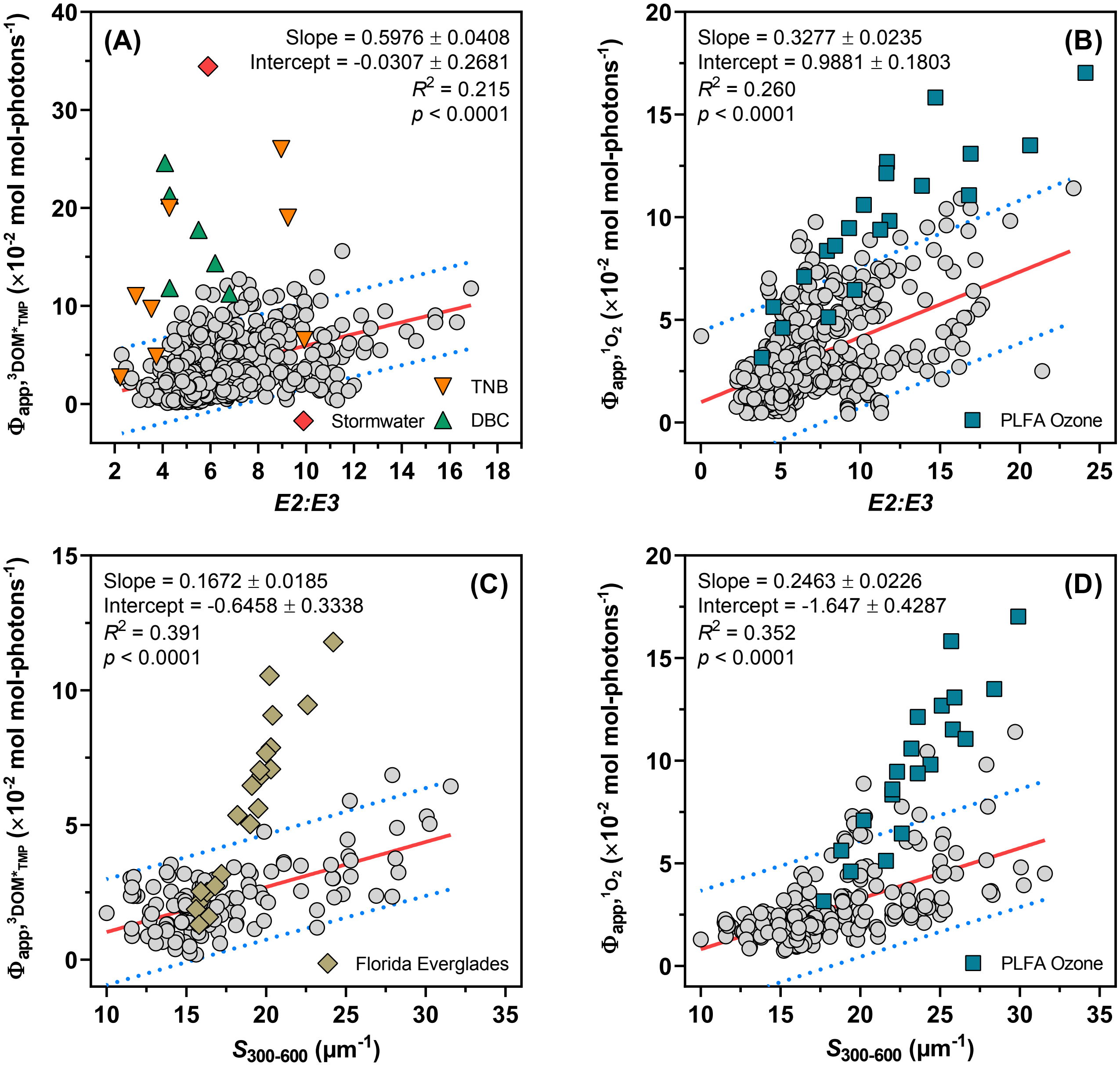


**Figure S6.** Global single linear regression models of $\Phi_{app,RI}$ based on *E2:E3* and $S_{300\text{-}600}$: (A) Single linear regression model of $\Phi_{app,\,^3DOM^*_{TMP}}$ based on *E2:E3* (*n*=833; including data from this study but excluding data measured for whole waters from lakes in the Terra Nova Bay area of Antarctica ("TNB"; *n*=8),[117] dissolved black carbon ("DBC"; *n*=6),[139] and an outlier stormwater sample ("Stormwater")[50]); (B) Single linear regression model of $\Phi_{app,\,^1O_2}$ based on *E2:E3* (*n*=704; including data from this study but excluding data measured for ozone-treated Pony Lake fulvic acid ("PLFA Ozone"; *n*=20)[124]); (C) Single linear regression model of $\Phi_{app,\,^3DOM^*_{TMP}}$ based on $S_{300\text{-}600}$ (*n*=129; including data from this study but excluding data measured for whole waters from the Florida Everglades ("Florida Everglades"; *n*=21)[102]); and (D) Single linear regression model of $\Phi_{app,\,^1O_2}$ based on $S_{300\text{-}600}$ (*n*=220; including data from this study but excluding data measured for ozone-treated Pony Lake fulvic acid ("PLFA Ozone"; *n*=20)[124]). $\Phi_{app,\,^3DOM^*_{TMP}}$ and $\Phi_{app,\,^1O_2}$ were tabulated in Table S16. *E2:E3* and $S_{300\text{-}600}$ were extracted from corresponding references when reported. The red solid line represents the linear regression line. The blue dot lines represent the 95% prediction interval. Note that no statistically significant correlation was identified between $\Phi_{app,\,^{\bullet}OH}$ and *E2:E3* (not shown).

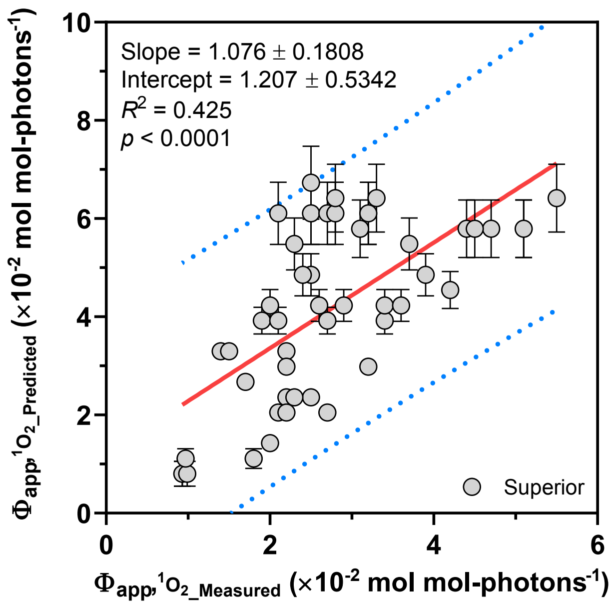


**Figure S7.** Crossplot of $\Phi_{app,\,{}^1O_2}$ measured for surface waters from Lake Superior[129] versus $\Phi_{app,\,{}^1O_2}$ predicted by $\Phi_{app,\,{}^1O_2}$ (×10$^{-2}$ mol mol-photons$^{-1}$) = 0.312(±0.037) $S_{290\text{-}400}$ (μm$^{-1}$) – 3.255(±0.659) developed in this study ($S_{300\text{-}400}$ from Peterson *et al.*[129] were used to approximate $S_{290\text{-}400}$). The red solid line represents the linear regression line. The blue dot lines represent the 95% prediction interval.

## 14. Effects of pH, Al, and Fe on the formation rates of RIs and the rate of light absorption

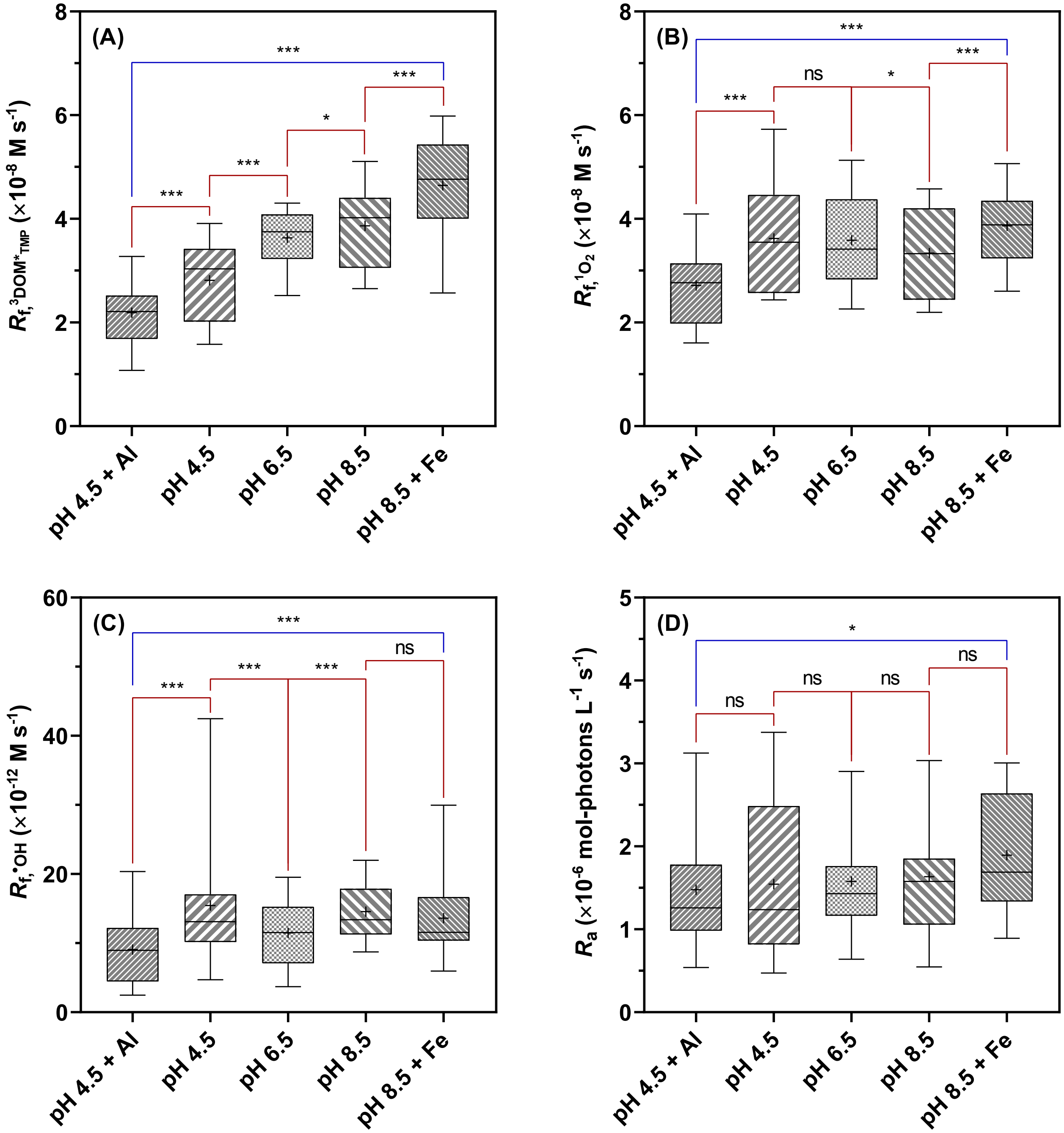


**Figure S8.** Effects of pH, Al, and Fe on $R_{f,RI}$ and $R_a$ for altered Adirondack lake water samples ($n$=16 for each treatment): (A) Box-and-whiskers plots of $R_{f,{}^3DOM^*_{TMP}}$; (B) Box-and-whiskers plots of $R_{f,{}^1O_2}$; (C) Box-and-whiskers plots of $R_{f,{}^\bullet OH}$; and (D) Box-and-whiskers plots of $R_a$. Box represents the interquartile range. Whiskers represent the 5th and 95th percentiles. The centerline in each box represents the median, while the plus sign "+" represents the mean. Significant differences between treatments are denoted as "*" ($p$<0.05), "**" ($p$<0.01), or "***" ($p$<0.001). "ns" represents no statistically significant difference.

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