**Supporting Information**

**Figure 1. Rising Temperatures of Global Freshwaters**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Complete Reference** | **Latitude**  | **Longitude** | **River/Water Body** | **Period of Record** | **Data/Sampling Frequency** | **Digitized Figure Data Originates From** |
| Casola, J.H., J.E. Kay, A.K. Snover, R.A. Norheim, L. C. Whitely Binder and the Climate Impacts Group. 2005. Climate Impacts on Washington’s Hydropower, Water Supply, Forests, Fish, and Agriculture. A report prepared for King County (Washington) by the Climate Impacts Group (Center for Science in the Earth System, Joint Institute for the Study of the Atmosphere and Ocean, University of Washington, Seattle). | 49.1 | -123.167 | Fraser River, Canada | 1952-1996 | Mean Annual Summer Temperature | Figure 10 |
| Kocan, R., P. Hershberger and J. Winton. 2003. Effects of Ichthyophonus on Survival and Reproductive Success of Yukon River Chinook Salmon. Federal Subsistence Fisheries Resource Monitoring Program, Final Project Report No. FIS 01-200. U. S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Information Services Division, Anchorage, Alaska. | 62.533 | -163.9 | Yukon River, Canada | 1975-2002 | Mean Annual June Temperature  | Figure 16 |
| Johnson, Stephanie L., and Heinz G. Stefan. “Indicators of Climate Warming in Minnesota: Lake ICE Covers and Snowmelt Runoff.” Climatic Change, vol. 75, no. 4, 2006, pp. 421–453., doi:10.1007/s10584-006-0356-0. | 35.514706 | -89.912506 | Mississippi River, United States | 1975-2002 | Annual Average Temperature | Figure 8 |
| Kaushal, Sujay S, et al. “Rising Stream and River Temperatures in the United States.” Frontiers in Ecology and the Environment, vol. 8, no. 9, 2010, pp. 461–466., doi:10.1890/090037. | 43.9419 | -71.7257 | Hubbard Brook, United States | 1965-2005 | Annual Average Temperature | Figure 1 |
| Kaushal, Sujay S, et al. “Rising Stream and River Temperatures in the United States.” Frontiers in Ecology and the Environment, vol. 8, no. 9, 2010, pp. 461–466., doi:10.1890/090037. | 42.080068 | -73.930390 | Hudson River, United States | 1905-1993 | Annual Average Temperature | Figure 1 |
| Kaushal, Sujay S, et al. “Rising Stream and River Temperatures in the United States.” Frontiers in Ecology and the Environment, vol. 8, no. 9, 2010, pp. 461–466., doi:10.1890/090037. | 40.29245 | -74.86848 | Delaware River, United States | 1965-2005 | Annual Average Temperature | Figure 1 |
| Kaushal, Sujay S, et al. “Rising Stream and River Temperatures in the United States.” Frontiers in Ecology and the Environment, vol. 8, no. 9, 2010, pp. 461–466., doi:10.1890/090037. | 39.82572 | -75.5732 | Brandywine Creek, United States | 1972-2006 | Annual Average Temperature | Figure 1 |
| Kaushal, Sujay S, et al. “Rising Stream and River Temperatures in the United States.” Frontiers in Ecology and the Environment, vol. 8, no. 9, 2010, pp. 461–466., doi:10.1890/090037. | 38.439373 | -77.302759 | Potomac River, United States | 1920-1999 | Annual Average Temperature | Figure 1 |
| Kaushal, Sujay S, et al. “Rising Stream and River Temperatures in the United States.” Frontiers in Ecology and the Environment, vol. 8, no. 9, 2010, pp. 461–466., doi:10.1890/090037. | 47.44304387279977 | -114.33724411548383 | Flathead River, United States | 1979-2005 | Annual Average Temperature | Figure 1 |
| Kaushal, Sujay S, et al. “Rising Stream and River Temperatures in the United States.” Frontiers in Ecology and the Environment, vol. 8, no. 9, 2010, pp. 461–466., doi:10.1890/090037. | 42.65046376265154 | -123.58786456729207 | Rogue River, Oregon, United States | 1979-2005 | Annual Average Temperature | Figure 1 |
| Isaak, D. J., et al. “Climate Change Effects on Stream and River Temperatures across the Northwest U.S. from 1980–2009 and Implications for Salmonid Fishes.” Climatic Change, vol. 113, no. 2, 2011, pp. 499–524., doi:10.1007/s10584-011-0326-z. | 48.15776 | -115.78408 | South Fork Bull Run River, Orgeon | 1980-2009 | Raw Seasonal Temperature (Winter): Temperatures offset by +4 Deg C on plot\*  | Figure 2 |
| Bartholow, J. M. “Recent Water Temperature Trends in the Lower Klamath River, California.” North American Journal of Fisheries Management, vol. 25, no.1, 2005, pp. 152–162., doi:[10.1577/M04-007.1](https://doi.org/10.1577/M04-007.1) | 42 | -123.03 | Klamath River | 1962-2001 (Water Years) | Mean Monthly Water Year Temperature | Figure 2 |
| Vollmer, M. K. et al. “Deep-water warming trend in Lake Malawi, East Africa.” Limnology and Oceanography, vol. 50, 2005, pp. 727–732. | -12 | 34.5 | Lake Malawi | 1939 -2000 | Mean Annual Temperature (100m depth) | Figure 2 |
| Webb, B. W. “Trends in stream and river temperature.” Hydrological Processes, vol. 10 no.2, 1996, pp. 205–226. [https://doi.org/10.1002/(SICI)1099-1085(199602)10:2<205::AID-HYP358>3.0.CO;2-1](https://doi.org/10.1002/%28SICI%291099-1085%28199602%2910%3A2%3C205%3A%3AAID-HYP358%3E3.0.CO;2-1) | 48.04 | 14.129719 | Kremsmünster River | 1901-1990 | Mean Annual Water Temperature | Figure 2 |
| Webb, B. W., & Nobilis, F. “Long-term changes in river temperature and the influence of climatic and hydrological factors.” Hydrological Sciences Journal, vol. 52, no.1, 2007, pp. 74-85. | 47.2794  | 12.4793 | Salzach River (Headwaters Site) | 1901-2000 | Mean Annual Water Temperature | Figure 2A |
| Ye, F. & Kameyama, S. “Long-term nationwide spatiotemporal changes of freshwater temperature in Japan during 1982–2016.” Journal of Environmental Management vol.281, 2021. | 34.648442 | 137.7935 | Tenryu River | 1982-2016 | Mean Annual Water Temperature | Figure 4 |

**Figure 2: State Factors Forming Freshwater Salinization Syndrome**

**These references correspond to superscripts from Figure 2 demonstrating the state factors and causes of Freshwater Salinization Syndrome, such as climate, geology, human activities, flowpaths, and time. These are examples from the literature which do not address FSS as a concept, but describe the increase of one/more salt ions and the impacts. The number in front of the reference below corresponds the number in the figure on the left-hand side of each example. The references are listed numerically below.**

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**Figure 3 Connecting Common FSS Causes to Consequences**

**These references correspond to superscripts in Figure 3 in the main text linking the causes and consequences of Freshwater Salinization Syndrome based on the state factors. These are examples from the literature which do not address FSS as a concept, but describe the increase of one/more salt ions and the impacts. The number in front of the reference is the number in the figure on the left-hand side of each example. These are listed numerically below.**

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**Table 1:**

**The number in front of each reference, listed numerically below, corresponds to numbers in the Reference column of Table 1 in the main text showing the impact of higher concentrations of base cations and ions resulting from Freshwater Salinization Syndrome on ecosystem functions and processes. The examples from the literature do not address FSS as a concept but describe increases in one or more salt ions and the impacts.**

[1] Cañedo-Argüelles et al. 2013 [2] Iglesias 2020 [3] Donnelly et al. 1997 [4] Nielsen et al. 2003 [5] Mclaughlin et al. 1996 [6] Mirlean et al. 2005 [7] Ramakrishna and Viraraghavan 2005 [8] de Oliveira-Filho et al. 2004 [9] Grosell et al. 2007 [10] Kaushal et al. 2021 [11] Liang et al. 1999 [12] Sandor et al. 2001 [13] Galella et al. 2021 [14] Bollhöfer et al. 2011 [15] McNaboe et al. 2017 [16] Lazur et al. 2020 [17] Riedel and Kübeck 2018 [18] Bergmann et al. 2018 [19] Green and Cresser 2008a [20] Duan and Kaushal 2015 [21] Kaushal et al. 2017 [22] Šimek and Cooper 2002 [23] Sahrawat 2008 [24] Kaushal et al. 2018b [25] Li et al. 2007 [26] Findlay and Kelly 2011 [27] Green et al. 2008a [28] Green and Cresser 2008b [29] Dai et al. 2012 [30] Mavi et al. 2012 [31] Nazarbeygi et al. 2011 [32] Geddes 1988 [33] Sauer et al. 2016 [34] Berger et al. 2019 [35] Marton et al. 2012 [36] van Dijk et al. 2019 [37] Green et al. 2008b [38] Jeppesen et al. 2015 [39] Lind et al. 2018 [40] Bernhardt and Likens 2002 [41] Tripler et al. 2006 [42] Kaushal et al. 2019 [43] White et al. 2013 [44] Yue et al. 2021 [45] Kaushal et al. 2018a [46] Ahmad et al. 2008 [47] Duan and Kaushal 2013 [48] Spiteri et al. 2008 [49] Smolders et al. 2006 [50] Haq et al. 2018 [51] Bernhardt and Palmer 2011 [52] Norrström and Bergstedt 2001 [53] Steele and Aitkenhead-Peterson 2011 [54] Kaushal et al. 2014 [55] Boyd et al. 2016 [56] Judd 1970 [57] Sherwood et al. 1991 [58] Best et al. 2007 [59] Hansson and Gustafsson 2011 [60] Amirbahman et al. 2003 [61] Bormans et al. 2016

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**Figure 5.**

Data illustrated in Fig. 5 (Bottom Panel) were derived from automated sensors deployed by the United States Geological Survey (USGS). The data for each site can be downloaded from the USGS National Water Information System. Sites shown include the [Northeast Branch Anacostia River (USGS gage number 01649500)](https://waterdata.usgs.gov/dc/nwis/uv/?site_no=01651000&PARAmeter_cd=00065,00060,62620), [Capacon River (01611500)](https://waterdata.usgs.gov/usa/nwis/uv?01611500), [Difficult Run (01646000)](https://waterdata.usgs.gov/usa/nwis/uv?01646000), and the [Potomac River (01646500)](https://waterdata.usgs.gov/usa/nwis/uv?01646500).