Water-Quality Data from Lakes in the Yukon Flats, Alaska, 2010–2011

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Cover photo: Yukon Flats looking northeast near Fort Yukon, Alaska.

Contents

Figure

Tables

Conversion Factors and Abbreviations

SI to Inch/Pound

Multiply	By	To obtain
	Length	
meter (m)	3.281	foot (ft)
centimeter (cm)	0.3937	inch (in.)
kilometer (km)	0.6214	mile (mi)
kilometer (km)	0.5400	mile, nautical (nmi)
meter (m)	1.094	yard (yd)
	Area	
square kilometer (km^2)	247.1	acre
square kilometer (km^2)	0.3861	square mile (mi^2)
	Volume	
liter (L)	33.82	ounce, fluid (fl. oz)
liter (L)	2.113	pint (pt)
liter (L)	1.057	quart (qt)
liter (L)	0.2642	gallon (gal)
liter (L)	61.02	cubic inch (in^3)
	Mass	
gram (g)	0.03527	ounce, avoirdupois (oz)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

°F=(1.8×°C)+32

Horizontal coordinate information is referenced to North American Datum of 1983 (NAD 83).

Vertical coordinate information is referenced to North American Vertical Datum of 1988 (NAVD 88).

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25 °C).

Abbreviations

µmol	micromole
µS	microsiemen
C	carbon
°C	degrees Celsius
$CaCO_3$	calcium carbonate
CH_4	methane
cm	centimeters
CO_2	carbon dioxide
DIC	dissolved inorganic carbon
GIS	geographic information system
H	hydrogen
L	liter
m	meter
mg	milligram
mL	milliliter

N	nitrogen
nm	nanometer
NRP	National Research Program
O	oxygen
per mil	parts per thousand
ppm	parts per million
ppmv	parts per million by volume
RSD	relative standard deviation
SUVA	specific ultra violet absorbance
USGS	U.S. Geological Survey
YFNWR	Yukon Flats National Wildlife Refuge

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Abstract

Over a two-year period (2010–2011), in-place measurements were made and water-quality samples were collected from 122 lakes in the Yukon Flats, Alaska, during a U.S. Geological Survey lake biological diversity inventory. The U.S. Geological Survey National Research Program performed the chemical analyses on the retrieved water-quality samples. Results from the analyses of water samples for dissolved carbon gases and carbon isotopes, hydrogen and oxygen stable isotopes, dissolved organic carbon, and major cations and anions, along with supporting site data, are presented in this report.

Introduction

The U.S. Geological Survey's (USGS) National Research Program (NRP) has been conducting research in Alaska's Yukon River basin since 2001. In 2010, the NRP had the opportunity to work with the U.S. Geological Survey's Alaska Cooperative Fish and Wildlife Research Unit at the University of Alaska–Fairbanks in their survey of biological diversity in and around lakes of the Yukon Flats. Over a two-year period (2010–2011), 122 lakes (117 within the Yukon Flats National Wildlife Refuge [YFNWR]) were sampled to evaluate water-quality (fig. 1).

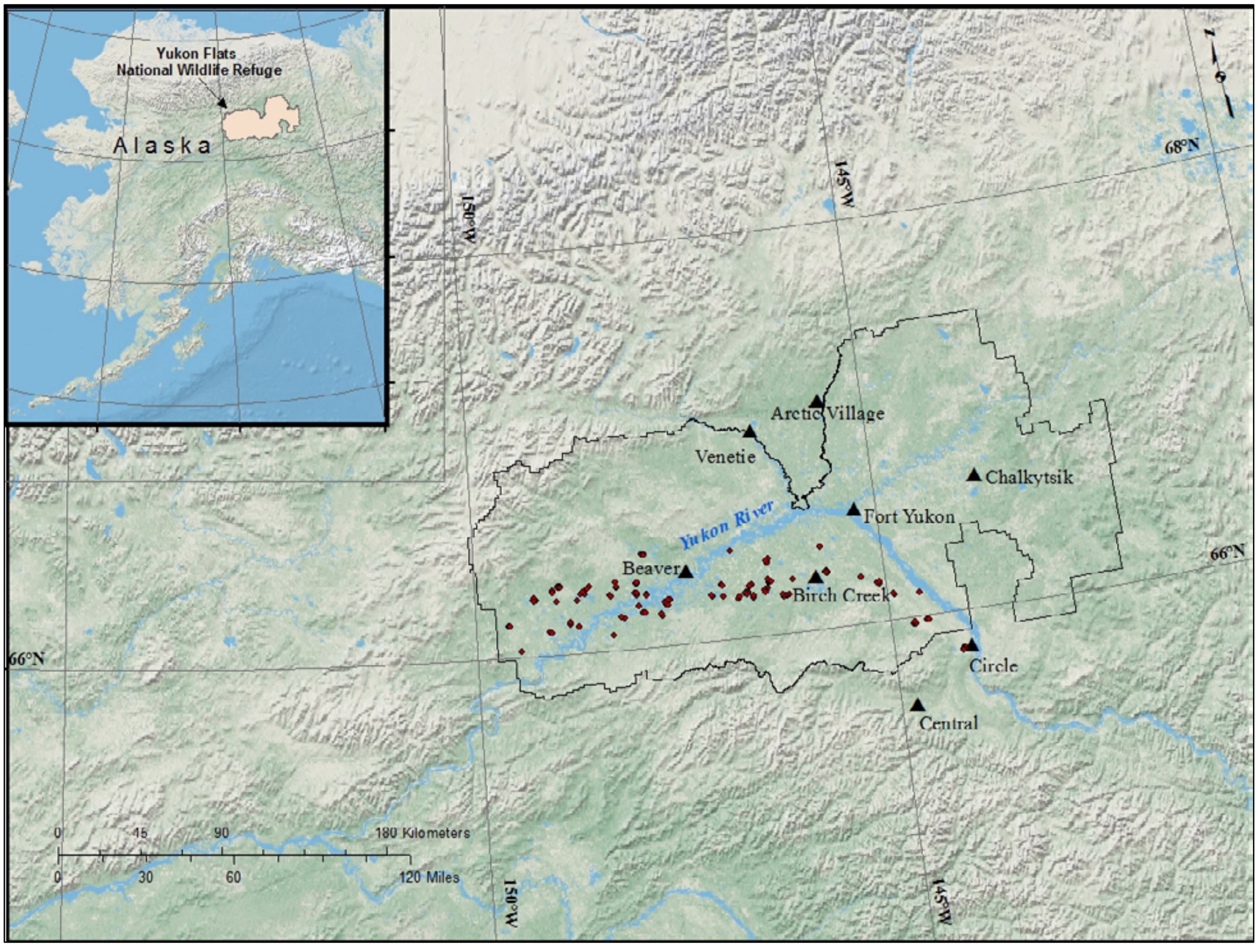

Figure 1. Location of the Yukon Flats and sample lakes. Red symbols indicate locations of lakes sampled. Black symbols indicate villages within the study area. (Base map: U.S. National Park Service, December 2009)

Purpose and Scope

This report presents site characteristics and water-quality data from lakes of the Yukon Flats, Alaska, sampled during June–August for the years 2010–2011. Water-quality data are from in-place field measurements (water temperature, specific conductance, and pH) and laboratory results for dissolved carbon gases and carbon isotopes, hydrogen and oxygen stable isotopes, dissolved organic carbon, and major cations and anions.

Site Description

The Yukon Flats ecoregion is a relatively flat, marshy basin which has braided, meandering rivers and streams and numerous thaw, basin, and oxbow lakes. The region is roughly located between 65.8° and 67.4° N. latitude and 143.3° and 149.6° W. longitude and is approximately 33,500 square kilometers in area (fig 1).

Climate in the Yukon Flats is continental, with average daily temperatures in winter ranging from lows of about -34 °C to highs of about -24 °C. Average daily temperatures in summer range from lows of about 0 °C to highs of about 22 °C. Daily annual extremes have reached lows of below -50 °C and above 32 °C. The Yukon Flats has an average annual precipitation of 16.5 centimeters (cm) and an average snowfall of 115 cm (Brabets and others, 2000).

Land cover is predominantly forest, with black and white spruce, aspen, white birch, balsam poplar, tall scrub communities, and graminoid herbaceous communities. The Yukon Flats is underlain by moderately thick to thin discontinuous permafrost. Taliks are present under most rivers and are likely under most large lakes (Minsley and others, 2012). Quaternary-age alluvial and eolian deposits mantle the region. Soils, predominantly Histic Pergelic Cryaquepts, Pergelic Cryaquepts, Aquic Cryochrepts, and Pergelic Cryochrepts, are derived from silty alluvium and loess (Brabets and others, 2000).

There are more than 30,000 lakes within the Yukon Flats (Heglund and Jones, 2003). Four main processes have formed the majority of the lakes: river movement creating lateral and oxbow lakes, changes in permafrost (Jorgenson and Osterkamp, 2005), accumulation of water in closed basins, and stream-channel damming by beaver activity (Lewkowicz and Coultish, 2004). Within the study area there are both open and closed lakes: those with inlets and outlets (open) and those without (closed). Most of the lakes have maximum depth of less than 2 meters (m) and may freeze to the sediments (Corcoran and others, 2009). Lake and wetland littoral zones have four main vegetation types: (1) uniform zones of bulrush, cattails, horsetails, and (or) marsh fleabane, (2) sedge and (or) grass meadow, (3) floating mats of bog vegetation, or (4) narrow or absent littoral zone with immediate transition to terrestrial shrubs and (or) forest (Guldager and others, 2010).

Over the last few decades, air temperatures in the region have shown a warming trend (Hinzman and others, 2005). This warming trend can lead to increased evaporation, terrestrialization, and (or) lake drainage resulting from taliks forming under the lake, all of which could cause the lake extent to shrink (Roach and others, 2011, 2013). This warming, and putatively related changes in lake extent, may affect the lake chemistry and therefore the biota of the lakes (Bowling and Lettenmaier, 2010; Roach and others, 2011, 2013). A recent study of lake-extent variability, using 30 years of Landsat scenes from 1979 through 2009, examined more than 15,000 lakes in or near the Yukon Flats. The study indicates that during this time 86 percent of the lakes had no significant change in extent, 8.7 percent of the lakes decreased in extent, and 5.3 percent increased in extent (Rover and others, 2012). Roach and others (2013) reported substantial heterogeneity in lake trends within YFNWR with regional annual rates of change ranging from -2.96 to +0.34 percent. Lakes with decreasing extents can usually be easily identified by sparse vegetation along the newly exposed shorelines and by recently formed adjacent meadow zones; stable lakes on the other hand, have shorelines that often quickly transition to terrestrial shrubs and trees or have naturally fluctuating marsh zones.

Water-Quality Sampling and Analysis

Water samples were obtained from 48 focal lakes and an additional 74 lakes adjacent to focal lakes. Focal lakes were identified by a generalized random tessellation stratified sample (Stevens and Olson, 2004) of lakes accessible by float plane in a study area that included lowlands both within and contiguous with YFNWR. Adjacent lakes were a simple random sample of lakes intersected by a 1-kilometer radius on focal lake centroids. Field measurements and water samples were collected from an inflatable raft near lake centroid or by wading a safe distance from shore. Water temperature, specific conductance, and pH were measured using a hand-held multiparameter instrument 0.5 m below the water surface. A 1-liter (L) bottle was filled with filtered water and a 2-L bottle was filled with unfiltered water at each lake at a water depth of 0.5 m and was kept chilled. Also, two 30-milliliter (mL) serum bottles were filled by syringe at each lake for analysis of dissolved carbon gases. Upon returning from the field, the 1-L and 2-L bottles were split into subsamples for the various analyses. Split samples were filtered and stabilized with preservatives according to requirements for the particular analysis being performed. Methods used for collecting and processing water-quality samples are described in the USGS National Field Manual for the Collection of Water-Quality Data (U.S. Geological Survey, variously dated).

Analyses of anions, cations, dissolved carbon gases, dissolved organic carbon and stable water isotopes in the water samples were performed at the USGS NRP laboratories in Boulder, Colorado. Carbon isotope 13 of dissolved inorganic carbon (^{13}C-DIC) was analyzed by the stable isotope laboratory at Florida State University in Tallahassee, Florida.

A description of processing and analyses of anion and cations can be found in Fishman and Friedman (1989). For a description of laboratory alkalinity analysis see U.S. Geological Survey (variously dated). The analytical method used for carbon dioxide, methane, dissolved inorganic carbon, and dissolved organic carbon is given in Schuster (2003). Chasar and others (2000) describe the analytical method used for the determination of ^{13}C-DIC. A description of stable water isotope analyses can be found in Lis and others (2008).

Analytical results, along with supporting site information, are presented in tables 1–6. Minimum detection levels are indicated by a less-than symbol (<). Analytical results were verified by a set of quality-assurance and quality-control criteria. Table 7 presents standard deviations and relative standard deviations for laboratory replicate samples. The differences in results for replicate analyses can be used to estimate a standard deviation using the following equation:

$$S = \sqrt{\frac{\Sigma d^2}{2k}}$$

where

S	is the standard deviation of the difference in concentration between replicate samples,
d	is the difference in concentration between each pair of replicate analyses, and
k	is the number of pairs of replicate analyses.

Relative standard deviation (RSD) can be used to indicate precision of analysis; it is computed from the standard deviation and the mean concentrations for all replicate analyses. Expressing precision relative to a mean concentration standardizes the comparison of precision among individual constituents. The RSD is calculated according to the following equation:

$$\text{RSD} = \frac{S}{\bar{x}} \times 100$$

where

RSD	is the relative standard deviation,
s	is the standard deviation, and
$\bar{x}$	is the mean concentration for all replicate analyses.

Acceptable precision for replicate samples is a maximum RSD of 20 percent.

All quality assurance and quality control results met internal laboratory guidelines established by the USGS NRP, and data were determined to be of acceptable quality.

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References Cited

Brabets, T.P., Wang, Bronwen, and Meade, R.H., 2000, Environmental and hydrologic overview of the Yukon River basin, Alaska and Canada: U.S. Geological Survey Water-Resources Investigation Report 99–4204, 106 p.

Bowling, L.C., and Lettenmaier, D.P., 2010, Modeling the effects of lakes and wetlands on the water balance of arctic environments: Journal of Hydrometeorology, v. 11, p. 276–295.

Chasar, L.S., Chanton, J.P., Glaser, P.H., Siegel, D.I., and Rivers, J.S., 2000, Radiocarbon and stable carbon isotopic evidence for transport and transformation of DOC, DIC and CH4 in a northern Minnesota peatland: Global Biogeochemical Cycles, v. 14, p. 1095–1105.

Corcoran, R.M., Lovvorn, J.R., and Heglund, P.J., 2009, Long-term change in limnology and invertebrate in Alaskan boreal wetlands: Hydrobiologia, v. 620, no. 1, p. 77–89.

Fishman, M.J., and Friedman, L.C., 1989, Methods for determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, book 5, chap. A1, 545 p.

Guldager, Nikki, Lake, B.C., Anderson, Lesleigh, and Hart, S.L., 2010, Evaluating occupancy models to investigate waterbird-wetland habitat relationships on Yukon Flats NWR: Yukon Flats National Wildlife Refuge Report 2010–02, 17 p.

Heglund, P.J., and Jones, J.R., 2003, Limnology of shallow lakes in the Yukon Flats National Wildlife Refuge, Interior Alaska: Lake and Reservoir Management, v. 19, no. 2, p. 133–140.

Hinzman, L.D., Bettez, N.D., Bolton, W.R., Chapin, F.S., Dyurgerov, M.B., Fastie, C.L., Griffith, Brad, Hollister, R.D., Hope, Allen, Huntington, H.P., Jensen, A.M., Jia, G.J., Jorgenson, Torre, Kane, D.L., Klien, D.R., Kofinas, Gary, Lynch, A.H., Lioyd, A.H., McGuire, A.D., Nelson, F.E., Oechel, W.C., Osterkamp, T.E., Racine, C.H., Romanovsky, V.E., Stone, R.S., Stow, D.A., Sturm, Matthew, Tweedie C.E., Vourlitis, G.L., Walker, M.D., Walker, D.A., Webber, P.J., Welker, J.M., Winker, K.S., and Yoshikawa, Kenji, 2005, Evidence and implications of recent climate change in northern Alaska and other Arctic regions: Climate Change, v. 72, p 251–298.

Jorgenson, M.T., and Osterkamp, T.E., 2005, Response of boreal ecosystems to varying modes of permafrost degradation: Canadian Journal of Forest Research, v. 35, no. 9, p. 2100–2111.

Lewkowicz, A.G., and Coultish, T.L., 2004, Beaver damming and palsa dynamics in a subarctic mountainous environment, Wolf Creek, Yukon Territory, Canada: Arctic, Antarctic and Alpine Research, v. 36, no. 2, p. 208–218.

Lis, G., Wassenaar, L.I., and Hendry, M.J., 2008, High-precision laser spectroscopy D/H and $^{18}O/^{16}O$ measurements of microliter natural water samples: Analytcal Chemistry, v. 80, no.1, p. 287–293.

Minsley, B.J., Abraham, J.D., Smith, B.D., Cannia, J.C., Voss, C.I., Jorgenson, M.T., Walvoord, M.A., Wylie, B.K., Anderson, Lesleigh, Ball, L.B., Deszcz-Pan, Maryla, Wellman, T.P., and Ager, T.A., 2012, Airborne electromagnetic imaging of discontinuous permafrost: Geophysical Research Letters, v. 39, L02503, 8 p.

Roach, Jennifer; Griffith, Brad; and Verbyla, David, 2013, Landscape influences on climate-related lake shrinkage at high latitudes: Global Change Biology, v. 19, no. 7, p. 2276–2284.

Roach, Jennifer; Griffith, Brad; Verbayla, David; and Jones, Jeremy, 2011, Mechanisms influencing changes in lake area in Alaskan boreal forest: Global Change Biology, v. 17, p. 2567–2583.

Rover, Jennifer; Ji, Lei; Wylie, B.K.; and Tieszen, L.L., 2012, Establishing water body areal extent trends in interior Alaska from multi-temporal Landsat data: Remote Sensing Letters, v. 3, no. 7, p. 595–604.

Schuster, P.F., 2003, Water and sediment quality in the Yukon River Basin, Alaska, during water year 2001: U.S. Geological Survey Open-File Report 03–427, 120 p. [Also available at *http://pubs.usgs.gov/of/2003/ofr03427/*.]

Stevens, D.L., and Olsen, A.R., 2004. Spatially balanced sampling of natural resources: Journal of the American Statistical Association, v. 99, p. 262–278.

U.S. Geological Survey, variously dated, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1–A9, accessed September 18, 2013, at *http://pubs.water.usgs.gov/twri9A*.

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All tables are presented as separate sheets in one Excel file. The link opens the Excel file to the default first sheet; please use the sheet tabs to find the desired table.

Table 1. Site characteristics for Yukon Flats sample lakes, Alaska, 2010–2011. (*link*)

Table 2. In-place measurements of water quality of Yukon Flats sample lakes, Alaska, 2010–2011. (*link*)

Table 3. Dissolved carbon gases and carbon isotopes in water samples from Yukon Flats sample lakes, Alaska, 2010–2011. (*link*)

Table 4. Composition of stable isotopic fractions of hydrogen and oxygen in water samples from Yukon Flats sample lakes, Alaska, 2010–2011. (*link*)

Table 5. Dissolved organic carbon and fractionation of water samples from Yukon Flats sample lakes, Alaska, 2010–2011. (*link*)

Table 6. Major anions, cations, and laboratory alkalinity in water samples from Yukon Flats sample lakes, Alaska, 2010–2011. (*link*)

Table 7. Precision of analyses of laboratory replicates for water and gas samples from Yukon Flats sample lakes, Alaska, 2010–2011. (*link*)