Water-Quality Data of Lakes and Wetlands in the Yukon Flats, Alaska, 2007–2009

By Douglas R. Halm and Nikki Guldager

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Contents

Figures

Tables

Conversion Factors

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 the insert datum name (and abbreviation) here, for instance, "North American Datum of 1983 (NAD 83)"

Abbreviations

The following terms are used in this report:

C	Carbon
°C	Degrees Celsius
$CaCO_3$	Calcium Carbonate
cm	centimeters
CRDS	Cavity Ringdown Spectroscopy
DIC	Dissolved Inorganic Carbon
GIS	Geographic Information System
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
km	Kilometers
L	Liter
m	meter
mg	milligrams
NAD	North American Datum
NGVD	North American Geodetic Vertical Datum
Nm	Nanometer
NRP	National Research Program
per mil	parts per thousand
ppm	parts per million
SUVA	specific ultra violet absorbance
µmol	micromole
µs	microsiemen
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
YFNWR	Yukon Flats National Wildlife Refuge

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By Douglas R. Halm[1] and Nikki Guldager[2]

Abstract

Over a three-year period (2007–2009), *in-situ* measurements were taken and water-quality samples were collected from 111 lakes and wetlands located in the Yukon Flats, Alaska, during a U.S. Fish and Wildlife Service wetlands inventory. The U.S. Geological Survey 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 (USGS) National Research Program (NRP) has been conducting research of the Yukon River basin since 2001. In 2007, the NRP had the opportunity to cooperate with the U.S. Fish and Wildlife Service (USFWS), Yukon Flats National Wildlife Refuge (YFNWR) in their survey of wetlands of the Yukon Flats. To increase our understanding of the water chemistry of the Yukon Flats region, a cooperative program was set up to collect water-quality samples from lakes and wetlands that were surveyed. Over a three year period (2007–2009), 111 lakes and wetlands were sampled to evaluate water-quality (fig. 1). Eleven of the lakes were sampled multiple times, and ten of the lakes were sampled under ice.

Purpose and Scope

This report presents site characteristics and water-quality data from lakes and wetlands of the Yukon Flats, Alaska, for the years 2007–2009. Water-quality data included in this report are *in-situ* field measurements (water temperature, specific conductance, pH, and dissolved oxygen) and laboratory results for dissolved carbon gases and carbon isotopes, hydrogen and oxygen stable isotopes, dissolved organic carbon, and major cations and anions.

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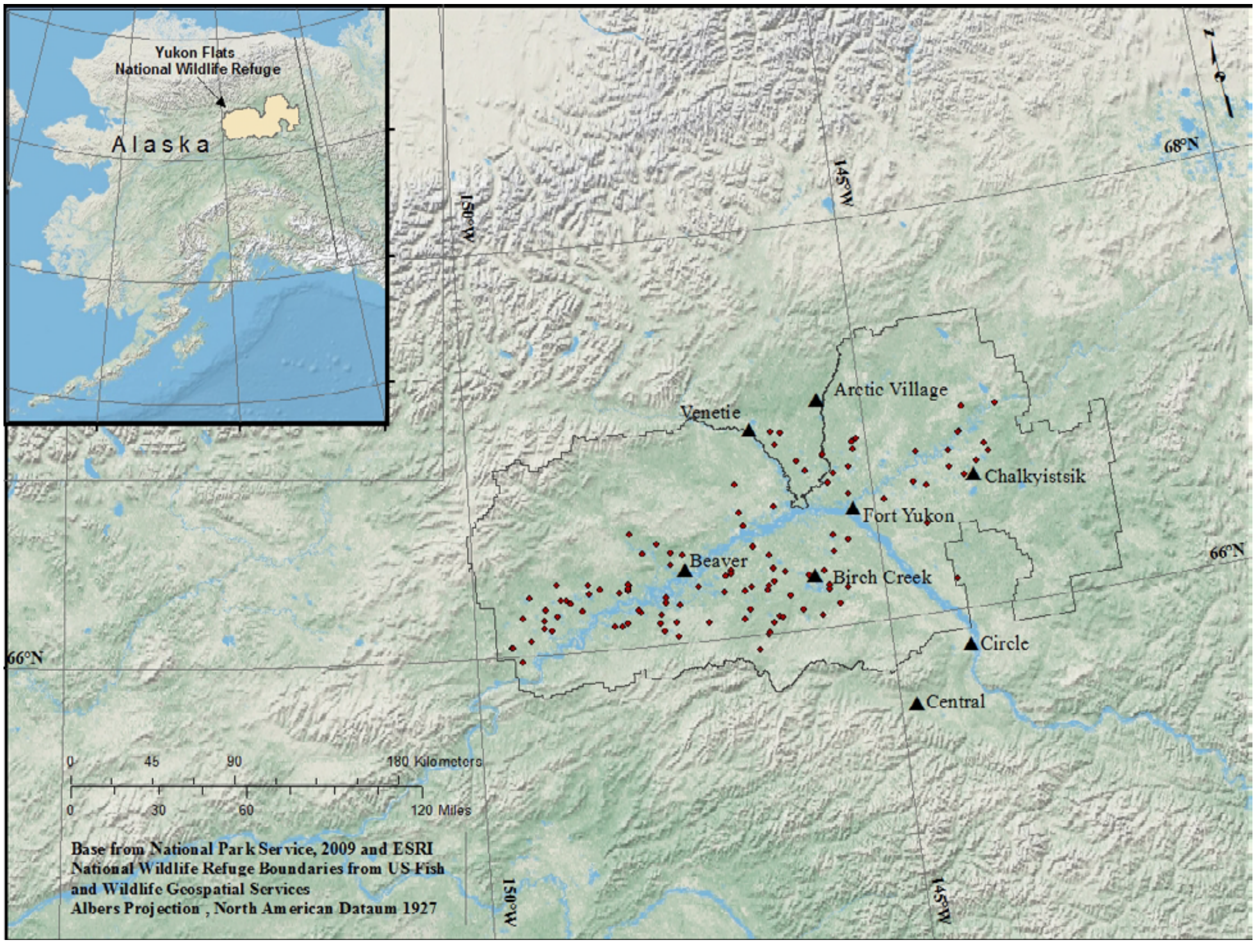

Figure 1. Location of the Yukon Flats with the Yukon Flats National Wildlife Refuge boundary indicated on the inset map. Red symbols indicate location of lakes sampled. Black symbols indicate villages within the study area.

Site Description

The YFNWR encompasses almost all of the Yukon Flats ecoregion in east-central Alaska. 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 located roughly between latitudes 65.8 and 67.4 degrees north and longitude 143.3 and 149.6 degrees west, and its area is approximately 26,000 square kilometers.

Climate in the YFNWR 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 extremes have reached lows of below -50°C and above 32°C. 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 YFNWR (Heglund, 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).

Over the last few decades, air temperatures in the region have shown a warming trend (Hinzman and others, 2005). This warming trend may cause shrinking of lake extent due to increased evaporation, terrestrialization, and/or draining of the lakes due to talik formation under the lake. This warming, and related changes in lake extent, may affect the chemistry and therefore the biota of the lakes and wetlands (Bowling and Lettenmaier, 2010; Roach and others, 2011). A recent study of lake-extent variability, using Landsat scenes from 1979 through 2009, looked at more than 15,000 lakes and wetlands in or near the Yukon Flats. The study indicates that 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 over the 30 years (Rover and others, 2012). Lakes with decreasing extents are usually apparent due to sparse vegetation along newly exposed shoreline and large adjacent meadow zones (fig. 2), while the shoreline of stable lakes often quickly transitions to terrestrial shrubs and trees or have a naturally fluctuating marsh zone (fig. 3). 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).

Figure 2. Yukon Flats Lake 292, an example of a lake with decreased extent.

Figure 3. Yukon Flats Lake 276A, an example of a lake with stable extent.

Water-Quality Sampling and Analysis

Access to all lake-sampling sites in this study was provided by USFWS fixed-wing aircraft equipped with either pontoons or skis, or by helicopter for small lakes. Sites selected for the inventory were randomly chosen. Field measurements and water samples were collected from the pontoons of the plane, from the frozen surface of the lake, or by wading from shore., Water temperature, specific conductance, pH, and dissolved oxygen were measured using a hand-held, multi-parameter instrument (YSI Professional Plus or similar) 0.5 m below the water surface. A 1-liter (L) Teflon bottle was filled at each lake or wetland at a water depth of 0.5 m and was kept chilled. Upon returning from the field each day, the 1-L bottle was split into sub-samples 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 presented 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, and dissolved organic carbon in the water samples were performed at the USGS NRP laboratories in Boulder, Colorado (Colo.). Analyses of stable water isotopes were performed at either the USGS laboratories in Reston, Virginia, by Inductively Coupled Plasma Mass Spectrometry, or at the USGS laboratories in Boulder, Colo., by cavity ringdown spectroscopy. Carbon isotope 13 of dissolved inorganic carbon (^{13}C-DIC) was analyzed by the stable isotope laboratory of Florida State University, 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 (1997–1999). Analytical methods used for carbon dioxide, methane, dissolved inorganic carbon, and dissolved organic carbon are given in Schuster (2003). Chasar and others (2000) describe the analytical method used for the determination of carbon ^{13}C-DIC. A description of the stable hydrogen isotope analyses can be found in Kendall and Coplen (1985), and a description of the analyses for stable oxygen isotopes in Epstein and Mayeda (1953).

Analytical results, along with supporting site information, are presented in tables 1 through 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 (S):

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

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, and 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:

$$\text{RSD} = \frac{s}{\bar{x}} \text{ x } 100$$

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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Table 1. Site characteristics for Yukon Flats lakes, Alaska, 2007–2009.

Table 2. *In-situ* measurements of water quality of Yukon Flats lakes, Alaska, 2007–2009.

Table 3. Dissolved carbon gases and carbon isotopes in water samples from Yukon Flats lakes, Alaska, 2007–2009.

Table 4. Composition of stable isotopic fractions of hydrogen and oxygen in water samples from Yukon Flats lakes, Alaska, 2007–2009.

Table 5. Dissolved organic carbon and fractionation of water samples from Yukon Flats lakes, Alaska, 2007–2009.

Table 6. Major anions, cations, and laboratory alkalinity in water samples from Yukon Flats lakes, Alaska, 2007–2009.

Table 7. Precision of analyses of laboratory replicates for water and gas samples, Yukon Flats lakes, Alaska, 2007–2009.