U.S. Fish & Wildlife Service

Monitoring Lake Water Temperature at Kodiak, Togiak and Alaska Peninsula/Becharof National Wildlife Refuges

2011 Progress Report

Bill Pyle, Patrick Walsh, and Ron Britton

Kodiak National Wildlife Refuge
Kodiak, Alaska;
Togiak National Wildlife Refuge
Dillingham, Alaska;
Alaska Peninsula/Becharof National Wildlife Refuge
King Salmon, Alaska;
February 2012

Citation:

Pyle, Bill, Walsh, Patrick, and Britton, Ron. 2012. Monitoring Lake Water Temperature at Kodiak, Togiak and Alaska Peninsula/Becharof National Wildlife Refuges: 2011 Progress Report. U.S. Fish and Wildlife Service, Kodiak National Wildlife Refuge, Kodiak, Alaska.

Keywords:

Lake monitoring, water temperature, National Wildlife Refuges, southwestern Alaska

Monitoring Lake Water Temperature at Kodiak, Togiak and Alaska Peninsula/Becharof National Wildlife Refuges

2011 Progress Report

Bill Pyle, Patrick Walsh, Ron Britton[1]

Abstract

Instrument arrays were established to conduct long-term, all-season monitoring of water temperature at eight lakes on Kodiak, Togiak, and Alaska Peninsula/Becharof National Wildlife Refuges in summer and fall 2011. Water temperature measurements will be recorded hourly throughout the year at various depth intervals from water surface to lake bottom. During periods of ice cover the surface measurements will be discontinued.

Introduction

Water temperature influences all biological and physicochemical interactions within aquatic systems. Water temperature monitoring is an essential part of lake management capable of providing early warning signs of climate change effects using straight forward, low-cost techniques. Water temperature data acquired in this study will be used to support analyses of trend of the lacustrine component of sockeye salmon habitat. The need for such analyses is acute because climate change will influence lake habitat quality; growth and survival of juvenile sockeye salmon; and subsistence, recreational, and commercial harvest opportunities. Additionally, data acquired in this project will be combined with data collected by the National Park Service (NPS), the University of Washington, and the U.S. Geological Survey's (USGS) Alaska Science Center (Jones et al. 2011) to facilitate analysis and interpretation of lake temperature trend across the entire Western Alaska Landscape Conservation Cooperative (WAKLCC). Initial funding for this cooperative study was provided by the Service's WAKLCC.

The primary goals of this project include: (1) establishment of baseline water temperature monitoring in selected lakes on Kodiak, Togiak and Alaska Peninsula/Becharof National

[1] **Authors:** Bill Pyle, U. S. Fish and Wildlife Service, Kodiak NWR, 1390 Buskin River Road, Kodiak, AK, (907) 487-0228, Bill_Pyle@fws.gov; Patrick Walsh, U. S. Fish and Wildlife Service, Togiak National Wildlife Refuge, P.O. Box 270, Dillingham, AK 99576, (907) 842-1063, Patrick_Walsh@fws.gov; Ron Britton, U. S. Fish and Wildlife Service, Alaska Peninsula/Becharof NWR, P.O. Box 277, King Salmon, AK 99613, (907) 246-1212, Ron_Britton@fws.gov.

Wildlife Refuges; (2) integration of data within an established NPS database; (3) provision of data to the USGS (Jones et al. 2011); and (4) evaluation and dissemination of summary results on status and trends of lake temperatures.

Study area

The study lakes occur within Kodiak NWR (Karluk and Red Lakes), Togiak NWR (Togiak and Ongivinuk Lakes), and Becharof and Alaska Peninsula NWRs (Becharof, upper Ugashik, Needle, and Mother Goose Lakes) (Figure 1).

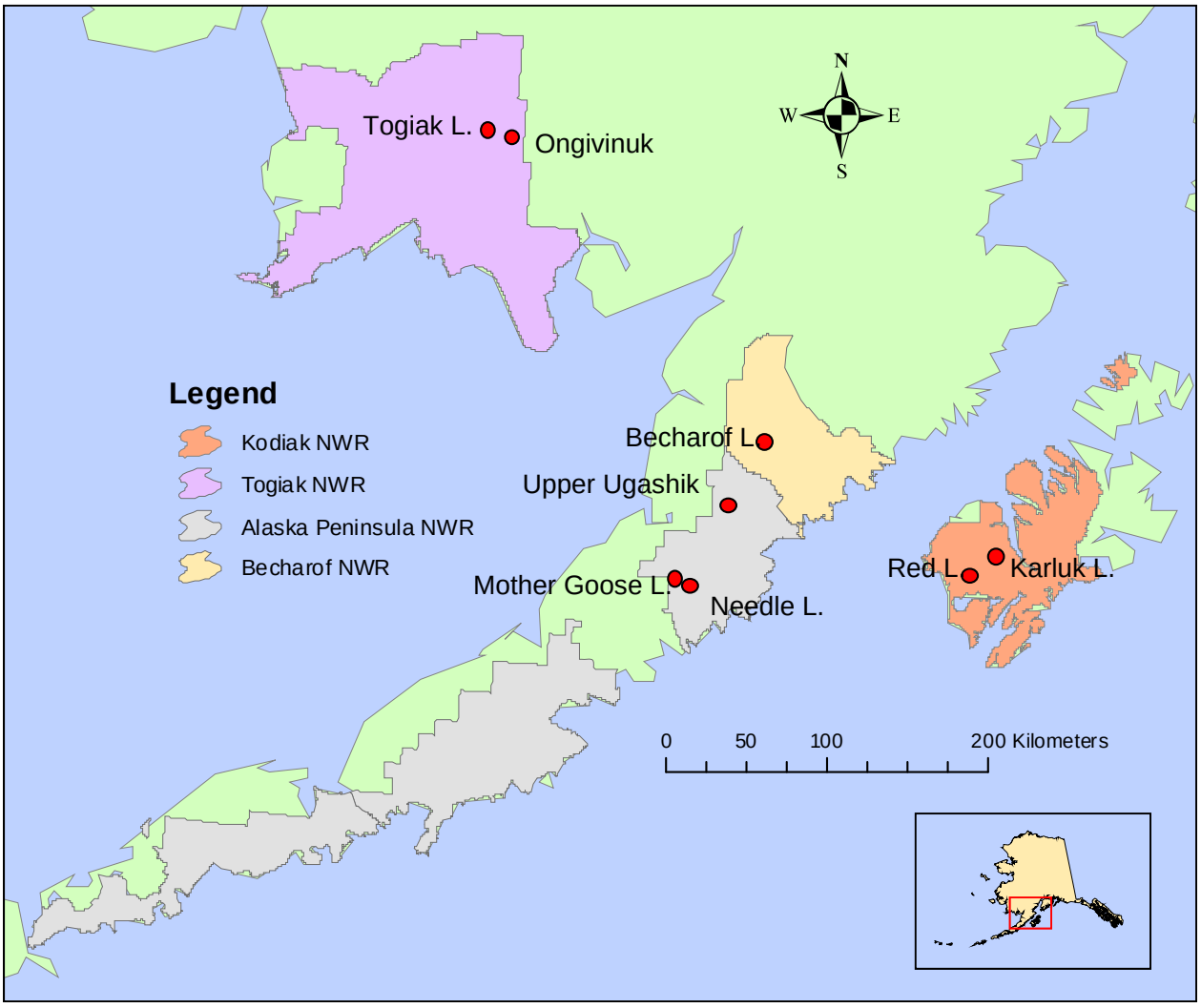

Figure 1. Location of study lakes in four National Wildlife Refuges in southwestern Alaska.

Methods

Lake selection

We selected study lakes based on several criteria. These included: (1) documented sockeye salmon habitat; (2) surface area larger than 10 ha; and (3) availability of relevant lake-specific technical information (e.g., limnology, bathymetry, fisheries inventory, monitoring, and/or research records). Study lakes differed substantially in physical characteristics especially lake watershed area, lake surface area, elevation, depth, and configuration (Table 1).

Table 1. Physical characteristics of study lakes.

Lake	Lake watershed (ha)	River watershed	Surface area (ha)	Elevation (m)	Max depth (m)	Mean depth (m)	Length (km)	Width (km)
Red[1]	5,687	Ayakulik	750	62	47	27	6.4	1.7
Karluk[1]	27,091	Karluk	3,810	112	139	41	19.1	3.2
Becharof[2,3]	-	Egegik	114,270	15	181	57	60	24
Mother Goose[4,5]	-	King Salmon	-	23	45	-	9.6	5
Upper Ugashik[2,3]	-	Ugashik	19,940	4	150	28.6	27	10
Needle	-	King Salmon	-	27	-	-	1.4	0.9
Togiak[6]	303,021	Togiak	3,835	67	143	77	22.5	1.6
Ongivinuk[6]	3,166	Togiak	122	163	12	6	2	0.8

Data sources: [1]H. Finkle, Alaska Dept. of Fish and Game, pers. comm.; [2]Spafard and Edmundson (2000); [3]Orth (1967); [4]Schaefer et al. (2008); [5]Schaefer et al. (2011); and [6]MacDonald (1996).

Protocol

We followed protocol established and currently used by the NPS in lakes of southwestern Alaska (Shearer & Moore, 2011). Accordingly, each temperature-monitoring array consisted of a tandem instrument line and anchor line. Line sets consisted of anchors at the lake bottom, buoys near the lake surface, and intervening lines. Length of lines was determined by estimated lake depth at the deployment sites. To prevent ice entrapment, buoys were suspended 3 to 5 m below the lake surface. To facilitate array retrieval, maintenance, and data collection, instrument and anchor lines were interconnected below surface buoys with a 60 m length of bridal line. In general, temperature sensors were attached to an instrument line at 5 m intervals where lake depth at a deployment site was less than 50 m; otherwise the interval was typically 10 m. No sensors were deployed deeper than 110 m due to potential for pressure-related sensor malfunction.

The entire lot of temperature sensors, Onset® HOBO® Pro v2 water temperature data loggers (Onset Computer Corp.), was purchased by Kodiak Refuge. Subsets of sensors were subsequently distributed to cooperating refuges. Other array materials were independently acquired by each of the three refuges.

Results

We deployed temperature arrays in eight lakes during the period 15 July 2011 through 3 October 2011 (Table 2). Deployments were performed by boat in three lakes and by float-equipped airplane in five lakes. Lake depths at deployment sites ranged from 12 to155 m, and sensor numbers per instrument line ranged from three to 12. Sensors were set to record water temperature at hourly intervals the day following deployment. At Togiak Refuge, surface temperature data was collected from two lakes, Togiak and Ongivinuk, in late August.

Table 2. Location and deployment characteristics of temperature arrays deployed at four National Wildlife Refuges in southwestern Alaska, 2011.

Lake	Refuge	Latitude	Longitude	Deployment date	Depth (m)	No. loggers
Red	Kodiak	N57.2515934	W154.3095645	16-Sep-11	43	7
Karluk	Kodiak	N57.3534643	W154.0379859	10-Sep-11	122	12
Becharof	Becharof	N57.9637000	W156.4678200	17-Sep-11	155	11
Mother Goose	Alaska Peninsula	N57.1882500	W157.3263100	17-Sep-11	47	5
Ugashik	Alaska Peninsula	N57.6086800	W156.8167900	28-Sep-11	46	5
Needle	Alaska Peninsula	N57.1514300	W157.1714800	3-Oct-11	16	3
Ongivinuk	Togiak	N59.5666900	W159.3625300	15-Jul-11	12	6
Togiak	Togiak	N59.5929300	W159.6260200	21-Jul-11	46	9

Acknowledgements

The authors would like to thank the pilots, boat operators and field staff who were instrumental in the execution and completion of the deployment phase of this project. These included: H. Klausner, T. Dietrich, and K. Van Hatten at Kodiak NWR; S. Lowe and M. Hink at Togiak NWR; and K. Payne, P. Finley, J. Wittkop, and B. Schaff at Alaska Peninsula/Becharof NWRs.

Literature cited

Jones, B.M., S. Hook, C.D. Arp, J.D. Lenters, and J. Shearer. (2011). Thermal response of western Alaska lakes and lagoons to past, present, and future changes in climate. Anchorage: U.S. Geological Survey.

MacDonald, R. (1996). Baseline physical, biological, and chemical parameters of 21 lakes, Togiak National Wildlife Refuge, 1984-1990.

Orth, D.J. (1967). Dictionary of Alaska place names. *US Geological Survey Professional Paper, 567*, 1084.

Schaefer, J.R., W.E. Scott, W.C. Evans, B. Wang, and R.G. McGimsey. (2011). Summit crater lake observations, and the location, chemistry, and pH of water samples near Mount

Chiginagak volcano, Alaska: 2004-2011 *Alaska Division of Geological & Geophysical Surveys Report of Investigation.* pp. 25.

Schaefer, J.R., W.E. Scott, W.C. Evans, J. Jorgenson, R.G. McGimsey, and B. Wang. (2008). The 2005 catastrophic acid crater lake drainage, lahar, and acidic aerosol formation at Mount Chiginagak volcano, Alaska, USA: Field observations and preliminary water and vegetation chemistry results. *Geochemistry Geophysics Geosystems, 9*(7). doi: 10.1029/2007gc001900.

Shearer, J. and C. Moore. (2011). Southwest Alaska Freshwater Flow Monitoring Protocol Standard Operating Procedures, Southwest Alaska Network. *Natural Resource Report NPS/AKR/SWAN/NRR.* Fort Collins, CO.

Spafard, M. and J.A. Edmundson. (2000). A Morphometric Atlas of Alaskan Lakes: Cook Inlet, Prince William Sound, and Bristol Bay Areas. *Alaska Dept. of Fish and Game Regional Information Report No. 2A00-23*.