Water Resources Center

Annual Technical Report

FY 2000

Introduction

From March 1, 2000 to February 28, 2001, the U.S. Geological Survey (Water Resources Institute Program) through the Water and Environmental Research Center (WERC) at the University of Alaska Fairbanks (UAF) funded four research projects. WERC at UAF utilizes the funds from the U.S. Geological Survey, Water Resources Institute Program primarily to support three or four graduate students on projects that have the potential of developing into larger, more comprehensive research efforts. We advertise these opportunities at the three University of Alaska campuses (Fairbanks, Juneau and Anchorage) and a private school, Alaska Pacific University, in Anchorage. Since the University of Alaska Fairbanks is the primary research university in the state, most research is done on this campus (in the past we have supported students at all campuses).

The four projects funded this year deal with:

i) Mercury levels in some of the Alaskan rivers and the biological transport by salmon. ii) Quality of snowfall precipitation measurements in an environment dominated by snow. iii) Using chemical finger printing techniques, the interaction of permafrost and hydrology (groundwater) can be studied. iv) What is the rates of sediment transport in Arctic rivers and how does it vary seasonally (rainfall vs. snowmelt events)?

Expenditures by WERC during the 2000 and 2001 State of Alaska fiscal years (July 1 to June 30) are shown in the following table. It can be seen that the State of Alaska contribution to the Water and Environmental Research Center greatly exceeds the 2:1 match required by the U.S. Geological Survey (the required match is $136,356). State expenditures are spent on the Director's position, partial support for faculty, partial support for five technicians (two for nine months, one for six months and two for three months) and for the everyday operation of the Center.

Research expenditures by WERC during the 2000 State fiscal year:

For Fiscal Year 2000: State Expenditures: $484,197 Restricted Expenditures: $1,361,200 Total Expenditures: $1,845,397

For Fiscal Year 2001: State Expenditures: $582,454 Restricted Expenditures: $1,889,458 Total Expenditures: $2,471,912 (as of June 23, 2001)

Information dissemination at WERC takes many pathways. First we actively maintain a website that contains a mission statement, faculty and staff listing, publications, student opportunities, relevant conferences and WERC seminars. Most of our publications are journal articles and are listed in our reprint series on the internet. We also have a report series for those projects that require a final report. We have also sponsored seminars workshops and conferences. In May 2000, we co-sponsored the American Water Resources Association conference on "Water Resources in Extreme Environments," held in Anchorage, AK. We have added one new faculty member in Civil and Environmental Engineering who will conduct her research through WERC; Dr. Silke Schiewer has expertise in environmental biological processes. The facilities of WERC are presently undergoing major renovation (May 1, 2000 to August 1, 2001). WERC will have all new offices, work areas, laboratories (including chemical storage and handling) and walk-in environmental rooms from below freezing to above room temperature. Several new pieces of analytical equipment have been purchased for installation after we reclaim our renovated space. This will compliment analytical equipment that we recently purchased on an equipment grant of $300,000 from the M.J. Murdock Charitable Trust, with $115,000 funds matching from the University of Alaska Fairbanks. With our new facilities and new analytical equipment, WERC will have the tools to continue with first class water related research. In our new laboratory space we will have a state-of-the-art facility for measuring various isotope ratios with three isotope mass spectrometers.

Research Program

Basic Information

Title:	Mercury Levels in Alaskan Rivers: Relationship between Hg levels and Salmon.
Project Number:	B4
Start Date:	3/1/2000
End Date:	3/1/2002
Research Category:	Water Quality
Focus Category:	Non Point Pollution, Toxic Substances, Education
Descriptors:	
Lead Institute:	University of Alaska-Fairbanks
Principal Investigators:	Lawrence Kevin Duffy, Xiaoming Zhang

Publication

1. Zhang, X., Naidu, A.S., Kelley, J.J., Jewett, S.C., Dasher, D. and Duffy, L.K. (under review) Baseline Concentrations of Total Mercury and Methylmercury in Salmon returning via the Bering Sea (1999-2000).
2. Marcy, S., Dasher, D., Deitz, R., Duffy, L., Evans, M., Juntto, S., Lindberg, S., Lockhard, L., Naidu, S., O’Haro, T., Pacyna, J., Robertson, A., Ynguadottir, E., and Asmund, G. 2000. Mercury in the Arctic. In AMAP Report on Issues of concern, AMAP Report 2000:4.
3. Duffy, L.K., Zhang, X., Naidu, A.S., Kelley, J.J., Jewett, S.C., and Dasher, A. (2001) Assessment of the inhaled and ingested contribution to mercury exposure in Alaskan river otters. Proceedings of the Electric Utilities Environmental Conference: Global Contaminants, Tucson, AZ. (CD-ROM format).
4. Zhang, Xiaoming. M.S. Thesis, August 2001. Department of Chemistry and Biochemistry, University of Alaska Fairbanks, Fairbanks, AK. 100pp.

Problem and Research Objectives

Global atmospheric cycling of mercury (Hg) and exchange at air-water, air-soil, and soil-water interfaces are major processes affecting the mobilization of Hg on earth. Once in a water system, mercury (Hg) bioaccumulation can occur. In Alaska, there is little information on processes and transport pathways related to Hg accumulation in water; however, there is major concern in relation to wildlife and human subsistence. In this project, we are continuing a long-term investigation of Hg in Alaskan rivers, focusing now on biotransport. For this, we measure total mercury (Hg) and methyl mercury (MeHg). We also provide opportunities for local residents to participate in the evaluation and to disseminate our research results by building a comprehensive education effort to inform the public of the changing levels of the mercury in their local environment. This research follows the priorities and direction set by the Arctic Council and AMAP. This project addresses a data gap in which contaminant inputs from salmon returning with MeHg are insufficiently known.

It is important to understand how biotransport of MeHg contributes to the mercury cycling in high latitude food webs, and into the waters of salmon spawning areas near the Bering Sea. For example, is the quantity of contaminant introduced inland by the return of salmon significant? In 1980, based on escapement data (i.e., number of salmon allowed to escape commercial and subsistence fisheries in order to spawn), Sockeye salmon contributed approximately 50 X 10^6kg of organic matter to the Kvichak River, in the Bristol Bay region of Alaska (ADF&G, 1999). Over 99% of this salmon biomass is derived during the marine growth period and represents a substantial new source of nutrients (and possibly MeHg) to the Bering Sea region's aquatic and terrestrial food webs (Kline et al, 1993; Bilby et al, 1996; Watkinson, 2000). In this study our primary objective was to assess the baseline of mercury and its speciation in returning salmon muscle and liver.

Methodology

Salmon muscle and liver samples were collected from sites on four major rivers throughout western Alaska during the summers of 1999 and 2000. The sites were mainly at Bethel (Kuskokwim R.), Pilot Station (Yukon R.), Levelock (Kvichak R.), and Portage Creek (Nushagak R.). The tissue samples were dissected in the field using surgical sheets, an acid-washed titanium knife and powder free latex gloves; then they were stored frozen until analysis. In the laboratory, the tissue samples were thawed and split before analysis. Total mercury (THg) was analyzed by cold vapor atomic fluorescence spectrophotometry (CVAF) after samples were digested with acid (Bloom, 1992; Bloom and Fitzgerald, 1998). For Thg, about 1 gram of tissue was transferred to a 40 mL pre-cleaned vial, to which 7 mL of 70% HNO_3/30% H_2SO_2 was added. The samples were heated on a hotplate at 90^o C for 4 hours, until all soft tissue was dissolved. After cooling, the digests were diluted to a final volume of 37 mL with 10% 0.2 N BrC1. For THg, aliquots of digests were reduced with $SnC1_2$, followed by CVAF detection. For MeHg analysis, 1 g of tissue was transferred to a 40 mL pre-cleaned vial, to which 10 mL of 25% KOH/methanol was added. The sample was then heated on a hotplate at 125^o C for approximately 2 hours. After cooling, the digest was diluted to 40 mL with methanol. An aliquot of the digest was analyzed for MeHg using aqueous phase ethylation, purging onto a carbotrap, isothermal GC separation, followed by CVAF detection.

To access the accuracy of THg and MeHg determinations, certified dogfish tissue (DORM-2) from the National Research Council of Canada was used. Our recovery was 100.3% for THg and 93.2% for MeHg for the published values for DORM-2. A check standard and a blank were run after every 10 samples. A duplicate and a spike of samples were performed once for each 20 samples. Additionally, selected tissue samples were sent to Frontier Geosciences (Seattle, WA.) for blind analysis. The mean relative difference between laboratories was 9.5%.

Principle Findings and Significance

Water samples from rivers were analyzed for mercury in order to establish baseline levels for comparison between atmospheric deposition and mineral runoff. We found that the glacial rivers averaged 26.4 ng/L of Hg while the non-glacial fed rivers mean Hg level was 10-fold lower with a Hg mean of 2.0 ng/L. During the early summer with high flow rate and runoff, mercury levels in the Yukon were fourfold higher.

The arithmetic mean concentrations of THg and MeHg in the two tissues of salmon taken at the four sites for 1999 and 2000 are summarized in Table 1. THg in salmon muscle had mean concentrations for the species ranging between 34 and 96 ng/g wet weight (ww). In 1999, THg in individual salmon muscles ranged from 25 to 137 ng/g (ww), while in 2000, THg ranged from 20 to 105 ng/g. THg concentrations in liver tissue tended to be higher than those in muscle tissue ($p < 0.001$), except in chum salmon. Mean THg in the salmon liver ranged from 54 to 112 ng/g (ww). Differences in the THg levels as well as MeHg differences between species were statistically significant ($p < 0.001$). Differences between species in the river systems were not significant, except for Chinook. For example, the mean THg in Kuskokwim Chinook muscle tissue was 96 ng/g in 1999, which is higher than the mean of the Yukon ($p = 0.038$). In contrast, THg in Kuskokwim Chinook livers in 2000 (mean 79 ng/g) was lower than the mean of those samples collected from the Yukon(mean 104 ng/g). Similar, but non-significant variations can be seen for chum, Coho and sockeye salmon for mean THg in muscle and liver tissue. Overall, the mean concentration of THg in salmon muscle was 62 ng/g (ww) (range: from 25 to 137 ng/g) while THg in salmon livers was 84.3 ng/g (range: from 32 to 172 ng/g).

In salmon muscle tissue, THg and MeHg concentrations correlated, and the mean MeHg levels were lower than the THg means ($p = 0.001$). This contrasts with the speciation data for freshwater fish (Duffy et al, 1999) where there was no difference between THg and MeHg. For salmon, the MeHg level was 78% THg in muscle tissue, while salmon liver tissue showed a lower relative abundance of MeHg (63%). Chinook salmon eggs have higher THg levels than those of the other salmon species sampled (Table 2).

As expected, we observed that THg levels in salmon increase with fish lengths. Only our sampling of Chinook contained a sufficiently wide range of sizes (fish length ranged between 400 and 950 mm) to show a good correlation. Other sampled salmon species had lengths in a smaller range (500-650 mm). The high mean concentrations of both forms of mercury in Chinook salmon muscle are related to 1) their larger size, and thus longer ocean period, and 2) their piscivorous habitat. Both sockeye and Coho are considered planktivorous and have lower mean levels of MeHg in their muscles.

Conclusions

Previous studies have demonstrated the presence of mercury in Alaskan subsistence users (Galster, 1976). As salmon is a common food for subsistence users in western Alaska (Nobmann et al, 1992), we determined the bioconcentration factor for THg and MeHg in these Bering Sea region salmon. Using a value of 1.5 ng/L Hg in seawater (Mason and Fitzgerald, 1996; Nelson et al, 1977; Gray et al, 2000), our estimated bioconcentration factors ranged around 2.5×10^4 and varied twofold between species in our data set (Table 3). Despite the bioconcentration of MeHg, the levels in the Alaskan salmon do not exceed critical values (200 ng/g) for human consumption (Yeardly et al, 1998; US EPA, 1997). Therefore, these low levels do not pose a risk for salmon food consumers (Wheatley et al, 1998; Meyer et al, 2000), including wildlife such as river otters.

Lastly, these baseline data suggest that biotransport of MeHg should be incorporated in Hg transport models, since MeHg is usually completely absorbed through the gastrointestinal tract in vertebrates. Spawning salmon, which have accumulated 99% of their biomass and most of their body burden of mercury in the ocean, can return to spawning areas notable amounts of MeHg as a readily bio-available form. Since this salmon biomass is delivered not as a dispersed source like atmospheric Hg but as a concentrate, salmon spawning areas can be a MeHg source to surface waters within the aquatic ecosystem. For example, a return of 2.25 X 10^6 sockeye salmon in 1980 (about 50 X 10^6 kg) to the Kvichak River represented an estimated input of 1kg of MeHg into surface water. This amount of MeHg is about 1/500 of the mercury reported released in the U.S. in 1996 (USEPA, 1997).

Twenty-year sockeye mean escapement data for eight rivers in the Bristol Bay region (ADF&G, 1998) were integrated with our MeHg mean value for sockeye (26 ng/g) to evaluate the magnitude of biotransport over time. Table 4 lists the estimated 20-year total mass loading for MeHg to Bristol Bay river ecosystems, showing about 16 kg MeHg transported from the ocean. Our data support the hypothesis of Ewald et al, (1998), that salmon biomass is an additional transport pathway for MeHg, in addition to atmospheric and local geological sources of Hg, to Alaska's interior fluvial waters. However, until more detailed research is available, the biogeochemical fate and impact of such transported MeHg remain unknown.

Literature Cited

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TABLE 1: Arithmetic mean concentrations (ng/g ww) with standard deviations (1) of total mercury (THg) and methylmercury (MeHg) in muscles and livers of salmon from rivers drainage into the Eastern Bering Sea, Alaska.

MUSCLE		**1999**			**2000**		
River	**Species**	**#Fish**	**THg**	**MeHg**	**#Fish**	**THg**	**MeHg**
Yukon	Chum	6	68 (22.9)	56 (23.7)	6	84 (11.3)	64 (6.0)
	Coho	6	44 (15.6)	36 (5.9)	6	58 (11.6)	42 (10.4)
	Chinook	6	50 (35.2)	39 (27.1)	6	70 (27.0)	59 (24.3)
Kuskokwim	Chum	6	58 (14.2)	44 (12.0)	6	74 (14.9)	60 (18.2)
	Coho	6	49 (6.5)	39 (5.9)	6	57 (14.2)	38 (12.7)
	Chinook	6	96 (30.4)	78 (27.6)	6	80 (26.1)	59 (25.0)
	Sockeye	6	34 (5.8)	23 (3.2)	6	51 (5.3)	33 (6.7)
Nushagak	Chum	6	72 (17.7)	58 (18.2)	6	73 (18.3)	54 (17.7)
	Coho				6	59 (11.4)	42 (7.4)
	Chinook	6	92 (28.9)	78 (28.2)	6	60 (20.2)	43 (19.1)
	Sockeye	6	38 (7.1)	27 (12.7)	6	61. (6.0)	44 (6.4)
Kvichak	Coho	5	47 (3.7)	41 (6.2)			
	Sockeye				6	58 (11.2)	46 (12.3)

LIVER							
River	**Species**	**#Fish**	**THg**	**MeHg**	**#Fish**	**THg**	**MeHg**
Yukon	Chum	6	71 (37.1)	41 (17.3)	6	95 (16.7)	58 (10.4)
	Coho	6	87 (15.6)	50 (14.2)	6	54 (13.8)	29 (12.4)
	Chinook	6	60 (45.0)	37 (39.8)	6	103 (34.0)	68 (27.6)
Kuskokwim	Chum	6	66 (10.2)	43 (13.4)	6	72 (9.0)	47 (9.9)
	Coho	6	94 (23.6)	62 (16.9)	6	104 (31.4)	69 (34.2)
	Chinook	6	107 (36.0)	76 (27.1)	6	79 (23.2)	49 (18.7)
	Sockeye	6	58 (15.8)	36 (12.5)	6	100 (27.0)	66 (18.5)
Nushagak	Chum	6	64 (11.6)	42 (11.4)	6	69 (14.1)	46 (13.1)
	Coho				6	112 (40.3)	72 (18.6)
	Chinook	6	99 (35.4)	59 (29.2)	6	77 (24.6)	39 (16.4)
	Sockeye	6	84 (16.8)	49 (16.0)	6	105 (40.3)	69 (25.5)
Kvichak	Coho	5	75 (14.1)	36 (13.4)	6	105 (40.3)	69 (25.5)
	Sockeye	6			6	94 (15.3)	51 (16.5)

TABLE 2: Total mercury for salmon eggs collected in 1999.

Species	**Sample site**	**THg (ng/g)**
Sockeye	Kuskokwim River	4.5
Sockeye	Kuskokwim River	3.4
Sockeye	Kuskokwim River	3.8
Chum	Kuskokwim River	5.0
Chum	Kuskokwim River	5.3
Chum	Kuskokwim River	7.4
Chum	Yukon River	4.3
Chum	Yukon River	7.8
Chum	Nushagak	7.0
Chinook	Kuskokwim River	11.6
Chinook	Kuskokwim River	14.7
Chinook	Kuskokwim River	7.7
Chinook	Kuskokwim River	10.8
Chinook	Yukon River	15.3
Chinook	Nushagak	13.0
Chinook	Nushagak	6.4
Chinook	Nushagak	7.1
Coho	Kuskokwim River	8.5
Coho	Kuskokwim River	6.4
Coho	Kuskokwim River	6.7
Coho	Kuskokwim River	7.2
Coho	Yukon River	8.0
Coho	Kvichak River	5.4
Mean (± SD)		7.7 (3.30)

TABLE 3: Bioconcentration factors for average THg content in organs of salmon[a].

	Muscle	Liver
Sockeye salmon	24,600	24,173
Chinook salmon	52,386	59,006
Chum salmon	43,086	44,633
Coho salmon	31,607	57,033

[a] water level 1.5 ng/L

TABLE 4: Estimated methylmercury biotransport to 8 Bristol Bay, Alaska, rivers over a 20 year period (1979-1998).

Bristol Bay, AK River Drainage	Sockeye Escapement [1]	20 Year Total Input in grams [2] MeHg Average
Kvichak River	6,054,000	7,422
Naknek River	1,521,000	1,863
Egegik River	1,371,000	1,681
Ugashik River	1,303,000	1,597
Wood River	1,326,000	1,626
Igushik River	465,000	570
Nushagak River	626,000	767
Togiak River	192,000	235
Total	**12,858,000**	**15,764**

[1] Alaska Department of Fish & Game, Annual Management Report, Bristol Bay, Area, 1999 Appendix Table 1. Number of fish escaping upriver per year based on mean for 20 years of annual escapement surveys.

[2] MeHg level based on muscle average of 25 ng/g ww and average weight for the sockeye.

TABLE 5: Mercury Level in Alaskan Rivers and Lakes

Location	Hg ng/L
<u>Glacial Rivers</u>	
Yukon (June, High water)	28.7
Yukon (August, Low water)	6.5
Tanana	44.1
<u>Non-Glacial Rivers</u>	
Chena, iceburg site	1.3
Chena, power plant site	2.9
Salcha	1.1
Chatanika	2.8
<u>Lakes</u>	
<u>Fairbanks Area</u>	
Float Pond	0.3
Chena Marina	0.3
Peger Lake	0.3
Lark Lake	0.4
<u>Delta Junction Area</u>	
Birch Lake	4.6
Lost Lake	0.8
Harding Lake	1.9

Basic Information

Title:	Compatibility Analyses of Various Snow Measurements/Data in Alaska
Project Number:	B-01
Start Date:	6/1/2000
End Date:	5/30/2002
Research Category:	Climate and Hydrologic Processes
Focus Category:	Climatological Processes, Hydrology, None
Descriptors:	snow cover and snowfall, snow data, climate, hydrology
Lead Institute:	University of Alaska-Fairbanks
Principal Investigators:	Daqing Yang

Publication

1. Yang, D., D.L. Kane, L.D. Hinzman, B.E. Goodison, J.R. Metcalfe, P.Y.T. Louie, G.H. Leavesley, D.G. Emerson, C.L. Hanson, 2000: An evaluation of the Wyoming gauge system for snowfall measurement. Water Resources Research, 36(9), 2665-2678.
2. Yang, D., B.E. Goodison, J.R. Metcalfe, P.Y.T. Louie, E. Elomaa, C.L. Hanson, V.S. Golubev, Th. Gunther, J. Fullwood, R. Johnson, J. Milkovic, M. Lapin, 2001: Compatibility evaluation of national precipitation gauge measurements. Journal of Geophysical Research-Atmospheres, Vol 106, No. D2, 1481-1491.

Problem and Research Objectives

Snow is one of the key components in cold region hydrology and climate systems. It is also the most important variable in global change analyses, as changes of snowfall amount, snowcover extent and mass will have a major impact on hydrology, climate and ecosystems of the Earth. Long-term snow (i.e. snowfall and snowcover) data have been collected at observational networks and in some research watersheds in Alaska. These data, quality-controlled and archived by various organizations, have been widely used in climatic and hydrologic applications. Proper utilization and interpretation of these data in Alaska is extremely important and largely depends on the user's knowledge of the observational methods and data processing and archiving procedures.

Studies have shown that the accuracy and compatibility of snow measurements in cold regions including Alaska are generally very poor, mainly due to the following factors: 1) precipitation gauge undercatch of snowfall by up to 50-70% at high wind conditions (Black 1954; Benson, 1983; Goodison et al., 1998; Yang et al., 1998a,b, 1999; Yang 1999); 2) poor spatial representativeness of point snow data (Benson, 1983; Woo et al., 1983; Yang and Woo, 1999); 3) incompatibility of various snowfall and snowcover observation methods and instruments (Woo et al., 1983; Yang et al., 2001).

In order to better understand the limitation of various types of snow data and make better use of them for climate, water resources and hydrology applications, this project will compile and analyze all available snow data collected in Alaska to focus our research on the following key aspects:

- Quantify the accuracy of the NWS gauge measured snowfall data.
- Evaluate the performance of the Wyoming gauge system in Alaska.
- Define the compatibility of various snow measurements/data.
- Develop a methodology/system for integrating different snow data.

Methodology

The following methods will be used in data analyses of this research project:

a) Bias correction of NWS gauge snowfall measurements: Bias correction of NWS gauge snowfall data will be based on the methodology derived from the WMO gauge intercomparison project (Goodison et al., 1998). A correction procedure (Yang et al., 1998b) will be applied to the selected NWS stations on a daily basis. Daily records of air temperature, wind speed, gauge measured precipitation are needed for this analysis. Long-term data in difference climate regimes in Alaska will be used for this study and reliable daily snowfall data will be generated. A comparison between the measured and bias-corrected daily snowfall data will also be conducted in order to assess the impact of bias-correction on climate change/variation analysis.

b) Compatibility analysis of bias-corrected gauge data vs. Wyoming gauge observations: Recently Yang et al (2000), using the WMO gauge intercomparison data, has reported that the Wyoming gauge system performed as well as the WMO reference (a Russian double fence system) and it can measure snowfall accurately in windy and cold conditions. To evaluate the bias-correction procedures and results, comparison of bias-corrected snowfall data (daily and seasonal totals) with the Wyoming gauge measurements will be carried out at selected locations in Alaska. This will enhance our ongoing efforts to better quantify the water and energy balances in the research basins (Kane et al., 1999; Hinzman et al., 1998; Zhang et al., 2000).

c) Comparison of Wyoming gauge data to snowcover information/data: Yang et al (2000) found Wyoming gauge measurements were generally compatible to snowpack water equivalent measurements at selected locations in northern Alaska. This project will examine the compatibility of Wyoming gauge data to snow survey/snow course data at more locations and for longer time periods. The differences of wind and snow conditions between years will be analyzed to explain the inter-annual variability of the relation between snowfall and snowcover data in the basins. This analysis will help us better define winter snowcover mass balance over these watersheds.

d) Compatibility of NWS snow depth observation with NRCS snow survey and SnowTel data: Snow depth data can be used to estimate the SWE by assigning a snow density to the measured snowpack or new snowfall. Snow density exhibits wide temporal and spatial variations, mainly due to variations of upper air temperature, wind speed and direction near the surface, the elapsed time of measurement of snowfall after the beginning or end of the storm, the siting of the measurement station and the observer bias. It is difficult to apply universal corrections to daily snow depth data. However, comparison of these measurements will crosscheck the data, quantify the systematic differences (if they exist) and hopefully lead to an establishment of a linkage (transfer function) between these data obtained and archived by different organizations.

e) Integration of different snow data/information: Based on the results of bias-corrections of gauge snowfall data and the comparative analysis of snowfall data with snowcover information, an integrated snow data information system will be created for Alaska. This information system will include all snow data available in Alaska and a detailed description of methods of observations and data processing procedures. It will present methods and results of bias-correction and compatibility analyses among various snow measurements. It will also include the presentation and validation of the derived transfer functions among different snow data.

Principal Findings and Significance

We have focused our effort on gauge bias correction at selected stations and assessment of Wyoming gauge performance for snowfall observations in Alaska. We found that daily adjustment for observational biases increases the gauge-measured annual precipitation by 65–800 mm (about 10–140% of the gauge-measured yearly total) at selected stations in Alaska. The NWS 8-inch standard gauges with an Alter wind shield have a much lower adjustment for wind-induced undercatch than the unshielded gauges. Monthly adjustment factors (adjusted/measured precipitation) differ by station, and at an individual station by type of precipitation. Considerable intra-annual variation of the magnitude of the adjustments has been found in Alaska owing to the fluctuation of wind speed, air temperature, and frequency of snowfall. It is expected that the adjustments will have an impact on climate monitoring.

Analysis of Wyoming gauge data show that (1) the mean snow catch efficiency of the Wyoming gauge compared with the DFIR (a Russian snow fence system) is about 80– 90%, (2) there exists a close linear relation between the measurements of the two gauge systems and this relation may serve as a transfer function to adjust the Wyoming gauge records to obtain an estimate of the true snowfall amount, (3) catch efficiency of the Wyoming gauge does not change with wind speed and temperature, and (4) Wyoming gauge measurements are generally compatible to the snowpack water equivalent at selected locations in northern Alaska. These results are important to our effort of determining true snowfall amounts in the high latitudes, and they are also useful for regional hydrologic and climatic analyses.

The focus for winter 2001 will be on (a) compatibility of NWS snow depth observation with NRCS snow survey and SnowTel data, and (b) integration of different snow data/information.

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Basic Information

Title:	Geomorphological Controls on Hydrological Processes in the Alaskan Arctic
Project Number:	B-03
Start Date:	6/1/1999
End Date:	5/30/2001
Research Category:	Climate and Hydrologic Processes
Focus Category:	Climatological Processes, Hydrology, Geomorphological Processes
Descriptors:	Geomorphology, Hydrogeology, Hydrological models
Lead Institute:	University of Alaska-Fairbanks
Principal Investigators:	Larry D. Hinzman

Publication

1. None to report at this time

Problem and Research Objectives

The objective of this research is to develop a better understanding of watershed morphology dynamics and to elucidate how a basin structure may evolve with the onset of climatic warming. Over the past several years, river morphology studies performed in the Kuparuk River have documented some of the changes that have occurred as a result of bedload transport. This study will provide insight into the nature of the bedload transport process. The study is being conducted in the upper Kuparuk River, near the intersection of the river and the Dalton Highway.

Objective

There are four primary goals for this study:

1) Determine the total sediment load in the river for a given flow rate.
2) Determine the amount and size of bedload material movement versus volumetric flow rate for a specific location of the Kuparuk River.
3) Establish a relationship between particle distance traveled and the flow distribution curve for the same portion of the river.
4) Compare the bedload material movement that occurs during the spring snowmelt to that which occurs in response to significant rainfall events during the summer.

Methodology

Several field measurement methods will be used to quantify the total amount of sediment transport.

Suspended sediment will be measured directly by using an auto-sampler to collect 1-liter samples at regular time intervals throughout the summer months. These samples will be filtered and weighed to determine the mass of solid material in each sample.

Bedload material movement will be monitored by two different methods. One method is tracer rocks; the other method is sediment traps.

Tracer rocks will be used to study the movement of specific pieces of cobble. Both active and passive tracer rocks will be used. The passive tracers are painted rocks. The active tracers are rocks that have a small radio transmitter implanted in them. These transmitters emit a different pulse rate at rest than during movement. This feature allows knowledge incipient motion.

Sediment traps will be used to capture particles (greater than 3mm diameter) during motion. These traps will be fixed to the riverbed and the current will carry particles into the traps.

Principal Findings and Significance

A set of passive tracer rocks (201 total tracers) was installed in the study site during June of 2000. During the remainder of the summer of 2000 there were no significant rainfall events and the peak flow volume was a lower than average 400 CFS. This flow was not capable of generating significant bedload movement.

This set of tracers was left in place over winter and monitored during the break-up period in early June of 2001. The peak flow volume during this break-up period was 570 CFS. Again, this value was below the average snowmelt peak flow value. However, during break-up there was some movement of the tracer rocks. 13% of the tracers had moved a significant distance or been buried in place and not recovered. Specifically, 12 rocks were not accounted for and are likely buried, and 15 rocks had moved significant distance ranging from 5’ to 565’. These results are still being analyzed.

The focus for the remainder of the summer of 2001 will be on monitoring and improving the various measurement methods and acquiring as much data as possible.

Basic Information

Title:	Fingerprinting orgnic material in the Caribou-Poker Creek Watershed to Support Hydrologic Investigations
Project Number:	B-02
Start Date:	3/1/2001
End Date:	3/1/2002
Research Category:	Ground-water Flow and Transport
Focus Category:	Hydrology, Groundwater, Water Supply
Descriptors:	
Lead Institute:	None
Principal Investigators:	Daniel M. White, Kenji Yoshikawa

Publication

1. White, D. K. Yoshikawa, and D. Garland, (in review), "Fingerprinting dissolved organic matter to support hydrologic investigations", submitted to Organic Geochemistry.
2. Jaspreet Narr, (2001), "Disinfection By-Product Experiences in Alaskan Village Drinking Water Systems and the Caribou-Poker Creek Watershed." MS. Environmental Engineering, Thesis, University of Alaska Fairbanks.

Problem and Research Objectives

The Caribou and Poker Creek Watershed (CPCRW) is an important component of the Bonanza Creek LTER (Long Term Ecological Research) Program. The CPCRW serves as a testbed for process studies on interactions between hydrology, meteorology and permafrost. By characterizing the nature and origin of organic matter in water below or above permafrost, in interpermafrost springs, and in streams we seek to better describe the influence of permafrost on the hydrology in this region. In addition to a better understanding of the hydrology of permafrost watersheds in general, understanding the origin of organic matter is important for studies on drinking water treatment and use. Many public drinking water systems in Alaska extract water from above or below permafrost. Depending on the origin of the organic matter, certain health risks may be present.

Natural organic matter (NOM) in drinking water is a health concern because it contributes to the formation of disinfectant by-products (DBPs) such as trihalomethanes (THMs) and haloacetic acids (HAAs). NOM causes other health, economic, and aesthetic problems since contaminants such as metals, hydrophobic organic chemicals, and radionuclides can be transported by NOM.

NOM in water from the CPCRW was collected and subjected to a suite of analytical tests including dissolved organic carbon (DOC), apparent molecular size fractionation, ultraviolet absorbance. NOM was also fingerprinted using pyrolysis-G/MS. Fingerprint analysis is being used to help determine the origin of surface water contributing to groundwater and vice versa during different seasons. The information is being used to evaluate the THM hazard potential of waters derived from different sources in a permafrost-dominated watershed.

Methodology

Site Selection

The CPCRW serves as an ideal research watershed for investigation. Water samples were collected from wells, streams, and springs from three different sub-watersheds (C2, C3, and C4). The graduate student collecting and analyzing all water samples worked under the direction of Dr. Kenji Yoshikawa.

Pyrolysis-GC/MS of water samples

Pyrolysis is being conducted with a CDS Model 2500 pyrolyzer and state of the art autosampler in tandem with a gas chromatograph/mass spectrometer (GC/MS). During pyrolysis the sample is heated from a starting temperature of 25 ^{o}C to 700 ^{o}C in 0.1 seconds and held at a constant 700 ^{o}C for 9.9 seconds (see Figure 2). The pyrolysis reactor is mounted on an HP 5890 Series II GC, with a Supelco SPB 35 (35% Ph Me silicon) column, 60 m x 0.25 m x 0.25 µm. The GC interface temperature will be set at 235 ^{o}C. The GC temperature program will be 45 ^{o}C for 5 minutes, 2 ^{o}C /min to 240 ^{o}C and hold for 25 min. The GC is plumbed directly to an HP 5971A Series Mass Selective Detector on electron impact (EI) mode. The MS scans mass units 45 to 650. All mass spectra will be compared to the NBS54K spectral library. Helium serves as a carrier gas at a flow rate of 0.5 cm^3/minute. Each sample will be injected with a split ratio of 1:50.

The fingerprinting technique provides us with generalizations and specifics about the chemical make-up of NOM. As in White and Beyer (1999), we expect to correlate the organic matter in various samples with the probable origin. For example, if the NOM in water from a spring exhibits the same fingerprint as NOM in streamwater samples we would postulate that the two are in direct communication and are derived from water at the same source.

Principal findings and significance

So far, a detailed analysis of organic matter in 33 spring, stream and groundwater samples has been made. Correlations between the organic matter showed that certain waters had very similar fingerprints, indicating either a similar source, or organic matter that had undergone similar transformation processes (White et al. in review). None of the correlations observed were contrary to hypotheses established for this research. Pyrolysis-GC/MS provided evidence of both the correlation that united the three subwatersheds and correlations that divided them, showing differences between individual watersheds. Analysis of distant watersheds suggested that the method is probably dependent on hydraulic residence time and the method may be limited to low residence time groundwaters. Additional study is expected to demonstrate that contaminant transport pathways and other factors affecting drinking water quality are predicted by pyrolysis-GC/MS fingerprinting.

Parallel research was conducted to elucidate the type of organic matter most likely to create harmful disinfection by-products should the waters in the watershed be developed as a drinking water source. The results from this research are being prepared for publication and are published in Ms. Narr's Masters thesis. The dissolved organic carbon (DOC) and UV absorbance at 254 nm (UV 254) of 33 ground water and surface water samples from the CPCRW were measured. The average winter DOC was 1.49 mg/L and the average summer DOC was 7.83 mg/L. The objective for this analysis was to use DOC, UV 254 and specific UV absorbance at 254 nm (UV 254) as predictors for disinfection by-product formation potential (DBPFP) of these waters. Furthermore, 8 of the samples waters were subjected to discrete molecular size fractioning using an array of ultrafiltration membranes in pressurized stirred cells. The results obtained from these samples were compared to the results from a study of water in 16 drinking water treatment systems throughout Alaska. The principle findings of this research were that disinfection by-products in water are strongly correlated to the ultraviolet absorbance at 254 nanometers. The specific UV absorbance (UV-254/DOC) was also a good indicator of relative abundance of disinfection by-product forming organic matter in a water sample.

Information Transfer Program

USGS Summer Intern Program

Student Support

Student Support					
Category	**Section 104 Base Grant**	**Section 104 RCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	0	0	0	0	3
Masters	3	0	0	0	0
Ph.D.	1	0	0	0	1
Post-Doc.	0	0	0	0	0
Total	4	0	0	0	4

Notable Awards and Achievements

None

Publications from Prior Projects

None