Water Quality Sampling of Mother Goose Lake Following the Mount Chiginagak Lahar Event, 2005

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Introduction

Mother Goose Lake is located on the Alaska Peninsula approximately 100 miles southeast of the community of King Salmon. The watersheds of Indecision and Volcano creeks originating on Mount Chiginagak provide the majority of water input for Mother Goose Lake (Figure 1). The Mother Goose Lake watershed supports populations of Chinook *Oncorhynchus tshawytscha*, chum *O. keta*, coho *O kisutch*, pink *O. gorbuscha*, and sockeye *O. nerka* salmon as well as resident fish species such as Dolly Varden *Salvelinus malma*, and Arctic grayling *Thymallus arcticus* (USFWS 1994). Fish stocks originating from the Mother Gosse Lake drainage contribute to the subsistence, sport and commercial fisheries of the area. The contribution of Mother Goose Lake stocks to the subsistence and commercial fisheries is minor compared to other systems in the area (e.g. Ugashik lakes). Painter Creek, a tributary to the King Salmon River provides the majority of sport fishing opportunity in the Mother Goose Lake drainage.

Between August 2004 and August 2005 geothermal activity within the Mount Chiginagak volcano melted a portion of the summit glacier resulting in the formation of a lake in the summit crater. In summer of 2005 (exact timing of the event is unknown) the glacier damming the lake was breached allowing a significant portion of the lake to drain. The draining event, known as a lahar (flowing mixture of rock debris and water) deposited a large volume of what was assumed to be acidic water into the Mother Goose Lake drainage. The water within the Mount Chiginagak summit lake has not been sampled to determine the pH however; the Alaska Volcano Observatory (AVO) reports pH levels from similar volcanic summit lakes to be in the range of 0 to 3. In August of 2005 AVO members conducted an onsite investigated of the area. The AVO crew discovered a vegetation kill along Indecision Creek leading into Mother Goose Lake and along an unnamed drainage on the Chiginagak Bay side of the mountain. Additionally, AVO tested the water in Indecision Creek, Mother Goose Lake, and in the King Salmon River at the outlet of Mother Goose Lake (Figure 1) and reported pH values in the 2-3 range. Optimal pH range for fish is in the 6-8 range (EPA 1976), Hill (1974) reports that pH in the range of 2 -4 is toxic to most forms of aquatic life.

In late July 2005 the Alaska Department of Fish and Game (ADFG) received reports of dead Chinook salmon in the King Salmon River. ADFG staff went to Mother Goose Lake in early August 2005 to collect genetic samples from sockeye salmon and were unable to find any salmon present in the lake; additionally, subsequent aerial surveys did not locate any adult salmon in Mother Goose Lake (P. Salomone, ADFG personal communication). Given the lack of observed adult salmon in the lake and reports from a local lodge owner of no adult salmon in Painter Creek, we believe any adult salmon present in lake at the time of the lahar were killed and returning salmon detected the abnormally low levels and avoided the system.

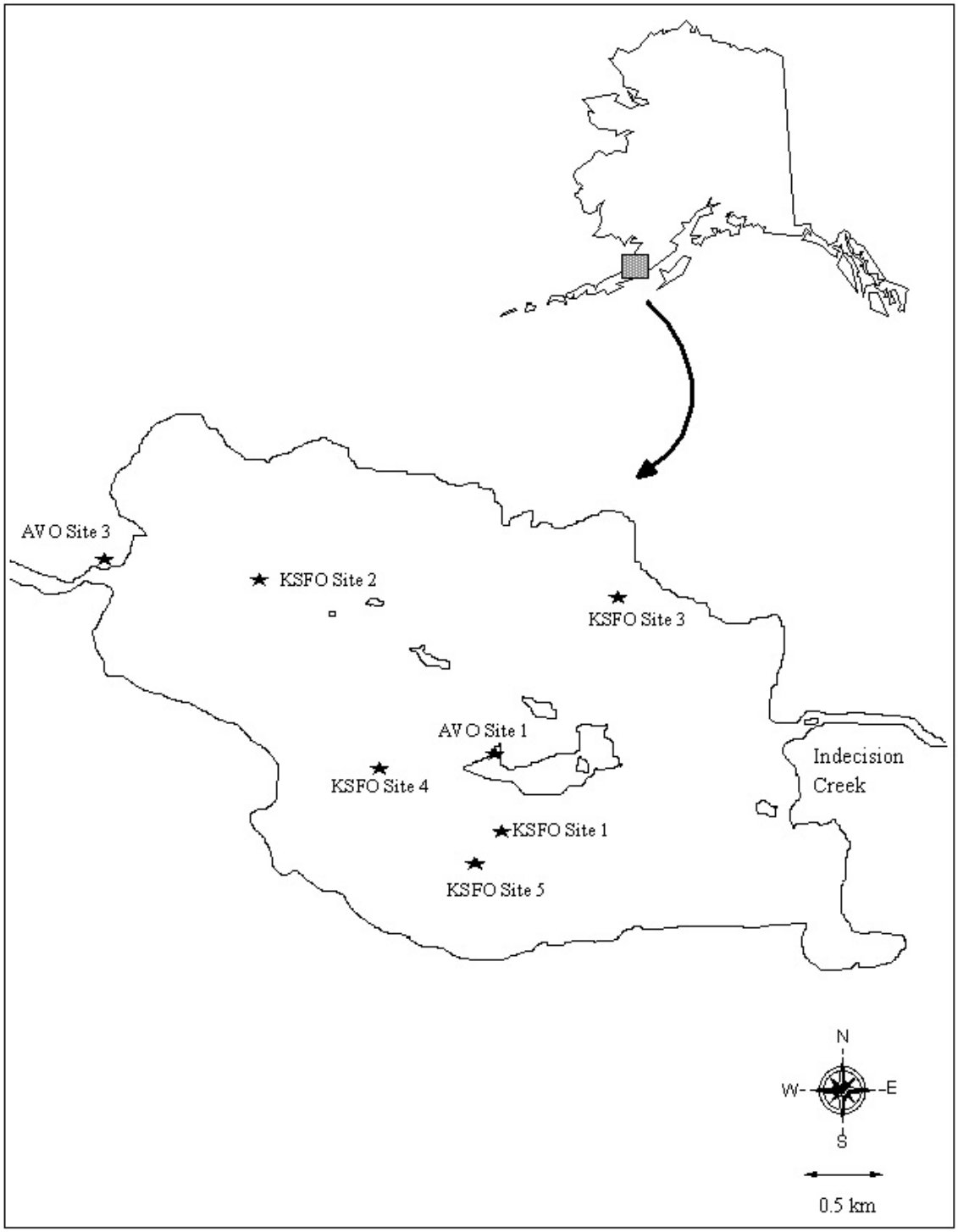

Figure 1. Location of 2005 Alaska Volcano Observatory (AVO) and King Salmon Fish and Wildlife Field Office (KSFO) water sampling locations on Mother Goose Lake.

No reports of dead resident fish species were received by ADFG or the U. S. Fish and Wildlife Service in King Salmon. The status of resident fish species remains unknown at this time; at the time of the lahar it was unknown if the lake was stratified or being mixed. Lake stratification could have restricted the acidic water to the epilimnion zone of the lake and provide fish with a refuge from the toxic water. The AVO collected surface water chemistry samples in August and September 2005, but did not sample at depth or collect biological samples. To determine if the lake was mixed and acidic throughout its volume, the King Salmon Fish and Wildlife Field Office (KSFO) collected water chemistry, temperature, and biological samples from various depths and locations in October 2005. This report summarizes the findings of those samples.

Methods

Sampling was conducted at seven locations on October 11-12 2005 (Figure 1). AVO sites 2 and 3 were surface only collections; the five remaining sites (KSFO 1-5) were depth and surface samples. KSFO sites were selected by depth (i.e. maximum depth) and area of the lake. Depth readings were made with an Eagle Accura 240 portable depth finder. Surface sample were collected with a 100 ml graduated cylinder and depth samples were collected at maximum depth with a Van Dorn bottle. At all sites pH and temperature were measured with a YSI model 63 handheld meter as soon as the water samples were retrieved to the boat, and Secchi depth readings were recorded. Vertical plankton tows were conducted from maximum depth at KSFO sites 2, 3, and 4 with a 20-cm diameter net with 153-µm mesh. Plankton samples were visually inspected to determine if any live plankton was captured and then placed in a 100 ml nalgene bottle for later identification. Plankton samples were identified and counted with a stereo microscope (ADFG 1987).

Results and Discussion

Surface pH values ranged from 2.87 to 3.03 and surface water temperatures ranged from 7.7 ºC to 10.0 ºC. The depth at which water samples were collected from ranged from 26.8 m to 44 m, pH values at depth ranged from 2.87 to 3.06 with water temperatures ranging from 8.3 ºC to 9.7 ºC (Table 1). Secchi disk readings ranged from 3.0 m to 4.2 m. Plankton sampling did not identify any living plankton and very few plankton remains (n = 10) from KSFO sites 2 and 4. Laboratory examination determined the majority of plankton remains were cladocerans zooplankton. We hypothesize that the origin of these zooplankton is Needle Lake, a system unaffected by the lahar which drains into Indecision Creek upstream of Mother Goose Lake.

The objective of this sampling was to determine if the acidic water in Mother Goose Lake is distributed throughout the lake, determine if the pH levels have changed since August 2005, and to determine if any aquatic organisms survived. Based on our samples of pH and temperature we conclude that the acidic water has mixed throughout the water column. Since we did not conduct a complete depth transect survey of the lake it is possible that portions of the lake exceed the maximum depth we documented and could be free of acidic water. However, we feel our search for deep areas of lake was adequate and if an area of greater depth exists it is a very small area and not sufficient in size to provide refuge for a large quantity of fish. Our re-sampling of two AVO sites indicates

Table 1. Results of water chemistry sampling Mother Goose Lake October 2005.

Location	Depth (m)	pH		Temperature		Secchi depth (m)
		Surface	Depth	Surface	Depth	
AVO 1	surface	2.98	-------	9.2	-------	-------
AVO 3	surface	2.99	-------	7.7	-------	-------
KSFO 1	31.6	3.03	3.06	10.0	9.6	3.8
KSFO 2	36.0	2.87	2.95	8.9	9.7	3.0
KSFO 3	26.8	2.98	2.94	10.0	8.3	4.2
KSFO 4	37.1	2.89	2.89	9.8	9.5	4.2
KSFO 5	44.0	2.97	2.87	9.9	9.6	4.2

the input of acidic water is continuing or is not being diluted enough to raise the pH (e.g. pH of 3.2 at AVO site #3 in August pH of 2.99 in October). At this time Mother Goose Lake is void of aquatic life and will remain so until the inflow of acidic water from Mount Chiginagak is reduced or eliminated. Once the pH level of the lake has increased recolonization by primary producers should occur rapidly given proximity of Needle Lake to provide a source population and the ecological void that currently exists. How quickly the food web of the lake recovers to support fish production is unclear, however if the pH increases we would expect adult salmon to return to the system in 2006. The return of resident fish to the lake is dependant on the distance to the nearest source population (Smith 1986) and length of time required for primary production to increase to the level necessary to support fish populations. We recommend continued monitoring of the system to determine when the inflow of acidic water is eliminated and to document the recolonization of the lake by aquatic life. We would like to thank the Alaska Peninsula National Wildlife Refuge for funding support of this project.

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