FINAL REPORT

UPPER YUKON RIVER DRAINAGE ANADROMOUS WATERS CATALOGING, AUGUST 2009

JOHN C. SEIGLE

PREPARED FOR

ARCTIC-YUKON-KUSKOKWIM SUSTAINABLE SALMON INITIATIVE
ANCHORAGE, ALASKA

PREPARED BY

ABR, INC.–ENVIRONMENTAL RESEARCH & SERVICES
ANCHORAGE, ALASKA

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Sustainable Salmon Initiative[1]

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[1]*Final products of AYK Sustainable Salmon Initiative-sponsored research are made available to the Initiatives Partners and the public in the interest of rapid dissemination of information that may be useful in salmon management, research, or administration. Sponsorship of the project by the AYK SSI does not necessarily imply that the findings or conclusions are endorsed by the AYK SSI.*

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ABSTRACT

In August 2009 ABR, Inc.—Environmental Research & Services (ABR) was contracted by the Arctic-Yukon-Kuskowim Sustainable Salmon Initiative (AYK-SSI) to survey headwater tributaries to the Upper Yukon River. The primary objective of these surveys was to identify salmon bearing streams so they could be nominated for inclusion in the State of Alaska's *Catalog of Waters Important for Spawning, Rearing, or Migration of Anadromous Fishes* (also known as the Anadromous Waters Catalog [AWC]). Following Alaska Department of Fish and Game (ADF&G) protocols, ABR conducted a gap analysis to determine candidate sampling locations (stream reaches) in the Upper Yukon River region of Alaska which could provide information on the presence and upstream extent of anadromous fish species. This information on salmon occurrence is critical in managing salmon and their habitat in areas of interior Alaska that may increasingly be impacted by human activities.

Two teams of ABR biologists surveyed streams in 2 periods (14–17 August and 20–24 August). Sampling in the first period was conducted in streams to the east of Fairbanks near the Salcha and Chena Rivers as well as in tributaries to Birch Creek. Fish surveys mainly were accomplished with electrofishing techniques. Low water levels and low fish abundance prompted the survey teams to relocate west of the Livengood area for the second sampling period, in tributaries to Hess Creek and Beaver Creek as well as the Tolvana River and Chatanika River. Sampling methods were augmented in the second period to include minnow trapping and dip netting. Water levels and fish densities remained low in the second period, however, and ABR suspended the sampling early on 24 August 2009 due to lack of significant anadromous salmon observations and concerns over the best use of resources for accomplishing project goals.

In total, ABR surveyed 63 stream stations in 48 distinct tributaries over 9 days of sampling. Seven species of fish were encountered with arctic grayling (*Thymallus arcticus*) and slimy sculpin (*Cottus cognatus*) being by far the most prevalent species observed. Anadromous salmon were observed in only 4 of 48 stations (6%), including one stream already nominated to the AWC (Beaver Creek). The remaining salmon were observed in lower reaches of streams very near previously cataloged anadromous waters. In 23 of 63 stations surveyed no fish of any kind were observed. Where fish were present, densities were low throughout both survey periods.

Two other fish surveys in the Upper Yukon River region, conducted by ADF&G and U. S. Fish and Wildlife Service (USFWS) between 2004 and 2009, also revealed relatively low fish densities and species richness. Buckwalter et al. (2004) found anadromous salmon in only 17% of 121 stations surveyed using mostly electrofishing techniques in 2004. In 2008 and 2009, USFWS biologists sampled 8 headwater streams in the region using a variety of sampling techniques during multiple site visits. Of 183 sampling records at more than 50 stations using 10 different sampling techniques, only 19 records of Chinook and coho salmon were made. No salmon were captured using electrofishing techniques in the USFWS surveys.

We conclude that likely low natural salmon densities in headwater tributaries to the Upper Yukon River were reduced further in late summer 2009 by record low rainfall in interior Alaska in July 2009. Future fish sampling in tributaries to the Upper Yukon River should take rainfall and stream flow conditions in particular (and environmental conditions in general) into consideration prior to sampling whenever possible. In addition, multiple sampling techniques and sample timing strategies over the course of the sampling season may be necessary to insure that “false negatives” are not reported with respect to anadromous salmon occurrence in these headwater streams.

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INTRODUCTION

Water bodies used by anadromous fish species for migration, spawning, and/or rearing are afforded special protection under the Anadromous Fish Act (Alaska Statue 16.05.871) and the federal Magnuson-Stevens Fishery Conservation and Management Act; the federal legislation is designed to protect Essential Fish Habitat for federally managed species, including freshwater habitats used by anadromous salmon. However, because of a lack of specific information on the occurrence of anadromous fish species and life history stages in Alaskan streams, these fish and fish habitat protection measures have been of limited utility in protecting salmon and other anadromous species in the state.

In Alaska, anadromous water bodies are listed in the *Catalog of Waters Important for the Spawning, Rearing or Migration of Anadromous Fishes* (known as the Anadromous Waters Catalog [AWC]) and its associated Atlas, which are maintained by the Alaska Department of Fish and Game (ADF&G 2010). Using the current AWC and its Operational Plan, the ADF&G seeks to identify fish species assemblages, their distribution, and aquatic habitat characteristics for streams in Alaska in order to manage water bodies according to state and federal law. Currently, it is estimated that the AWC lists nearly 17,000 water bodies in Alaska as supporting anadromous fish, but it is believed this number represents less than half the streams, rivers, and lakes used by anadromous species in the state (Buckwalter et al. 2009). To increase the number of anadromous streams listed in the AWC and improve the management of habitat available to salmon in Alaska, guidelines for selecting and sampling candidate streams for inclusion in the AWC were sought by the ADF&G. The standards for sampling streams in Alaska as candidates for the AWC are outlined in the AWC Operational Plan.

In August 2009, ABR, Inc.—Environmental Research & Services (ABR) was contracted to conduct a rapid, systematic inventory of anadromous fish distribution and associated aquatic and riparian habitat characteristics in selected headwater streams of the Upper Yukon River drainage. Before we conducted field work, we consulted with state, federal, and university fisheries experts to determine an appropriate sampling strategy for this area. The final strategy developed takes into consideration information from previously surveyed streams in nearby or similar watersheds, the proximity of candidate streams to known anadromous waters, and the presence of protected lands as well as human activities (e.g., mining claims) in the area.

OBJECTIVES

Objective 1: To determine the distribution and farthest upstream extent of anadromous fish use within headwater streams and increase the number of documented anadromous fish habitats depicted in the AWC within the study area.

Objective 2: To document aquatic and riparian habitat characteristics associated with the target stream reaches.

METHODS

Survey areas in the Upper Yukon River (UYR) region were chosen by identifying gaps in the AWC coverage for the UYR drainages as well as known locations of human activities and protected lands in the UYR area. Information on human activities and protected lands were used to aid future management efforts in locating areas where salmon, if present, could be affected by human activities. During our own gap analysis, we identified sub-basins in the UYR region and then overlaid GIS layers depicting identified AWC streams, human activity, land ownership, and protected land status in an effort to isolate sub-basins with potential target streams. Potential target streams for sampling then were identified by the ranking criteria described in Buckwalter et. al. (2009), in which, "...each potential target stream [was ranked] by the length of stream channel located between the upstream terminus of AWC coverage, and the 50-sq km catchment outlet point." (The longer the stream channel between these points, the greater the ranking as a target stream.)

For this study, we sampled only wadeable, headwater streams from the set of target streams derived above. This meant using ADF&G's 50 km catchment-outlet or "pour-point" method for site selection in which, "…streams draining up to 50 km were considered wadeable" (Buckwalter et al.

2009). A total of 372 wadeable pour points in 8 sub-basins were identified using these methods (see Appendix 1, Tiles 1–3 for pour-point locations and relative rankings indicating the stream length that would be added to the AWC if salmon were found to be present). The target streams and associated pour points were located in three adjacent regions of the UYR area, starting in the northwest with the Koyukuk and Chandalar sub-basins (Appendix 1, Tile 1), and moving southeast to the Salcha, Chena, Birch–Beaver, and Tolovana sub-basins (Appendix 1, Tile 2), and then further southeast to the Tok and Healy sub-basins (Appendix 1, Tile 3).

We chose to concentrate our sampling efforts in 2009 on streams near the road system in the Salcha, Chena, Birch–Beaver, and Tolovana sub-basins (Appendix 1, Tile 2) because these locations afforded the project greater access to logistic support (e.g., helicopter refueling). Pour points in target streams within each sub-basin were ranked in importance by the number of kilometers they would add to the AWC and by their proximity to areas where there are concerns about development (Appendix 1, Tiles 1–3). We began our sampling effort in August to take advantage of 2 key features of salmonid life history in Alaska. First, sampling in August maximizes the chance of recording rearing anadromous fishes that have moved upstream of natal waters prior to the onset of cooler fall water temperatures (Buckwalter et al. 2009). Second, sampling in August maximizes the chances of encountering spawning grounds for salmon (Buckwalter et al. 2009). These methods are similar to those used by ADF&G biologists when conducting AWC surveys and were designed to "…maximize[e] our chances of observing a variety of anadromous fishes at the upstream limits of their range…" (Buckwalter et al. 2009). It should be noted that one assumes average precipitation levels when choosing to sample during late summer. If water levels fall below normal levels, as occurred in this study, it may become difficult for rearing salmonids to move upstream of natal locations.

Using this set of target streams and pour points, 2 crews of 2 people, with a fisheries biologist team leader and a technician on each crew, travelled by helicopter to the pre-determined pour points. Upon arriving at each point, the sampling team travelled either upstream or downstream to suitable stream habitats for salmon and for sampling via electrofishing. Fish species were collected by single-pass backpack electrofishing along stream reaches with lengths equivalent to 40 wetted channel widths (minimum stream-reach lengths were 150 meters). This reach length was chosen to limit excessive sampling in larger wadeable streams and ensure adequate sampling in smaller wadeable streams (Buckwalter et al. 2009). This reach sampling length is in keeping with standards set by the National Water-Quality Assessment Program (NAWQA) protocols for sampling in fish bearing streams (Fitzpatrick et al. 1998).

Because precipitation in interior Alaska in summer 2009 was below average (see below) and because water levels in headwater streams were expected to be low as a result, we conducted only a small set of exploratory surveys in summer 2009 (Figures 1 and 2). We did not complete the full set of field surveys planned for 2009, but instead focused our efforts on assessing fish use of a subset of headwater streams in the UYR region during low water conditions, and on evaluating the efficacy of the standard field methods for AWC surveys during low water in this area. From a camp near Chena Hot Springs, sampling was started on 14 August 2009 in headwater tributaries of the Chena River, Salcha River, Chatanika River and Birch Creek (Figure 1), and continued through 17 August, when it was determined that fish presence other than sculpin and arctic grayling was limited, perhaps due to low water conditions. The sampling teams then adjourned to Fairbanks on 18 August to meet with local experts to discuss an alternative course of action. For the first four days of sampling (14–17 August), in addition to electrofishing, we employed a modified habitat assessment program designed by ADF&G to describe in-stream and adjacent riparian habitat features within each surveyed stream reach. This information could be important in describing salmonid presence in headwater streams and could aid future sampling crews in predicting salmonid presence in various aquatic habitats in Alaska. However, following discussions with local fisheries experts in Fairbanks on 18 and 19 August, and for reasons described further below (see Discussion), we abandoned systematic habitat sampling for the last

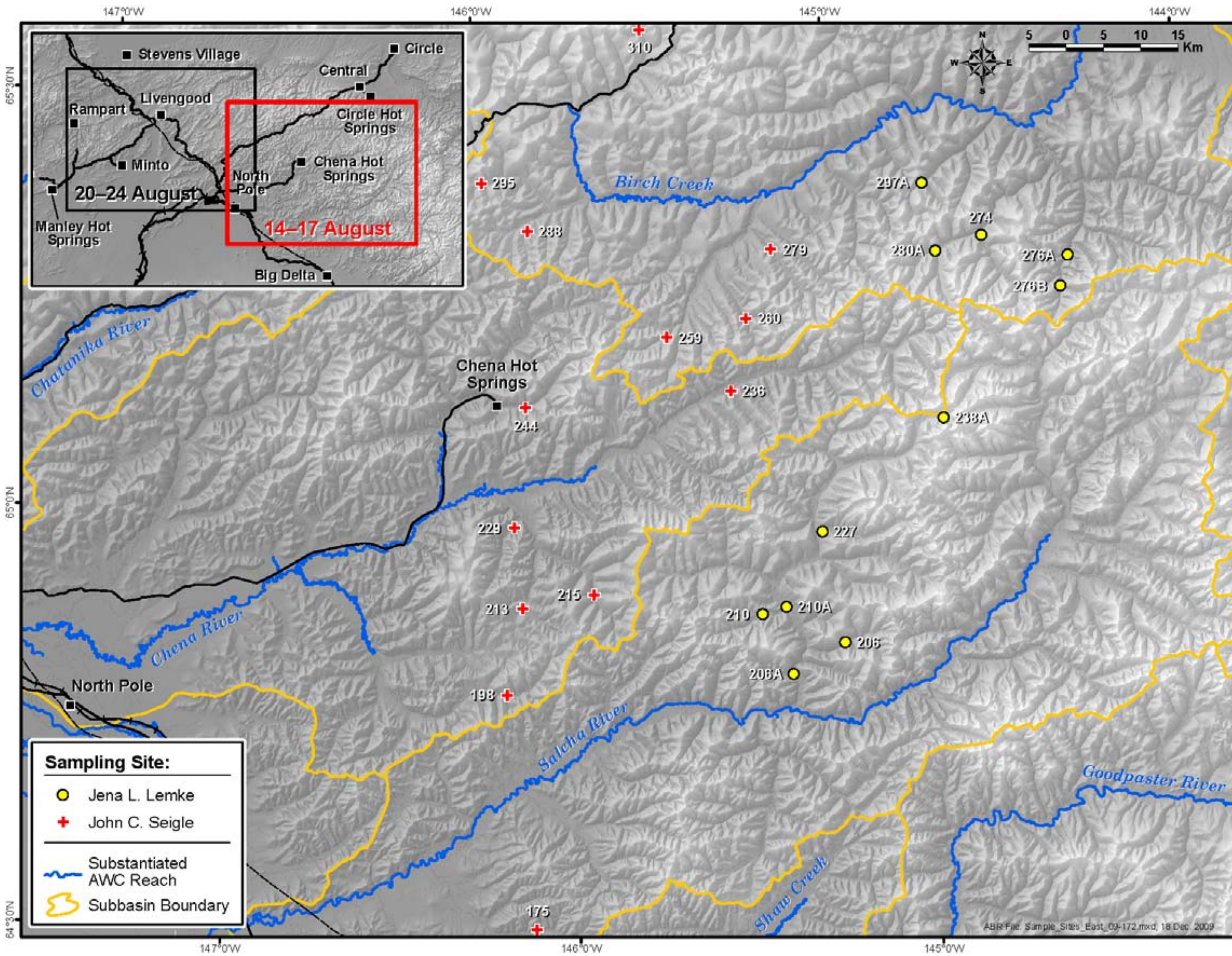

Figure 1. Sampling locations in the eastern section of the AYK-SSI Anadromous Waters Catalog survey area, Upper Yukon tributaries, Alaska, 14–17 August 2009.

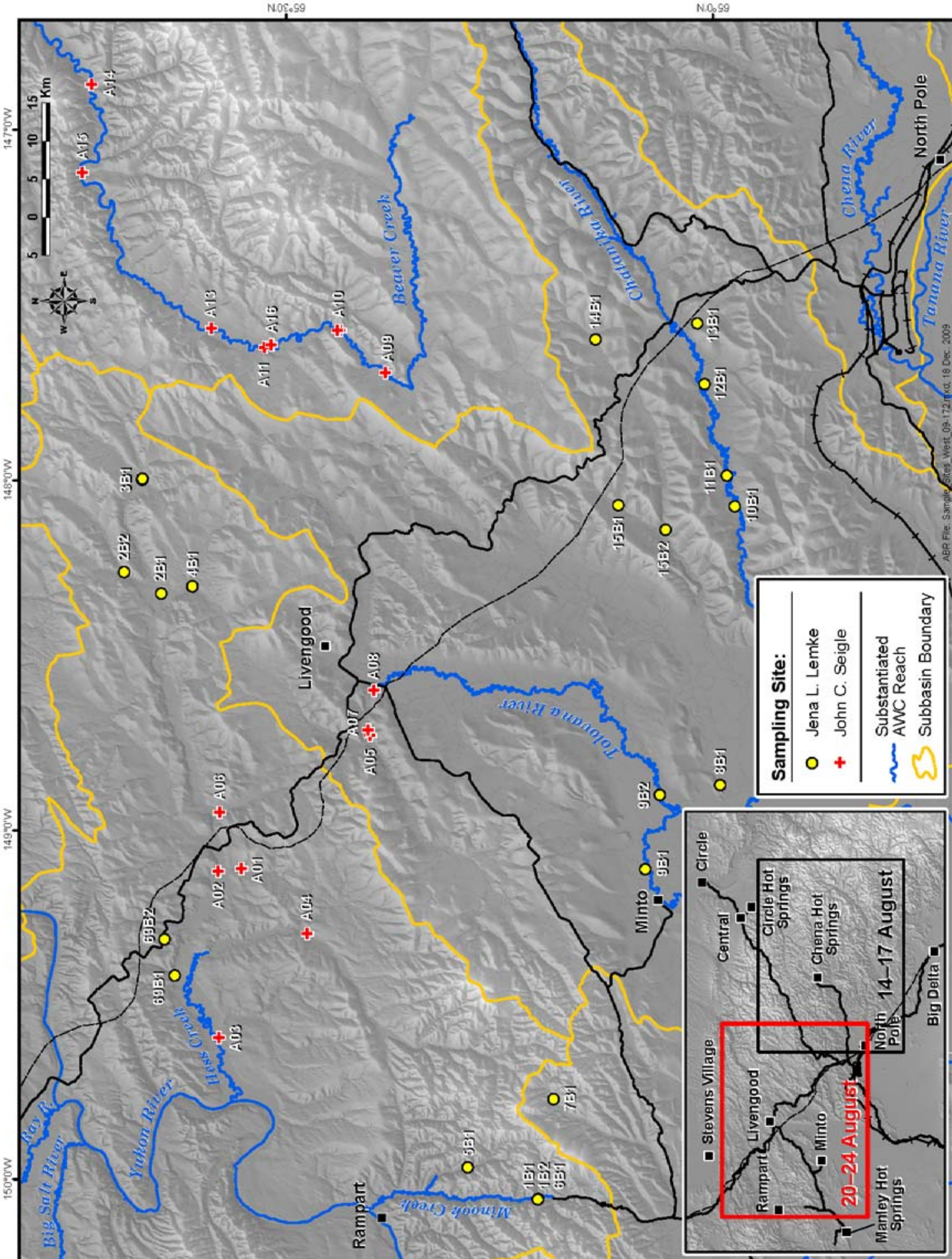

Figure 2. Sampling locations in the western section of the AYK-SSI Anadromous Waters Catalog survey area, Upper Yukon tributaries, Alaska, 20–24 August 2009.

5 days of sampling in favor of focusing our efforts solely on fish capture and observation.

On the evening of 19 August, the sampling teams moved to the West Fork Tolovana River to establish a second camp, and on 20 August, we began focusing on recording anadromous fishes. Our modified sampling protocol for 20–24 August included minnow trapping and dip netting along with electrofishing and visual observations. This modified plan was agreed upon in consultation with AYK-SSI personnel and other biologists familiar with the region, specifically Ray Hander, Chris Stark, and representatives of Mark Wipfli's lab at the University of Alaska Fairbanks. These methods were implemented in an attempt to maximize our ability to capture anadromous fish (if present) while minimizing helicopter time. In addition, we began sampling reaches closer to documented anadromous waters with the goal of finding anadromous fishes.

As the sampling continued, it became clear that water levels in all the sampled streams were abnormally low and the capture of anadromous fishes was generally unproductive, so in response we curtailed the field sampling on 24 August. After the field effort, we acquired local precipitation data to help explain the low water levels in the UYR streams. Precipitation data were collected from the National Weather Service for the greater Fairbanks area and were plotted by month to express cumulative precipitation as a function of amounts above or below the long-term average.

RESULTS

In 9 sampling days in August 2009, we sampled 63 stream reaches/stations in 48 distinct tributaries (Table 1). We observed fish in 40 of the 63 stations sampled and in 17 of the 48 tributaries. Arctic grayling (*Thymallus arcticus*) was the most prevalent species observed, being found in 28 of 63 stations or 44% of the stream stations sampled (Figure 3). The next most prevalent species was slimy sculpin (*Cottus cognatus*), recorded in 22 of 63 stations (35%). In 23 of 63 stream reaches sampled, we did not observe fish of any kind. A total of 7 species of fish were observed during the 9-day sampling period.

During the first 4 days of sampling (14–17 August, prior to changing the field survey focus), 2 sampling teams surveyed 24 stations in 21 streams, via electrofishing and visual observation. No capture or observation of anadromous species occurred during this time period. Only 2 fish species (arctic grayling and slimy sculpin) were observed during this period, We did not observe any fish in 9 of the 24 sampled stations during the initial 4 days of sampling.

Following consultation with fisheries biologists in Fairbanks on 18 and 19 August (see Methods), we sampled solely to record fish from 20–24 August. During this period, after adding minnow traps and dip netting to the sampling design, we sampled an additional 39 stations in 24 tributaries. We observed a total of 7 species during this sampling period. In addition to grayling and sculpin, we observed Alaska blackfish (*Dallia pectoralis*), burbot (*Lota lota*), Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*Oncorhynchus kisutch*), and Dolly Varden (*Salvelinus malma*). We did not observe any fish in 14 of 39 stations sampled during these 5 days of sampling.

In total, we found salmon in only 4 of 48 streams, all during the second half of the sampling effort. Of these 4 streams, one was already categorized as an anadromous fish bearing stream (Beaver Creek). (We sampled here to verify we could capture salmon in known anadromous waters.) In the other 3 sampling streams where we observed salmon in 2009, the sites were far down stream at the confluence with known anadromous waters (2 near Beaver Creek and 1 near the Chatanika River).

DISCUSSION

Initially, we assumed that the low fishing success for fish of all species in this study in August 2009 was largely because of the low precipitation in interior Alaska during summer 2009 and the low water levels in streams in the UYR region in August (low water levels could contribute to downstream movement of fishes away from headwaters towards main-stem habitats). However, when comparing the results of our fish sampling to those of the ADG&G in the

Table 1. Sample locations and species recorded in the AYK-SSI Anadromous Waters Catalog surveys of Upper Yukon River tributaries, Alaska, August 2009.

Location ID	Latitude	Longitude	Waterbody	Date	Sampler[1]	Method[2]	Species
175	64.42111	-146.11884	McCoy Creek	8/14	JCS	EF	*T. arcticus*
229	64.9055	-146.04753	Little Munson Creek	8/14	JCS	EF	*T. arcticus, C. cognatus*
244	65.04697	-145.97525	Monument Creek	8/15	JCS	EF	*C. cognatus*
236	65.03602	-145.38961	Ohio Creek	8/15	JCS	EF	*T. arcticus, C. cognatus*
238A	64.97053	-144.80054	N. Fork Salcha River	8/16	JLL	EF	no fish observed
210	64.76449	-145.38223	Bonanza Creek	8/16	JLL	EF, VO	*T. arcticus*
210A	64.76946	-145.31264	Bonanza Creek	8/16	JLL	EF	*C. cognatus*
206	64.71793	-145.16182	Big Granite Creek	8/16	JLL	EF	*C. cognatus*
206A	64.68818	-145.31734	Mascot Creek	8/16	JLL	EF	*C. cognatus*
227	64.85392	-145.18374	Tributary to N. Fork Salcha River	8/16	JLL	VO	no fish observed
213	64.8071	-146.05216	Ohio Creek	8/16	JCS	EF	*T. arcticus, C. cognatus*
198	64.70555	-146.12501	S. Fork Chena River	8/16	JCS	EF	no fish observed
215	64.81338	-145.84728	Munson Creek	8/16	JCS	VO	no fish observed
276A	65.14357	-144.38567	S. Fork Birch Creek	8/17	JLL	EF	no fish observed
276B	65.10804	-144.41880	S. Fork Birch Creek	8/17	JLL	EF	*T. arcticus*
274	65.18178	-144.62155	Tributary to Big Windy Creek	8/17	JLL	EF	no fish observed
297A	65.25414	-144.76986	Sheep Creek	8/17	JLL	EF, VO	*T. arcticus*
280A	65.17071	-144.75837	Big Windy Creek	8/17	JLL	EF, VO	*T. arcticus, C. cognatus*
260	65.12058	-145.32159	Cash Creek	8/17	JCS	EF	*T. arcticus, C. cognatus*
288	65.25754	-145.9096	Crooked Creek	8/17	JCS	EF	no fish observed
295	65.32173	-146.02421	Harrington Fork Birch Creek	8/17	JCS	EF	no fish observed
310	65.48211	-145.51892	Ptarmigan Creek	8/17	JCS	EF	no fish observed
259	65.11029	-145.55255	Munson Creek	8/17	JCS	VO	*C. cognatus*
279	65.19933	-145.22506	Anvil Creek	8/17	JCS	VO	no fish observed
2B1	65.71202	-148.35676	Bear Creek	8/20	JLL	EF, MT, VO	*T. arcticus, C. cognatus*
Camp2	65.46556	148.66745	W. Fork Tolovana River	8/20	JCS	MT	*D. pectoralis*
69B1	65.73047	-149.44554	Hess Creek Tributary	8/21	JLL	EF	no fish observed
69B2	65.73953	-149.34023	Hess Creek Tributary	8/21	JLL	EF	no fish observed
1B1	65.32015	-150.14312	Fish Creek	8/21	JLL	EF, MT	*T. arcticus, C. cognatus*

Table 1. Continued.

Location ID	Latitude	Longitude	Waterbody	Date	Sampler[1]	Method[2]	Species
1B2	65.31940	-150.14199	Fish Creek	8/21	JLL	MT	*T. arcticus*
2B2	65.75323	-148.28710	N. Fork Bear Creek	8/21	JLL	MT, VO	*T. arcticus*
3B1	65.72244	-148.02930	Grouse Creek	8/21	JLL	EF, MT, VO, DN	*T. arcticus*
4B1	65.67448	-148.34406	S. Fork Hess Creek	8/21	JLL	MT	*T. arcticus*
A01	65.64343	-149.15601	Rich Creek	8/21	JCS	MT	no fish observed
A02	65.67081	-149.15876	Rich Creek	8/21	JCS	MT	no fish observed
A03	65.68336	-149.63108	Lynx Creek	8/21	JCS	MT, VO	*T. arcticus, L. lota, C. cognatus*
A04	65.57167	-149.35370	Troublesome Creek	8/21	JCS	MT, VO	*T. arcticus, C. cognatus*
A06	65.66414	-148.99214	Erickson Creek	8/21	JCS	VO, DN	*T. arcticus*
A09	65.42562	-147.79098	Beaver Creek	8/21	JCS	EF	*T. arcticus, C. cognatus*
5B1	65.40053	-150.04170	Hoosier Creek	8/22	JLL	MT	*S. malma malma*
6B1	65.32015	-150.14312	Chapman Creek	8/22	JLL	MT	no fish observed
7B1	65.29444	-149.86429	Bear Creek	8/22	JLL	MT	no fish observed
A05	65.48031	-148.80783	W. Fork Tolovana River	8/22	JCS	MT, VO	*T. arcticus*
A06	65.66414	-148.99214	Erickson Creek	8/22	JCS	MT, VO, DN	*T. arcticus, C. cognatus*
A07	65.48175	-148.79177	W. Fork Tolovana River	8/22	JCS	MT, VO	*T. arcticus, L. lota*
A08	65.47145	-148.68054	W. Fork Tolovana River	8/22	JCS	MT, VO	*T. arcticus, L. lota*
A10	65.47408	-147.6597	Fossil Creek	8/22	JCS	EF, MT, VO	*T. arcticus, C. cognatus*
8B1	65.07353	-149.02051	Tatalina River	8/23	JLL	MT	no fish observed
9B1	65.16857	-149.23983	Tolovana River	8/23	JLL	MT	no fish observed
9B2	65.14527	-149.03522	Tolovana River	8/23	JLL	MT	no fish observed
9B3	65.18870	148.82924	Tolovana River	8/23	JLL	MT	no fish observed
10B1	65.02988	-148.25069	Tributary to Chatanika River	8/23	JLL	EF	*T. arcticus, C. cognatus*
11B1	65.03624	-148.16398	Tributary to Chatanika River	8/23	JLL	EF	*O. kisutch, T. arcticus, C. cognatus*
A11	65.5643	-147.68672	Beaver Creek	8/23	JCS	MT	*O. tshawytscha, C. cognatus*
12B1	65.05255	-147.90517	Tributary to Chatanika River	8/24	JLL	EF, MT, VO	*T. arcticus, L. lota*
13B1	65.05450	-147.73462	Tributary to Chatanika River	8/24	JLL	MT	no fish observed
14B1	65.17552	-147.75280	Washington Creek	8/24	JLL	EF	no fish observed
15B1	65.16651	-148.21975	Aggie Creek	8/24	JLL	VO	no fish observed
15B2	65.11336	-148.29956	Aggie Creek	8/24	JLL	EF, VO	*C. cognatus*
A12	65.4771	-147.65988	Fossil Creek	8/24	JCS	VO	*T. arcticus*
A13	65.62512	-147.61917	Lost Horse Creek	8/24	JCS	EF, VO	*T. arcticus, L. lota*
A14	65.73683	-146.89445	Mascot Creek	8/24	JCS	MT	*O. tshawytscha, C. cognatus*

Table 1. Continued.

Location ID	Latitude	Longitude	Waterbody	Date	Sampler[1]	Method[2]	Species
A15	65.75799	-147.14116	Willow Creek	8/24	JCS	MT	*O. tshawytscha, L. lota*
A16	65.55613	-147.681680	Windy Creek	8/24	JCS	MT	no fish observed

[1] JCS=John C. Seigle, JLL=Jena L. Lemke
[2] EF= Electrofishing, MT=Minnow Trapping, VO=Visual Observation, DN=Dip Netting

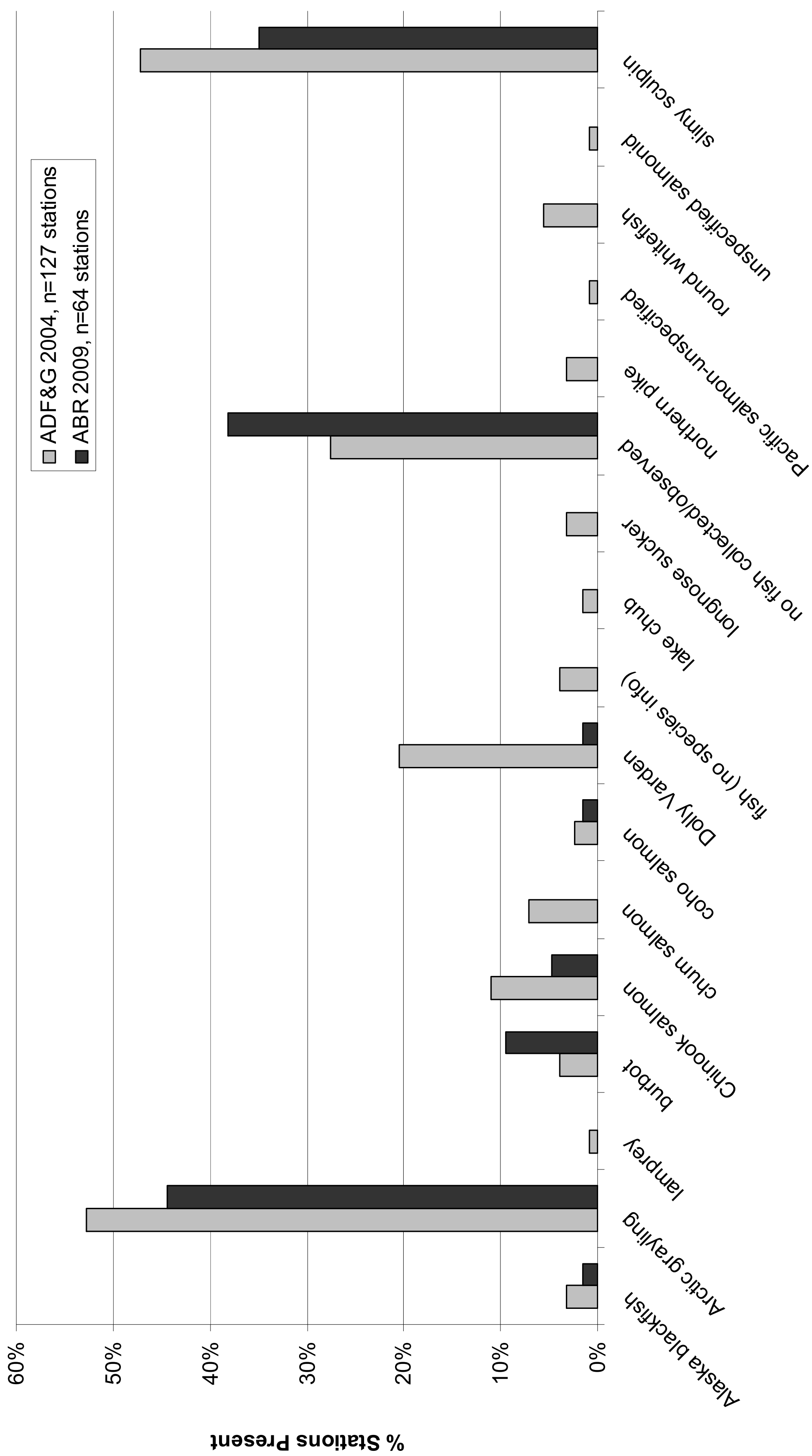

Figure 3. Percentage of stations in which fish species were collected during Anadromous Waters Catalog surveys of Upper Yukon tributaries, Alaska, August 2004 (ADF&G) and August 2009 (ABR).

UYR region during 2004 (a year closer to average precipitation for the Fairbanks area), it is apparent that the fishing results in the 2 studies are not entirely dissimilar (Tables 1 and 2, Figure 3).

In 2004, ADG&G biologists found a similar pattern in fish availability as noted by ABR in 2009 (Tables 1 and 2, Figure 3). In both studies, arctic grayling was the most commonly observed species followed by slimy sculpin. In addition, the third most observed outcome of surveys in both studies was no fish recorded. ADF&G sampled 127 distinct stations in 2004 and observed no fish in 35 sites sampled (28% with no fish recorded in 2004 compared to 38% in 2009 by ABR).

A notable difference in the results of the ADF&G sampling in 2004 and our sampling effort is that ADF&G observed 6 species of fish that ABR did not observe in 2009. However, none of these species were observed in greater than 7% of stations sampled (lamprey <1%, chum salmon 7%, lake chub <2%, longnose sucker 3%, northern pike 3%, and round whitefish <6%). Initially there were concerns from fisheries biologists in Fairbanks in August 2009 (see Methods) over our use of sole use of electrofishing as a method of sampling these tributaries. However, the addition of minnow trapping (with salmon roe) in streams over night in our surveys did not radically increase species diversity in our harvests.

In 2004, ADF&G did have greater success in recording salmonids compared to the 2009 ABR survey. ADG&G observed anadromous salmon at 21 unique stations out of 127 sites (~17% of sites compared with ~6% salmonid presence in the ABR survey). These relatively low numbers for both surveys suggest the region may not provide extensive headwater stream habitats suitable for salmonid rearing.

ABR was successful only in observing Pacific salmon in 4 stations out of 63, and in all cases the fish were observed very near already cataloged anadromous waters. While ADF&G had greater success in observing salmon in general, the ADF&G results do not indicate the ubiquitous presence of salmon in headwater tributaries of the Upper Yukon River region. ABR's success in recording salmon may have been greater had we chosen to commence the 2009 sampling in the lower reaches of tributaries nearer to known AWC waters such as those near Hess and Beaver Creeks nearer to the Yukon River. However, in a year of average precipitation, these lower stream reaches may not have been wadeable.

Another notable difference between the two surveys was that ADF&G recorded Dolly Varden at 20% of the stations sampled in 2004 while ABR observed Dolly Varden at only 1 station out of 63 sampled (2%). (Dolly Varden otoliths are increasingly being analyzed for microchemical signatures indicative of anadromous behavior and thus their occurrence is important to the AWC nomination process.) We expected to observe more Dolly Varden during our sampling based on the ADF&G results from the UYR region in 2004. The paucity of Dolly Varden observations in 2009, as well as the observation of 6 fewer fish species in 2009 compared to the 2004 survey suggests that low water conditions likely influenced our fishing results in 2009. Our personal experience is that Dolly Varden are particularly susceptible to harvest by both electrofishing and minnow trapping in Alaskan waters, hence their scarcity in our surveys was surprising.

The objectives for this study were to document the presence and upstream extent of anadromous fishes in headwater tributaries of the Yukon River and to document stream- and riparian-habitat conditions in these tributaries. However, as explained above, because of the lack of harvest of fish in many sampling stations in 2009, we determined that the best use of our time (and funding) was to drop the habitat-sampling objective and instead focus solely on sampling for fish in an attempt to capture anadromous salmon (the more important objective).

In consultation with AYK-SSI personnel and fisheries biologists with the USFWS and University of Alaska, Fairbanks, it was determined that multiple factors could be leading to our not finding anadromous fishes in August 2009. The first concern was that the month of July 2009 had been the driest on record for the greater Fairbanks region. From 9 July until the end of sampling on 24 August, there was a negative cumulative precipitation anomaly in the Fairbanks data (the beginning of this precipitation decline actually started on approximately 28 June; Figure 4). Because of this stretch of low rainfall, there were concerns that our survey results could be providing "false negatives" in terms of anadromous salmon

Table 2. Sample locations and species recorded in Anadromous Waters Catalog surveys of Upper Yukon River tributaries, Alaska, by ADF&G biologists, August 2004.

Location ID	Latitude	Longitude	Date	Method*	Species
01A01	64.22208	-148.224	8/3	EF, VOG	*T. arcticus*
01A02	64.41686	-149.127	8/3	VOG, VOH	*T. arcticus, O. keta*
01A03	64.21387	-149.087	8/3	EF	no fish observed
02A01	64.13232	-149.551	8/4	EF, VOG	unspecified salmon
02A02	64.05711	-149.383	8/4	EF	no fish observed
02A03	64.07543	-149.431	8/4	EF	no fish observed
02A04	64.07715	-149.442	8/4	EF, VOG	*T. arcticus*
02A05	64.1185	-149.742	8/4	EF	no fish observed
02A06	64.28455	-149.776	8/4	EF	*D. pectoralis, T. arcticus, L. camtschatica, C. cognatus*
03A01	64.16509	-149.636	8/5	EF, S, VOH	*T. arcticus, O. tshawytscha, O. kisutch, C. cognatus,* unspecified salmon
03A02	64.06917	-149.622	8/5	VOG	*O. keta*
03A03	64.00626	-149.557	8/5	VOG	*O. keta*
03A04	64.3627	-149.402	8/5	EF, VOG	*D. pectoralis, O. tshawytscha, O. keta, C. cognatus*
03A05	64.51995	-148.799	8/5	EF	*D. pectoralis*
03A06	64.13484	-149.243	8/5	VOH	*O. keta*
03A07	64.00756	-149.556	8/5	EF, VOG	*T. arcticus, O. keta, P. cylindraceum, C. cognatus*
04A01	63.97366	-148.387	8/6	EF	*T. arcticus*
04A02	64.24682	-148.741	8/6	EF	*T. arcticus, L. lota, C. cognatus*
04A03	64.0955	-148.734	8/6	EF	*T. arcticus, C. cognatus*
04A04	63.97464	-148.186	8/6	EF	*C. cognatus*
04A05	63.97448	-148.183	8/6	EF	no fish observed
04A06	64.29524	-148.417	8/6	EF	*T. arcticus, P. cylindraceum, C. cognatus*
05A01	64.54427	-148.819	8/7	EF	*T. arcticus, C. plumbeus, E. lucius, C. cognatus*
05A02	64.50131	-148.577	8/7	EF	general fish observation, *C. plumbeus*
05A03	64.33939	-148.081	8/7	EF	*T. arcticus, C. cognatus*
05A04	64.31338	-147.925	8/7	EF	*T. arcticus, P. cylindraceum, C. cognatus*
06A01	63.96013	-147.801	8/8	EF	*T. arcticus, C. cognatus*
06A02	63.96013	-147.801	8/8	EF	*T. arcticus, C. catostomus, C. cognatus*
06A03	63.71635	-147.614	8/8	EF	no fish observed
06A04	63.59325	-147.906	8/8	EF	no fish observed
06A05	63.63099	-148.233	8/8	EF	*T. arcticus, P. cylindraceum, C. cognatus*
06A06	63.62403	-148.556	8/8	EF	*S. m. malma*
07A01	63.46838	-148.2	8/9	EF	*S. m. malma, C. cognatus*
07A02	63.32686	-148.147	8/9	EF	*T. arcticus, C. cognatus,* general fish observation
07A03	63.47396	-147.784	8/9	EF	*T. arcticus, C. cognatus*
07A04	63.30008	-147.829	8/9	EF	*T. arcticus, C. cognatus,* general fish observation
07A05	63.28131	-148.072	8/9	EF	*T. arcticus, C. cognatus*
07A06	63.66808	-148.665	8/9	EF	*S. m. malma, C. cognatus*
08A01	63.31288	-148.705	8/10	EF	*T. arcticus, S. m. malma*
08A02	63.32609	-149.242	8/10	EF	*T. arcticus, L. lota, C. cognatus*
08A03	63.87962	-148.679	8/10	EF	*T. arcticus, C. cognatus*

Table 2. Continued.

Location ID	Latitude	Longitude	Date	Method*	Species
08A04	63.83151	-148.844	8/10	EF	*O. keta*
09A01	64.3266	-146.936	8/11	VOH	*O. tshawytscha*
09A02	64.29569	-147.036	8/11	EF	*C. cognatus*
09A03	64.05044	-147.077	8/11	EF	no fish observed
09A04	64.422	-147.089	8/11	EF	*T. arcticus*
09A05	64.33233	-147.356	8/11	EF	*T. arcticus, C. cognatus*
09A06	64.59906	-147.379	8/11	EF	*T. arcticus*
09A07	64.60341	-147.396	8/11	VOG, VOH	*T. arcticus, O. tshawytscha*
10A01	64.39097	-147.654	8/12	EF	*T. arcticus, C. cognatus*
10A02	64.43403	-147.754	8/12	EF	*T. arcticus, C. cognatus*
10A03	64.45057	-147.599	8/12	EF	*E. lucius, C. cognatus*
11A01	64.6489	-147.759	8/13	MT	no fish observed
11A02	64.64579	-147.928	8/13	MT	no fish observed
11A03	64.6436	-148.076	8/13	MT	no fish observed
11A04	64.64107	-148.278	8/13	MT, VOG	*O. tshawytscha*
11A05	64.71352	-147.011	8/13	EF, VOG	*T. arcticus, P. cylindraceum*
11A06	64.61212	-146.94	8/13	EF	*T. arcticus*
12A01	64.29247	-145.854	8/14	EF	no fish observed
12A02	64.37926	-145.577	8/14	EF	*T. arcticus, C. cognatus*
12A03	64.46375	-145.269	8/14	EF	*T. arcticus*
12A04	64.48887	-145.153	8/14	EF	no fish observed
12A05	64.43976	-145.268	8/14	EF	*T. arcticus*
12A06	64.41824	-145.367	8/14	EF, VOG	*T. arcticus, O. tshawytscha, C. cognatus*
13A01	64.60141	-150.836	8/15	EF	*P. cylindraceum*
13A02	64.74047	-150.844	8/15	A	no fish observed
13A03	64.58656	-151.008	8/15	EF	no fish observed
13A04	64.47027	-151.244	8/15	EF	*T. arcticus*
13A05	64.43485	-151.529	8/15	EF	no fish observed
14A01	64.91441	-150.794	8/16	EF	*D. pectoralis*
14A02	64.60664	-151.391	8/16	EF, VOG	*T. arcticus*
14A03	64.72823	-151.169	8/16	EF	no fish observed
14A04	64.5412	-151.958	8/16	EF, VOG	*T. arcticus*
14A05	64.52425	-151.748	8/16	EF	*T. arcticus*
14A06	64.54982	-151.623	8/16	EF	*T. arcticus*
15A01	65.08418	-150.369	8/17	EF	*T. arcticus, C. cognatus*
15A02	65.10263	-150.674	8/17	EF	*T. arcticus*
15A03	65.2382	-150.517	8/17	EF	no fish observed
15A04	65.19793	-150.415	8/17	EF	*S. m. malma*
15A05	65.16981	-150.215	8/17	EF	*T. arcticus*
15A06	65.22079	-150.066	8/17	EF	no fish observed
16A01	65.17621	-150.059	8/18	EF	*S. m. malma, C. cognatus*
16A02	65.28481	-149.89	8/18	EF, VOG	*S. m. malma*
16A03	65.2147	-149.995	8/18	EF	*S. m. malma, C. cognatus*
16A04	65.10954	-149.752	8/18	EF	no fish observed
16A05	65.15558	-149.831	8/18	EF, VOG	*T. arcticus, S. m. malma*

Table 2. Continued.

Location ID	Latitude	Longitude	Date	Method*	Species
16A06	65.22311	-149.561	8/18	EF	no fish observed
17A01	65.11465	-151.38	8/19	EF, VOG	*S. m. malma, E. lucius*
17A02	65.14345	-151.098	8/19	EF	*S. m. malma*
17A03	65.04275	-150.943	8/19	EF, VOG	*T. arcticus*
17A04	64.91461	-151.557	8/19	EF, S, VOG	*C. catostomus, E. lucius, C. cognatus,* general fish observation
18A01	65.36426	-152.504	8/20	A, EF	*T. arcticus, S. m. malma, C. cognatus*
18A02	65.38358	-152.409	8/20	EF	*T. arcticus, O. tshawytscha, C. cognatus*
18A03	65.63616	-152.104	8/20	EF	*C. cognatus*
19A01	65.64826	-151.634	8/21	EF	*L. lota, S. m. malma, C. cognatus*
19A02	65.59406	-151.658	8/21	EF	*O. tshawytscha, S. m. malma, C. cognatus*
19A03	65.59979	-151.339	8/21	A, EF	*T. arcticus, O. tshawytscha, S. m. malma, C. cognatus*
19A04	65.66554	-151.21	8/21	EF, VOG	*S. m. malma, C. cognatus, S. m. malma, C. cognatus*
19A05	65.56142	-151.125	8/21	A, EF	*T. arcticus, O. tshawytscha, S. m. malma, C. cognatus*
19A06	65.62669	-150.832	8/21	EF	*S. m. malma, C. cognatus*
20A01	65.20501	-152.343	8/22	EF	*T. arcticus, C. cognatus*
20A02	65.57343	-152.437	8/22	EF	no fish observed
20A03	64.70816	-152.389	8/22	A, EF	*T. arcticus, P. cylindraceum*
20A04	64.71736	-152.556	8/22	EF	no fish observed
20A05	64.61394	-152.359	8/22	A, EF, VOG	*T. arcticus,* general fish observation
21A01	65.88144	-150.265	8/24	A, EF, VOG, VOH	*T. arcticus, O. keta, O. kisutch, C. cognatus*
21A02	65.82351	-150.766	8/24	A, EF, VOG	*T. arcticus, C. cognatus*
21A03	65.87111	-150.5	8/24	A, EF	*T. arcticus, C. cognatus*
21A04	65.81862	-150.17	8/24	EF, VOG	*T. arcticus*
22A01	65.99093	-150.494	8/25	A, EF	*T. arcticus, C. cognatus*
22A02	65.96046	-150.921	8/25	A, EF, VOG	*T. arcticus, C. cognatus*
22A03	65.59091	-151.441	8/25	A, EF	*O. tshawytscha, S. m. malma, C. cognatus*
22A04	65.63838	-151.44	8/25	A, EF	*S. m. malma*
22A05	65.65723	-151.299	8/25	EF	*S. m. malma, C. cognatus*
23A01	65.68917	-149.388	8/26	A, EF, VOG	*T. arcticus, L. lota, O. tshawytscha, O. keta, C. cognatus*
23A02	65.56291	-149.304	8/26	EF	*T. arcticus, C. cognatus*
23A03	65.68069	-148.972	8/26	A, EF	*T. arcticus, L. lota, C. catostomus, C. cognatus*
23A04	65.72896	-148.266	8/26	EF	*T. arcticus, C. cognatus*
23A05	65.7026	-149.285	8/26	EF	*T. arcticus, C. catostomus*
23A06	65.57041	-149.356	8/26	EF	*T. arcticus, C. cognatus*
24A01	65.56725	-150.424	8/27	EF	*O. tshawytscha, O. kisutch, C. cognatus*
24A02	65.62946	-150.52	8/27	EF	*T. arcticus, O. tshawytscha, S. m. malma, C. cognatus*
24A03	65.69847	-150.407	8/27	EF	*S. m. malma, C. cognatus*
24A04	65.79058	-150.558	8/27	EF	*T. arcticus, S. m. malma*
24A05	65.82183	-150.519	8/27	EF	*C. cognatus*

Table 2. Continued.

Location ID	Latitude	Longitude	Date	Method*	Species
24A06	65.84454	-150.509	8/27	EF	*T. arcticus, S. m. malma, C. cognatus*
24A07	65.82729	-150.936	8/27	EF	*S. m. malma*

* EF= Electrofishing, VOG=Visual Observation Ground, VOH=Visual Observation Helicopter, S= Seine, A=Angling

occurrence since rearing salmonids might not have received normal queues for moving into headwater streams due to low flows. We hoped that by shifting our sampling further west to tributaries nearer to the Yukon River, we would have greater success in observing fish of all species. That increase in fishing success, however, did not occur. The results of the minnow-trap sampling on the Tolovana River during 22–23 August 2009 provide a good example because no fish were observed in minnow traps or by visual observation in the Tolovana River (a known fish-bearing stream). Anecdotal information from local residents in the sampling region and from agency and university experts suggested that stream water levels were abnormally low during this period, again providing more evidence that upstream fish movements in 2009 probably were being negatively affected by the low stream flows in summer 2009.

The second concern raised during our consultation in Fairbanks with fisheries experts in the region was that we were perhaps sampling at the outer edge of salmon habitat and that any salmon in these areas naturally would be scarce, even under typical water flow conditions (Ray Hander, USFWS, pers. comm.). As mentioned above, after this consultation in Fairbanks, we decided to alter our methods to focus more on roe-baited minnow trapping and visual observation to achieve longer fishing times per reach/station. Where it was deemed necessary, we used dip nets or electrofished the station. The second adjustment we made was to move further west towards the Yukon River (away from headwaters and closer to known anadromous waters). However, even in sites where fish of any species were observed, the densities in 2009 remained low.

Primarily because of the persistent low water conditions, it was decided, in consultation with AYK-SSI personnel on 23 August, that the 2009 summer sampling effort should be halted. The discussion centered on apparent low flows in areas that had clearly been affected by low rainfall in July 2009. A continued point of discussion was the theory that we were perhaps sampling in areas that could be scarcely populated by salmon even under average stream-flow conditions. The conclusions in these discussions was that we were reaching a point of diminishing returns with regard to salmonid capture, so the minnow traps were retrieved on 24 August and the season was suspended.

FUTURE SAMPLING

Our unproductive fish sampling in the UYR region in 2009 underscored several important considerations that should be taken into account for future AWC cataloging surveys. These considerations are particularly important because the process itself is inherently expensive and challenging due to the frequent need for helicopter access to remote areas. In the UYR region, the possibility that the headwater streams are perhaps near the upper limit of salmonid distribution, as well as the ever-present possibility of low stream flow cycles in interior Alaska, demonstrates the need for contingency planning and flexibility when attempting to catalog anadromous waters.

While the State of Alaska has created a successful approach to identifying potential salmon streams, at the upper extent of salmonid presence in headwater streams in Alaska (because of the variability in use by salmonids), it can be challenging to ascertain which streams and their associated habitat are critical to the life history of salmonids. In these areas on the margins of salmonid ocurrence, there is still a need to

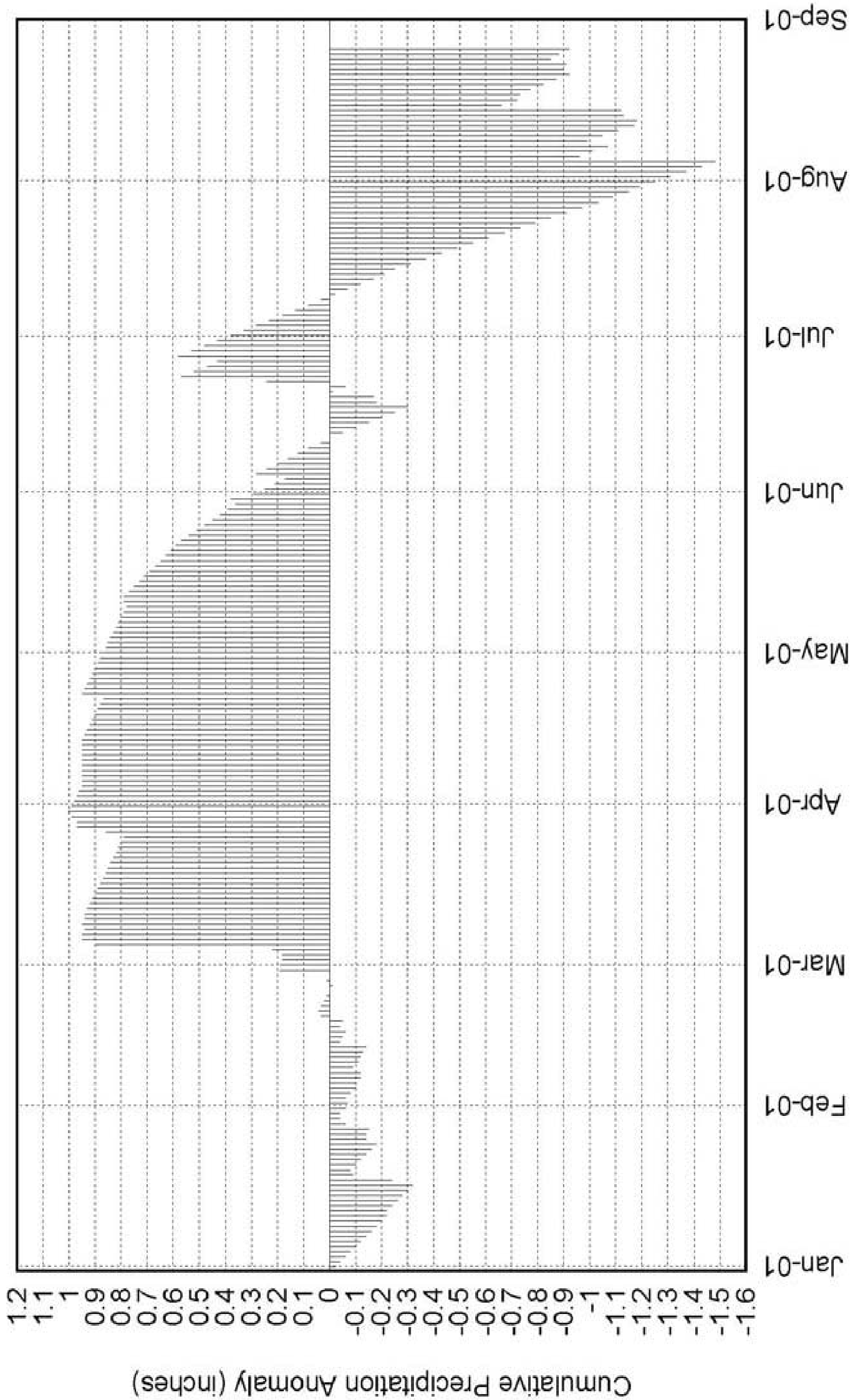

Figure 4. Cumulative precipitation anomaly (deviation from the long-term average) from 1 January until 24 August 2009 for the Fairbanks area.

fine-tune the approach to sampling for the presence of salmonids. Our experience in 2009 suggests that a combination of low salmonid density and low precipitation were factors contributing to the low harvest success. We suggest the following approaches could result in higher success rates in recording salmonids, if present, in tributaries to the Upper Yukon River:

- Select fewer and higher-potential streams for field sampling to maximize the probability of capturing anadromous fish if present. This can be achieved in advance of the sampling season by taking the best available evidence from local residents and biologists familiar with the area and by considering tributaries flowing directly into known anadromous waters.
- Begin sampling of candidate streams closer to confluences with known anadromous streams to establish the presence of anadromous fish in the tributaries and *then* return in subsequent field seasons or later in the year (e.g., after the late summer rains) to establish the upstream extent of anadromous fish. This would be a "bookmark" approach and could allow for an enhanced upstream focus on a tributary in subsequent years.
- Maximize the sampling effort by continuing to employ multiple sampling methods, which could include a mix of electrofishing, fyke netting, minnow trapping, seining and dip netting. This approach would reduce the number of streams that could be sampled over a season but would maximize effort in the streams sampled, resulting in greater confidence in fish occurrence and a reduction in the probability of false negatives.

To expand on the importance of the last point above, we make use of the results of surveys conducted in 2008 and 2009 by biologists (led by Ray Hander) from the USFWS. They sampled more than 50 distinct stations in 8 headwater streams in the UYR region using multiple survey techniques to accomplish similar goals as those described in this study (Tables 3 and 4). The major difference between their sampling strategy and that employed by ABR and ADF&G was that many fewer streams were sampled and each stream was sampled multiple times over the course of the season (Figure 5). Though results are not directly comparable to the aforementioned surveys, when taken in total with results of ADF&G and ABR surveys, the interpretation is that fish densities are indeed quite low in the region and particularly so for anadromous salmon. The USFWS data from 2008 and 2009 also clearly indicate the importance sampling method and timing in determining fish occurrence. If each station sampled by the USFWS is analyzed by method employed or "method/stations" (n=183), it becomes clear that both sampling method and timing are important factors in determining which fish species and life-history stages are observed. A good example is Clear Creek (Table 3) where Chinook salmon carcasses were observed in August but juveniles were only caught in minnow traps in September even though sampling had occurred in June and July. An analysis of the "method/station" results show that 10 methods were used to survey fish in 2008 and 2009 but only visual observations of adults, minnow trapping, and seining produced observable salmon.

Table 3. Sample locations and species recorded in Anadromous Waters Catalog surveys of Upper Yukon River tributaries, Alaska, by USFWS biologists, 2008–2009.

Site ID	Latitude	Longitude	Waterbody	Date	Method	Species
08KSFS0021A	64.23072	146.44432	S. Fork Kiana Creek	6/13/08	EF	*C. cognatus*
08KSFS0021A	64.23072	146.44432	S. Fork Kiana Creek	6/13/08	MT	*C. cognatus, O. kisutch, C. plumbeus, C. catostomus*
08KSFS0021A	64.23072	146.44432	S. Fork Kiana Creek	6/13/08	VOG	*T. arcticus*
08KSFS0021B	64.23072	146.44432	S.Fork Kiana Creek	9/11/08	A	no fish
08KSFS0021B	64.23072	146.44432	S.Fork Kiana Creek	9/11/08	EF	*C. cognatus*
08KSFS0021B	64.23072	146.44432	S.Fork Kiana Creek	9/11/08	MT	*C. cognatus*, *O. kisutch*
08KSFS0021B	64.23072	146.44432	S.Fork Kiana Creek	9/11/08	VOG	unknown
08KSFS0031A	64.23575	146.42650	S. Fork Kiana Creek	6/14/08	EF	*C. cognatus*
08KSFS0031A	64.23575	146.42650	S. Fork Kiana Creek	6/14/08	MT	*O. kisutch*
08KSFS0031B	64.23575	146.42650	S.Fork Kiana Creek	9/12/08	A	no fish
08KSFS0031B	64.23575	146.42650	S.Fork Kiana Creek	9/12/08	EF	*C. cognatus*, *C. catostomus*
08KSFS0031B	64.23575	146.42650	S.Fork Kiana Creek	9/12/08	MT	*C. cognatus*, *O. kisutch*
08KCS0041A	64.24738	146.45372	Kiana Creek	6/15/08	EF	no fish
08KCS0041A	64.24738	146.45372	Kiana Creek	6/15/08	MT	*O. kisutch, C. catostomus*
08KCS0041B	64.24713	146.45993	Kiana Creek	9/14/08	A	no fish
08KCS0041B	64.24713	146.45993	Kiana Creek	9/14/08	EF	*C. cognatus*
08KCS0041B	64.24713	146.45993	Kiana Creek	9/14/08	MT	no fish
08KCS0041B	64.24713	146.45993	Kiana Creek	9/14/08	VOG	*T. arcticus*
08KCS0051A	64.25452	146.48622	Kiana Creek	6/16/08	EF	*C. cognatus*, *L. japonicum, C. plumbeus, C. catostomus*
08KCS0061A	64.25742	146.53978	Kiana Creek	6/16/08	MT	*O. kisutch, C. plumbeus, C. catostomus*
08KCS0061B	64.25738	146.53975	Kiana Creek	9/15/08	EF	*C. cognatus*, *C. plumbeus*
08KCS0061B	64.25738	146.53975	Kiana Creek	9/15/08	MT	*C. plumbeus*
08WCS0011B	64.63446	148.05803	Willow Creek	7/25/08	MT	no fish
08WCS0011B	64.63446	148.05803	Willow Creek	7/25/08	GN	no fish
08WCS0011B	64.63446	148.05803	Willow Creek	7/25/08	VOG	*E. lucius*
08WCS0011C	64.63446	148.05803	Willow Creek	8/25/08	MT	no fish
08WCS0011C	64.63446	148.05803	Willow Creek	8/25/08	VOG	*E. lucius*
08WCS0021A	64.63848	148.06421	Willow Creek	6/27/08	MT	no fish
08WCS0021B	64.63848	148.06421	Willow Creek	7/26/08	MT	no fish
08WCS0021B	64.63848	148.06421	Willow Creek	7/26/08	GN	no fish
08WCS0021B	64.63848	148.06421	Willow Creek	7/26/08	VOG	*E. lucius*

Table 3. Continued.

Site ID	Latitude	Longitude	Waterbody	Date	Method	Species
08WCS0021C	64.63848	148.06421	Willow Creek	8/26/08	MT	no fish
08WCS0021C	64.63848	148.06421	Willow Creek	8/26/08	GN	no fish
08WCS0031A	64.65269	148.09904	Willow Creek	6/28/08	MT	no fish
08WCS0031B	64.65266	148.09898	Willow Creek	7/28/08	MT	no fish
08WCS0041A	64.65360	148.10416	Willow Creek	6/28/08	MT	no fish
08WCS0041C	64.65374	148.10431	Willow Creek	8/27/08	MT	no fish
08WCS0051A	64.65950	148.13531	Willow Creek	7/29/08	MT	no fish
08WCS0051A	64.65950	148.13531	Willow Creek	7/29/08	S	no fish
08WCS0061A	64.66157	148.14684	Willow Creek	7/30/08	MT	no fish
08WCS0061B	64.66157	148.14684	Willow Creek	8/28/08	MT	no fish
08WCS0061B	64.66157	148.14684	Willow Creek	8/28/08	GN	no fish
08WCS0071A	64.67160	148.18895	Willow Creek	8/14/08	MT	*C. catostomus*
08WCS0071A	64.67160	148.18895	Willow Creek	8/14/08	DN	*C. catostomus*
08WCS0071A	64.67160	148.18895	Willow Creek	8/14/08	FN	no fish
08WCS0071A	64.67160	148.18895	Willow Creek	8/14/08	GN	*C. catostomus, C. pidschian*
08WCS0071A	64.67160	148.18895	Willow Creek	8/14/08	VOG	*E. lucius*
NONE*	64.67130	148.18823	Willow Creek	8/14/08	DN	*C. catostomus*
-	64.69916	148.09480	Willow Creek	8/27/08	A	*E. lucius*
08UTCLRS0011A	64.64215	147.75745	Clear Creek	6/22/08	S	*C. catostomus, E. lucius*
08UTCLRS0011A	64.64215	147.75745	Clear Creek	6/22/08	DN	unknown whitefish
08UTCLRS0011A	64.64215	147.75745	Clear Creek	6/22/08	VOG	*E. lucius*
08UTCLRS0011B	64.64215	147.75745	Clear Creek	9/3/08	A	no fish
-	64.69057	147.78970	Clear Creek	9/4/08	S	*C. pidschian*
-			Clear Creek	9/4/08	O	*L. lota*
08UTCLRS0021A	64.68812	147.79079	Clear Creek	6/24/08	EF	*C. cognatus*
08UTCLRS0021A	64.68812	147.79079	Clear Creek	6/24/08	DN	*T. arcticus*
08UTCLRS0021B	64.68812	147.79079	Clear Creek	9/4/08	S	*C. cognatus*, *C. catostomus*
08CLRS0021A	64.58937	147.73570	Clear Creek	6/20/08	MT	*C. cognatus*
08CLRS0021A	64.58937	147.73570	Clear Creek	6/20/08	GN	no fish
08CLRS0041A	64.64048	147.75865	Clear Creek	6/21/08	MT	*C. cognatus*
08CLRS0041B	64.64082	147.75851	Clear Creek	8/12/08	GN	C. catostomus
08CLRS0041C	64.64058	147.75856	Clear Creek	9/2/08	MT	no fish

Table 3. Continued.

Site ID	**Latitude**	**Longitude**	**Waterbody**	**Date**	**Method**	**Species**
08CLRS0051A	64.65600	147.76006	Clear Creek	6/22/08	MT	*C. cognatus*
08CLRS0061A	64.68668	147.79343	Clear Creek	6/24/08	MT	no fish
08CLRS0061C	64.68664	147.79344	Clear Creek	9/3/08	MT	no fish
08CLRS0081A	64.71163	147.83707	Clear Creek	6/24/08	MT	no fish
08CLRS0081C	64.71181	147.83690	Clear Creek	9/5/08	MT	no fish
08CLRS0091A	64.72854	147.87469	Clear Creek	6/25/08	EF	no fish
08CLRS0091A	64.72854	147.87469	Clear Creek	6/25/08	DN	unknown whitefish
08CLRS0091C	64.72854	147.87469	Clear Creek	9/7/08	MT	no fish
08CLRS0091C	64.72854	147.87469	Clear Creek	9/7/08	S	*T. arcticus C. catostomus*
08CLRS0101A	64.73637	147.90097	Clear Creek	6/25/08	GN	*C. catostomus*
08CLRS0111A	64.73774	147.91251	Clear Creek	6/26/08	MT	no fish
08CLRS0131A	64.64532	147.75652	Clear Creek	8/12/08	MT	*C. cognatus*
08CLRS0141A	64.66610	147.77393	Clear Creek	8/13/08	GN	*C. catostomus*
08CLRS0151A	64.58121	147.71230	Clear Creek	8/30/08	A	*T. arcticus*
08CLRS0151A	64.58121	147.71230	Clear Creek	8/30/08	MT	*C. cognatus*
08CLRS0151A	64.58121	147.71230	Clear Creek	8/30/08	S	*P. cylindraceum*
08CLRS0161A	64.60081	147.73163	Clear Creek	9/1/08	S	*T. arcticus*
08CLRS0161A	64.60081	147.73163	Clear Creek	9/1/08	GN	*E. lucius*
08CLRS0181B	64.61208	147.73579	Clear Creek	9/2/08	MT	*C. cognatus*
08CLRS0181B	64.61208	147.73579	Clear Creek	9/2/08	O	*O. tshawytscha*
-	64.63260	147.75829	Clear Creek	9/2/08	O	*O. tshawytscha*
-	64.63374	147.75676	Clear Creek	9/2/08	O	*O. tshawytscha*
08CLRS0191A	64.70326	147.80325	Clear Creek	9/4/08	A	no fish
08CLRS0191A	64.70326	147.80325	Clear Creek	9/4/08	MT	no fish
-	64.69410	147.79407	Clear Creek	9/4/08	S	*P. cylindraceum*
-	64.70166	147.80109	Clear Creek	9/4/08	S	*T. arcticus*
-	64.70344	147.80368	Clear Creek	9/4/08	S	*T. arcticus*
-	64.70451	147.81087	Clear Creek	9/5/08	S	*T. arcticus, P. cylindraceum*
-	64.70389	147.81453	Clear Creek	9/5/08	S	*P. cylindraceum*
-	64.70334	147.81573	Clear Creek	9/5/08	S	no fish
-	64.70860	147.82758	Clear Creek	9/5/08	S	no fish
-	64.71156	147.83894	Clear Creek	9/5/08	S	*P. cylindraceum*
-	64.71806	147.84315	Clear Creek	9/6/08	S	*C. catostomus*

Table 3. Continued.

Site ID	Latitude	Longitude	Waterbody	Date	Method	Species
-	64.71991	147.86172	Clear Creek	9/6/08	S	no fish
-	64.72461	147.86682	Clear Creek	9/6/08	A	no fish
-	64.72461	147.86682	Clear Creek	9/6/08	GN	no fish
08CLRS0201A	64.58940	147.73575	Clear Creek	9/1/08	MT	*C. cognatus*, *O. tshawytscha*
09BCS0011A	64.76124	146.41089	Beaver Creek	6/2/09	A	*T. arcticus*
09BCS0011A	64.76124	146.41089	Beaver Creek	6/2/09	MT	*C. cognatus*
09BCS0011A	64.76124	146.41089	Beaver Creek	6/2/09	S	*C. cognatus*
09BCS0011B	64.76124	146.41089	Beaver Creek	7/23/09	A	no fish
09BCS0011B	64.76124	146.41089	Beaver Creek	7/23/09	EF	*C. cognatus*, *T. arcticus*
09BCS0011B	64.76124	146.41089	Beaver Creek	7/23/09	MT	*C. cognatus*
09BCS0011B	64.76124	146.41089	Beaver Creek	7/23/09	S	*T. arcticus*
09BCS0011B	64.76124	146.41089	Beaver Creek	7/23/09	VOG	*O. tshawytscha*
09BCS0011C	64.76200	146.40411	Beaver Creek	9/9/09	MT	*C. cognatus*, *O. tshawytscha*
09BCS0011C	64.76200	146.40411	Beaver Creek	9/9/09	S	*C. cognatus*
09BCS0021A	64.76020	146.44495	Beaver Creek	6/3/09	A	*T. arcticus*
09BCS0021A	64.76020	146.44495	Beaver Creek	6/3/09	MT	*C. cognatus*
09BCS0021B	64.76020	146.44495	Beaver Creek	7/24/09	MT	*C. cognatus*
09BCS0021B	64.76020	146.44495	Beaver Creek	7/24/09	S	*T. arcticus*
09BCS0021B	64.76020	146.44495	Beaver Creek	7/24/09	VOG	*O. tshawytscha*
09BCS0021C	64.76020	146.44495	Beaver Creek	9/9/09	MT	*C. cognatus*, *O. tshawytscha*
09BCS0031A	64.76067	146.45435	Beaver Creek	6/4/09	S	*C. cognatus*
09WRS0011A	64.46204	148.22171	Wood River	6/15/09	S	*C. cognatus*, *C. plumbeus, T. arcticus*
-	64.48749	148.25957	Wood River	6/16/09	S	*C. plumbeus*
-	64.48749	148.25957	Wood River	6/16/09	S	*E. lucius*
09WRS0011B	64.45048	148.21512	Wood River	9/20/09	S	*C. cognatus*, *C. plumbeus*
09WRS0021A	64.50594	148.32695	Wood River	6/16/09	MT	*C. plumbeus*
09WRS0021A	64.50594	148.32695	Wood River	6/16/09	S	*C. cognatus*, *C. plumbeus*
09WRS0031A	64.56366	148.43967	Wood River	6/17/09	MT	*C. plumbeus*
09WRS0031A	64.56366	148.43967	Wood River	6/17/09	S	*C. plumbeus*
09WRS0041B	64.61198	148.53941	Wood River	9/23/09	MT	*C. plumbeus*
09WRS0051B	64.58870	148.66232	Wood River	8/12/09	MT	*C. plumbeus*
09WRS0061A	64.34595	148.05576	Wood River	9/19/09	MT	*C. cognatus*, *T. arcticus, C. plumbeus*
09WRS0061A	64.34595	148.05576	Wood River	9/19/09	S	*C. cognatus*, *T. arcticus, C. plumbeus*

Table 3. Continued.

Site ID	Latitude	Longitude	Waterbody	Date	Method	Species
09WRS0071A	64.41689	148.19240	Wood River	9/19/09	MT	*C. plumbeus*
09WRS0071A	64.41689	148.19240	Wood River	9/19/09	S	*C. plumbeus*
09WRS0081A	64.49314	148.27097	Wood River	9/21/09	MT	*C. cognatus*, *C. plumbeus, C. catostomus*
09WRS0081A	64.49314	148.27097	Wood River	9/21/09	S	*C. plumbeus*
09WRS0091A	64.59535	148.47580	Wood River	9/21/09	MT	*C. plumbeus*
09WRS0091A	64.59535	148.47580	Wood River	9/21/09	S	*T. arcticus*
09GCS0011A	64.36537	145.56282	Gilles Creek	6/23/09	EF	*C. cognatus*
09GCS0011A	64.36537	145.56282	Gilles Creek	6/23/09	MT	*C. cognatus*
09GCS0011B	64.36537	145.56282	Gilles Creek	8/24/09	EF	*C. cognatus, T. arcticus*
09GCS0011B	64.36537	145.56282	Gilles Creek	8/24/09	MT	*C. cognatus, T. arcticus*
09GCS0011C	64.36537	145.56282	Gilles Creek	9/29/09	MT	*C. cognatus*
09GCS0021A	64.37721	145.57378	Gilles Creek	6/24/09	EF	*C. cognatus*
09GCS0021A	64.37721	145.57378	Gilles Creek	6/24/09	MT	*C. cognatus*
09GCS0021B	64.37721	145.57378	Gilles Creek	8/25/09	MT	*C. cognatus*
09GCS0021B	64.37721	145.57378	Gilles Creek	8/25/09	S	*C. cognatus, T. arcticus*
09GCS0021C	64.37721	145.57378	Gilles Creek	9/30/09	MT	no fish
09GCS0031A	64.38013	145.58049	Gilles Creek	6/25/09	A	*T. arcticus*
09GCS0031A	64.38013	145.58049	Gilles Creek	6/25/09	EF	*C. cognatus*
09GCS0031A	64.38013	145.58049	Gilles Creek	6/25/09	MT	*C. cognatus*
09GCS0041A	64.35305	145.54457	Gilles Creek	8/26/09	MT	no fish
09GCS0041A	64.35305	145.54457	Gilles Creek	8/26/09	S	*C. cognatus*
09GCS0041B	64.35305	145.54457	Gilles Creek	10/1/09	MT	*C. cognatus*
09SFCS0011A	64.71294	146.21596	South Fork Chena River Tributary	5/21/09	EF	*C. cognatus*
09SFCS0011A	64.71294	146.21596	South Fork Chena River Tributary	5/21/09	MT	*C. cognatus*
09SFCS0011B	64.71294	146.21596	South Fork Chena River Tributary	7/9/09	EF	*C. cognatus*
09SFCS0011B	64.71294	146.21596	South Fork Chena River Tributary	7/9/09	MT	*C. cognatus*
09SFCS0011B	64.71294	146.21596	South Fork Chena River Tributary	7/9/09	VOG	*T. arcticus*
09SFCS0021A	64.70645	146.25200	South Fork Chena River Tributary	5/22/09	MT	*C. cognatus*
-	-	-	South Fork Chena River Tributary	5/23/09	S	no fish
09SFCS0031A	64.70350	146.25934	South Fork Chena River Tributary	5/23/09	MT	*C. cognatus*
09SFCS0041A	64.69447	146.27788	South Fork Chena River Tributary	7/10/09	A	*T. arcticus*
09SFCS0041A	64.69447	146.27788	South Fork Chena River Tributary	7/10/09	EF	*C. cognatus*
09SFCS0041A	64.69447	146.27788	South Fork Chena River Tributary	7/10/09	MT	*C. cognatus*

Table 3. Continued.

Site ID	**Latitude**	**Longitude**	**Waterbody**	**Date**	**Method**	**Species**
09SFCS0041B	64.69447	146.27788	South Fork Chena River Tributary	9/4/09	EF	*C. cognatus*
09SFCS0041B	64.69447	146.27788	South Fork Chena River Tributary	9/4/09	MT	*C. cognatus*
09SFCS0051A	64.68818	146.31650	South Fork Chena River Tributary	7/11/09	MT	*C. cognatus*
09SFCS0051A	64.68818	146.31650	South Fork Chena River Tributary	7/11/09	S	no fish
09SFCS0051B	64.68818	146.31650	South Fork Chena River Tributary	9/5/09	EF	*C. cognatus*
09SFCS0051B	64.68818	146.31650	South Fork Chena River Tributary	9/5/09	MT	*C. cognatus*
09SFCS0051B	64.68818	146.31650	South Fork Chena River Tributary	9/5/09	S	no fish
09SFCS0061A	64.69072	146.36382	South Fork Chena River Tributary	7/12/09	MT	*C. cognatus*
09SFCS0061A	64.69072	146.36382	South Fork Chena River Tributary	7/12/09	S	*C. cognatus, T. arcticus*
09SFCS0061B	64.69073	146.36397	South Fork Chena River Tributary	9/6/09	EF	*C. cognatus*
09SFCS0061B	64.69073	146.36397	South Fork Chena River Tributary	9/6/09	MT	*C. cognatus*
09SFMS0011A	64.76903	146.47002	South Fork Chena River Mainstem	6/5/09	A	*T. arcticus*
09SFMS0011A	64.75958	146.46918	South Fork Chena River Mainstem	6/5/09	MT	*C. cognatus, O. tshawytscha*
09SFMS0011A	64.75958	146.46918	South Fork Chena River Mainstem	6/5/09	S	*C. cognatus*
09SFMS0011B	64.75839	146.47159	South Fork Chena River Mainstem	7/25/09	MT	*C. cognatus, O. tshawytscha*
09SFMS0011C	64.75956	146.46912	South Fork Chena River Mainstem	9/10/09	MT	*C. cognatus, O. tshawytscha, L. lota*
09SFMS0021B	64.76052	146.46680	South Fork Chena River Mainstem	7/25/09	CN	*T. arcticus, P. cylindraceum*
09SFMS0021B	64.76052	146.46680	South Fork Chena River Mainstem	7/25/09	VOG	*O. tshawytscha*
09SFMS0021B	64.76052	146.46680	South Fork Chena River Mainstem	7/25/09	S	*T. arcticus*
09SFMS0021B	64.76052	146.46680	South Fork Chena River Mainstem	7/25/09	VOG	*O. tshawytscha*
09SFMS0031A	64.77782	146.49060	South Fork Chena River Mainstem	6/5/09	MT	*L. lota*

Table 4. Methods of capture for species recorded in Anadromous Waters Catalog surveys of Upper Yukon River tributaries, Alaska, by USFWS biologists, 2008–2009.

	Angling	Cast Net	Dip Net	Electrofishing	Fyke Net	Gill Net	Minnow Trap	Olfactory	Seine	Visual Observation
arctic grayling	X	X	X	X			X		X	X
arctic lamprey				X						
burbot							X	X		
Chinook salmon							X	X	X	X
coho salmon							X			
humpback whitefish						X			X	
lake chub				X			X		X	
longnose sucker			X	X		X	X		X	
northern pike	X					X			X	X
round whitefish		X							X	
slimy sculpin				X			X		X	
unknown whitefish			X							

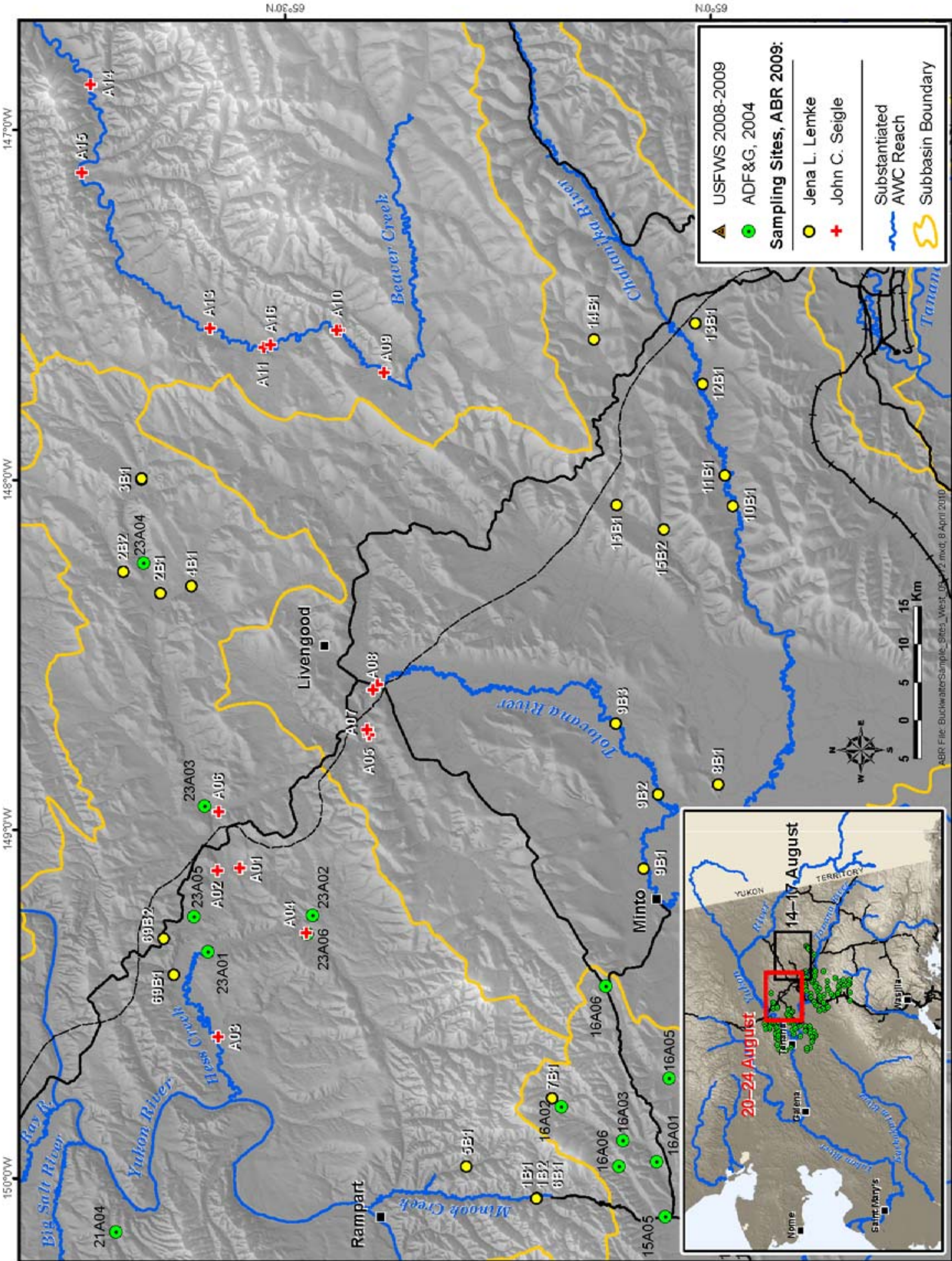

Figure 5. Locations of fish surveys by ADF&G, ABR, and USFWS biologists between 2004 and 2009 in Upper Yukon River drainages.

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Alaska Department of Fish and Game (ADF&G). 2010. Anadromous Waters Catalog. Available online at: http://www.sf.adfg.state.ak.us/SARR/awc/ (May 2010).

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Hander. R. 2009. U.S. Fish and Wildlife Service, Unpublished Data

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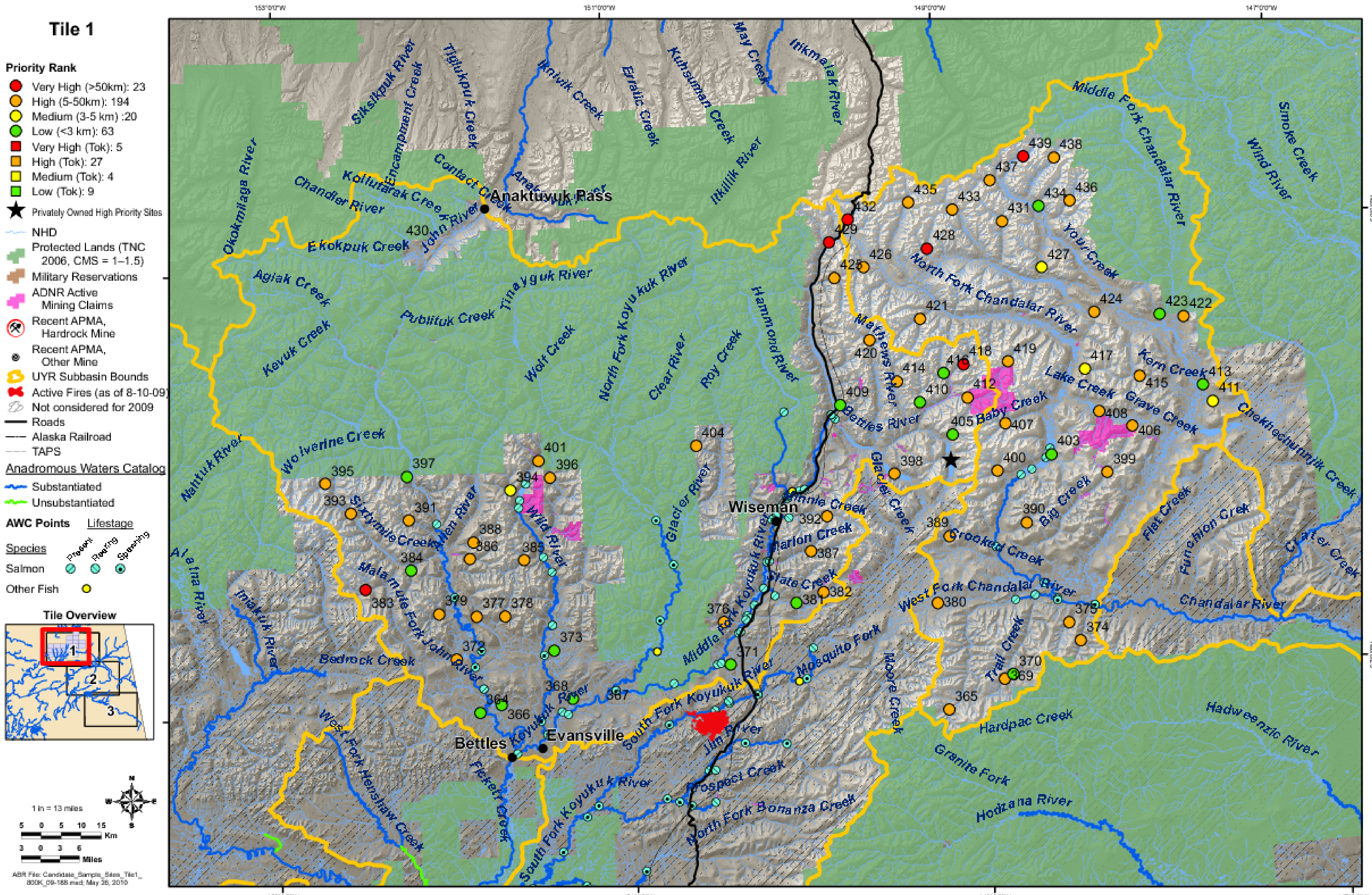
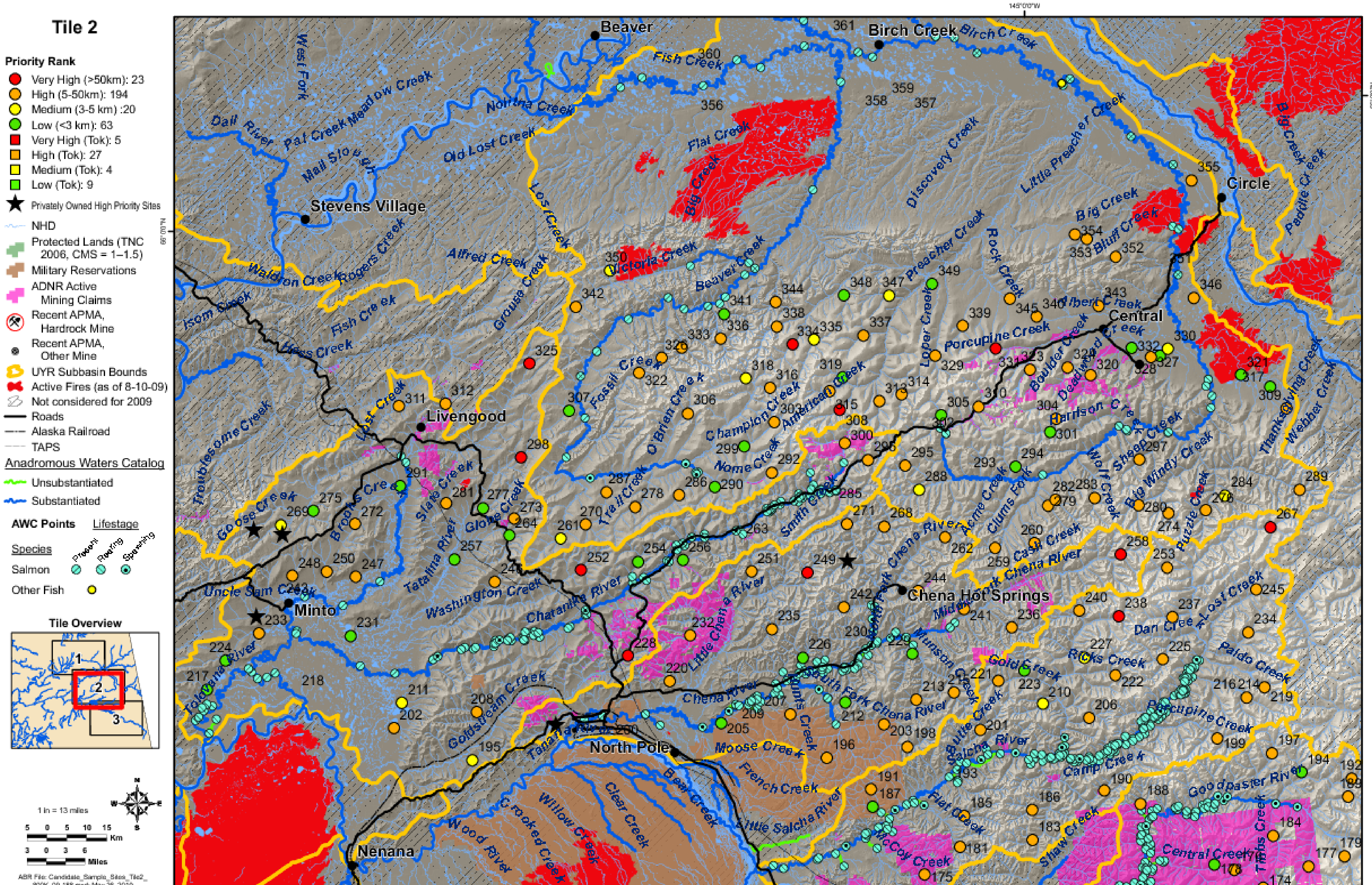
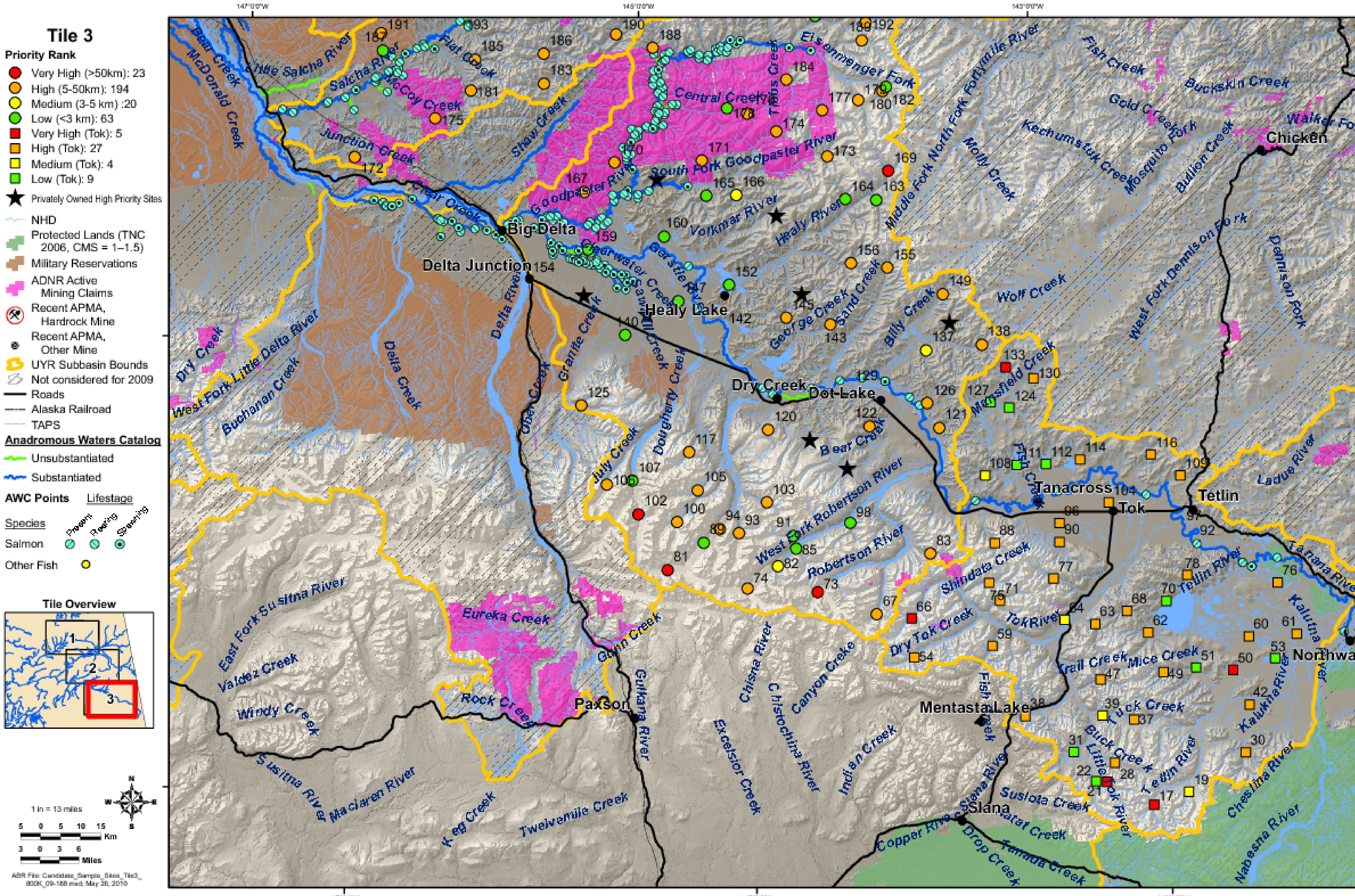
Appendix 1. Potential sampling points (pour points) in Upper Yukon River drainage sub-basins derived from a spatially explicit gap analysis of Anadromous Waters Catalog coverage, human activities, and land ownership (see Methods). Please note that colored squares in the tiles refer specifically to the Tok sub-basin in Tile 3 which was given a slightly lesser priority when performing the pour-point analysis.


Tile 1
Priority Rank
Very High (>50km): 23
High (5-50km): 194
Medium (3-5 km) :20
Low (<3 km): 63
Very High (Tok): 5
High (Tok): 27
Medium (Tok): 4
Low (Tok): 9
Privately Owned High Priority Sites
NHD
Protected Lands (TNC 2006, CMS = 1–1.5)
Military Reservations
ADNR Active Mining Claims
Recent APMA, Hardrock Mine
Recent APMA, Other Mine
UYR Subbasin Bounds
Active Fires (as of 8-10-09)
Not considered for 2009
Roads
Alaska Railroad
TAPS
Anadromous Waters Catalog
Substantiated
Unsubstantiated
AWC Points
Lifestage
Species
Present
Rearing
Spawning
Salmon
Other Fish
Tile Overview
1 in = 13 miles
Km
Miles
Anaktuvuk Pass
Wiseman
Bettles
Evansville
Middle Fork Chandalar River
North Fork Chandalar River
West Fork Chandalar River
Chandalar River
Middle Fork Koyukuk River
South Fork Koyukuk River
North Fork Koyukuk River
John River
Wild River
Alatna River
Hodzana River
Hadweenzic River
Wind River
Smoke Creek


Tile 2
Priority Rank
Very High (>50km): 23
High (5-50km): 194
Medium (3-5 km) :20
Low (<3 km): 63
Very High (Tok): 5
High (Tok): 27
Medium (Tok): 4
Low (Tok): 9
Privately Owned High Priority Sites
NHD
Protected Lands (TNC 2006, CMS = 1–1.5)
Military Reservations
ADNR Active Mining Claims
Recent APMA, Hardrock Mine
Recent APMA, Other Mine
UYR Subbasin Bounds
Active Fires (as of 8-10-09)
Not considered for 2009
Roads
Alaska Railroad
TAPS
Anadromous Waters Catalog
Unsubstantiated
Substantiated
AWC Points
Lifestage
Species
Presence
Rearing
Spawning
Salmon
Other Fish
Tile Overview
1
2
3
1 in = 13 miles
Km
Miles
Beaver
Birch Creek
Stevens Village
Circle
Central
Livengood
Minto
Chena Hot Springs
North Pole
Nenana
Chatanika River
Chena River
Tanana River
Goodpaster River
Salcha River
Little Salcha River
Wood River
Crooked Creek
Willow Creek
Clear Creek
Dall River
West Fork
Tolovana River
Porcupine Creek
Preacher Creek
Birch Creek
Goose Creek
Washington Creek
Goldstream Creek
Moose Creek
French Creek
Central Creek
Shaw Creek
Caribou Creek
Flat Creek
McCoy Creek
Camp Creek
Big Creek
Fish Creek


Tile 3
Priority Rank
Very High (>50km): 23
High (5-50km): 194
Medium (3-5 km) :20
Low (<3 km): 63
Very High (Tok): 5
High (Tok): 27
Medium (Tok): 4
Low (Tok): 9
Privately Owned High Priority Sites
NHD
Protected Lands (TNC 2006, CMS = 1–1.5)
Military Reservations
ADNR Active Mining Claims
Recent APMA, Hardrock Mine
Recent APMA, Other Mine
UYR Subbasin Bounds
Not considered for 2009
Roads
Alaska Railroad
TAPS
Anadromous Waters Catalog
Unsubstantiated
Substantiated
AWC Points
Lifestage
Species
Salmon
Other Fish
Tile Overview
1 in = 13 miles
Km
Miles
Big Delta
Delta Junction
Healy Lake
Dry Creek
Dot Lake
Tanacross
Tok
Tetlin
Chicken
Northway
Mentasta Lake
Slana
Paxson
Goodpaster River
South Fork Goodpaster River
Central Creek
Volkmar River
Healy River
Delta River
Robertson River
West Fork Robertson River
Tok River
Tetlin River
Little Tok River
Tanana River
Ladue River
Kalutna River
Chestna River
Nabesna River
Copper River
Gulkana River
East Fork Susitna River
Susitna River
Maclaren River
Eureka Creek
Gunn Creek
Rock Creek
Twelvemile Creek
Excelsior Creek
Chistochina River
Chisna River
Canyon Creek
Indian Creek
Mosquito Fork
Middle Fork North Fork Fortymile River
Dennison Fork
West Fork Dennison Fork
Wolf Creek
Billy Creek
George Creek
Sand Creek
Bear Creek
Mansfield Creek
Fish Creek
Kechumstuk Creek
Molly Creek
Gold Creek
Buckskin Creek
Walker Fork
Bullion Creek
Eisenmenger Fork
Tibbs Creek
Shaw Creek
Salcha River
Little Salcha River
McCoy Creek
Flat Creek
Junction Creek
Clear Creek
Clearwater Creek
Gerstle River
Sawmill Creek
Dougherty Creek
Granite Creek
Jarvis Creek
July Creek
Delta Creek
Buchanan Creek
West Fork Little Delta River
Dry Creek
Bear Creek
McDonald Creek
Valdez Creek
Windy Creek
Keg Creek
Dry Tok Creek
Trail Creek
Mice Creek
Buck Creek
Suslota Creek
Drop Creek
Tanada Creek
Shindata Creek
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