Seasonal Distribution of Rainbow Trout Relative to Sport and Subsistence Fisheries in the Aniak River

Annual Report for Study 08-300

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ABSTRACT

A two-year radiotelemetry study of Aniak River rainbow trout was initiated in 2008 to collect information on seasonal movements and distribution in order to determine whether discrete geographic stocks exist within the drainage. From 5 to 12 August 2008, radio tags were surgically implanted into 125 rainbow trout ≥420 mm FL in four different areas within 134 river kilometers (rkm) of the Aniak River drainage. A total of 16 aerial tracking surveys have been flown to date, two of which were incomplete due to inclement weather. Preliminary results of the surveys indicate that 1) none of the tagged rainbow trout overwintered near the Doestock River, the primary location of the winter subsistence fishery; 2) none of the tagged rainbow trout overwintered in the Salmon River; 3) spawning in the Salmon River appeared to be limited to the lower two miles; 4) overwintering and spawning areas were intermittent in the Kipchuk River and in the Upper Aniak River; 5) within the confines of our tagging study area, overwintering and spawning areas were widespread in the Aniak River mainstem; 6) no tagged rainbow trout made extensive spawning migrations from overwintering areas; 7) spawning appeared to take place from late May-early June; and, 8) most rainbow trout appear to have exhibited summer and overwintering site fidelity between years. Four more aerial tracking surveys are scheduled for spring 2010.

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INTRODUCTION

This project is a joint venture between the Alaska Department of Fish and Game (ADF&G)-Sport Fish Division and the Kuskokwim Native Association. The U.S. Fish and Wildlife Service, Office of Subsistence Management provided partial funding. This report is an annual report covering the period May 1, 2009–April 30, 2010. Since the implantation of radio tags took place in 2008 and were previously reported in Schwanke and Thalhauser (2009), discussion of the implantation procedures are limited in this report. Two aerial tracking surveys took place in 2008, another 12 took place in 2009, and two additional aerial tracking flights took place in 2010. For continuity, the preliminary results for all the surveys will be presented in this report. A State of Alaska Fishery Data Series Report will be published in 2011 detailing all project procedures and findings.

The number of people sport fishing in the Aniak River peaked in the mid-1990s and has since appeared to stabilize (Figure 1). The proportion of sport fishing effort directed at rainbow trout *Oncorhynchus mykiss* is unknown, but has likely trended with total effort. Annual sport fishing harvests of rainbow trout have remained low, averaging 74 fish from 1989 to 2000, and zero fish since 2000. Total catch peaked in 1997, and has averaged about 5,600 rainbow trout annually the last five years (Figure 1). Since 1985, sport fishing regulations for rainbow trout have become increasingly restrictive, prompted largely by local concerns about the health of the population. Prior to 1985, up to 15 rainbow trout could be harvested as part of a combined resident species bag limit. The combined bag limit was reduced to 2 fish in 1985. In 1990, the drainage upstream of Doestock Creek was restricted to catch-and-release for rainbow trout (single hook and no bait), and in 2001 the entire Aniak River was similarly restricted to catch-and-release sport fishing for rainbow trout.

The rainbow trout population in the Aniak River also contributes significantly to the local subsistence harvest of freshwater fish. Recently, there has been a strong local concern about an apparent large decline in the population and size of rainbow trout in the Aniak River since the mid-1980s. This decline was noted in interviews with subsistence users who reported being able to easily jig 30 or more rainbow trout through the ice per day (one report of 100 fish) from overwintering locations downstream of the Buckstock River during the 1960s and 1970s (Krauthoefer et al. 2006). Because of the declines and low catch rates (e.g., 5 fish per day) many subsistence users from Aniak and Chuathbaluk are no longer targeting rainbow trout as they did previously. The cause for this apparent decline is unclear, but it has been linked by subsistence users to the rise in the popularity of sport fishing in the region, and the overfishing and habitat problems associated with a large increase of people using the Aniak River and its tributaries (Krauthoefer et al. 2006).

A large majority of the subsistence harvest of rainbow trout in the Aniak River is caught using rod-and-reel during winter and spring through the ice downstream of the Buckstock River, with limited fishing occurring as far up as the mouth of the Salmon River. The retention of rainbow trout by rod-and-reel subsistence users is prohibited only from June 1 to August 31 upstream of the Doestock Creek, and rainbow trout caught incidentally in other gears (e.g., gill nets) may be retained throughout the drainage and throughout the year. A complete and complex history of federal and state subsistence regulations are described by Krauthoefer et al (2006). Two household census surveys were done to estimate subsistence harvest of rainbow trout. In 2001, a total of 331 rainbow trout were taken and in 2002, a reported 165 trout were taken from the Aniak River.

To evaluate these concerns and the long-term sustainability of rainbow trout in the Aniak River, information on both population size and life history is needed. The life history information is required to determine if unique sub-populations or stocks exist within the drainage that are affected differently based on harvest patterns or environmental factors. Telemetric studies have demonstrated that rainbow trout within a drainage can be composed of multiple spawning stocks, can exhibit extreme or little fidelity to spawning, feeding, and overwintering areas, and can exhibit either very small (e.g., < 3 km) or large (> 75 km) intra-annual movements to these areas (Adams 1996 and 1999; Fleming 2004; Lisac 1996; Meka et al. 2000; Schwanke and Hubert 2000).

The ongoing goal of this study is to collect information on the seasonal movements and distribution of rainbow trout in the Aniak River to determine if discrete stocks exist within the drainage. In the absence of abundance–based information, quantifying rainbow trout movements will help to identify the distribution(s) of those fish affected by inriver fisheries.

OBJECTIVES

1) Describe the seasonal (summer 2008 to winter 2009/2010) distributions of mature sized rainbow trout ≥ 420 mm fork length (FL) in the Aniak River implanted with radio transmitters during the summer feeding period when rainbow trout distributions are most widespread; and,

2) For each of the four hydrologic units --- Salmon River, Kipchuk River, the Upper Aniak River, and mainstem Aniak River from the Kipchuk River downstream to a point approximately 6 rkm below the Buckstock River --- estimate the proportion of radio-tagged rainbow trout that remained in the hydrologic unit where they were tagged. These estimates will be made for each aerial tracking survey and each estimated proportion will be within 25 percentage points of the true value 95% of the time.

Relative to Objective 1, quantitative descriptions of rainbow trout locations during biologically meaningful periods will be used to describe significant habitats (i.e., spawning and overwintering) by identifying aggregates of rainbow trout (e.g., 3 or more fish within a 1-km reach of the river). Mature-sized fish were selected because these fish will help to identify spawning habitats and because larger-sized fish are better able to bear a radio tag. Because very limited annual movements of rainbow trout have been observed in neighboring systems, Objective 2 was constructed as a means to identify potential discrete stocks and to grossly assess these stocks in terms of their contribution to both the sport and subsistence fisheries.

STUDY AREA

The Aniak River is located approximately 300 river kilometers (rkm) upstream from the mouth of the Kuskokwim River and approximately 200 rkm upstream from the city of Bethel. In the upper third of the Aniak drainage, the Salmon and Kipchuk rivers are two major tributaries that join the upper portion of the Aniak River (hereafter referred to as the Upper Aniak River; Figure 2). These three drainages flow northward from the Kilbuck Mountains and converge to form the mainstem Aniak River. The Yukon Delta National Wildlife Refuge includes the lower 70 rkm of the Aniak River upstream from its confluence with the Kuskokwim River.

The Aniak River is the natal stream for five species of anadromous Pacific salmon: Chinook *Oncorhynchus tshawytscha*, chum *O. keta*, sockeye *O. nerka*, pink *O. gorbuscha*, and coho *O. kisutch*. In addition to rainbow trout, resident fish species inhabiting the Aniak River include: Dolly Varden *Salvelinus malma*, northern pike *Esox lucius*, Arctic grayling *Thymallus arcticus*, burbot *Lota lota*, sheefish *Stenodus leucichthys*, lake trout *Salvelinus namaycush*, humpback whitefish *Coregonus pidschian*, round whitefish *Prosopium cylindraceum*, longnose sucker *Catostomus catostomus*, blackfish *Dallia pectoralis*, and slimy sculpin *Cottus cognatus.*

METHODS

RADIOTAGGING

Radio tags (125) were deployed throughout what is believed to be most (i.e., >90%) of rainbow trout summer range in the Aniak River drainage from 5 to 12 August 2008 (Schwanke and Thalhauser 2009). The radio-tagged fish will continue to be monitored over an approximately 24-month period from tagging and will be used to describe seasonal movement patterns, locate

significant spawning and overwintering areas, and identify potentially unique stocks within the drainage that may be differentially affected by fishing mortality. Radio tag specifications and design were reported in Schwanke and Thalhauser (2009).

TELEMETRIC PROCEDURES

Tracking flights have been conducted using a fixed wing aircraft and a Lotek SRX 600 receiver with an internal global positioning system (GPS) that records time and location data. Flights will span a 24-month period and be used to determine summer feeding, winter refuge migration timing, winter refuge locations, pre-spawning migration, and spawning locations (Table 1). Summer locations and fidelity to summer locations during 2008 (tagging locations) in 2009 (summertime tracking locations) will be described by noting fish locations on a map. Winter refuge locations were determined during flights conducted in March 2009 and March 2010. At that time there was sufficient daylight to allow the pilot to travel safely to and from the tracking areas. Multiple tracking flights were conducted from early May through early June 2009 and will be conducted again in 2010 to locate all fish during the spawning period (Tables 1 and 2). The spring flights will provide information about migration timing, spawning timing and spawning locations, and will also allow detection of overwinter mortalities (a fish that failed to move from winter refuge locations).

TELEMETRIC DATA COLLECTION AND REDUCTION

During all surveys, the receiver (Lotek SRX 600) automatically records date, time, and location (GPS decimal-degree, Datum WGS 84) of radio-tagged fish. Approximate locations will also be manually transcribed on a printed map. All data related to radiotelemetry will be integrated into one master Excel spreadsheet designed to be compatible with ArcGIS®. All available information for each radio-tagged fish will be recorded in a single row in a worksheet. Three columns will be entered for each tracking flight. The first column will record a fish's fate under the following nomenclature: (A)-alive, (I)-inactive and (AL)-at large (not found). The second column will contain GPS coordinates for all found fish, regardless of whether a tag is displaying an inactive code. A final fate of (M)-mortality will be added after a fish has remained inactive and at the same GPS location for three consecutive surveys. The third column will contain a code for the hydrologic unit a fish was located in. This worksheet will be archived upon completion of the final report in the ADF&G-Sport Fish Division's Intranet Docushare website. The file name and directory location will be presented in the final report.

DATA ANALYSIS

The bulk of the data analyses will not be completed until all of the tracking surveys are done. The reason for this is because ultimate fates of fish cannot be assigned immediately after surveys. It takes subsequent surveys to validate that fish are indeed dead (or alive). For example, in wintertime, many tags that are in live fish emit an inactive signal due to the dormant state of the live fish. During subsequent surveys, these tagged fish move and emit active signals meaning they are likely alive. Also, it takes a series of surveys to actually determine if a fish is truly out of

the study area or if it was just missed during survey flights. It would be redundant to do the full-scale analyses several times throughout this study. For this reason, we are waiting for the conclusion of all surveys before the fish-by-fish analyses are performed.

Objective 1

Detected transmitters emitting active signals, or deemed to be alive by subsequent surveys, will be assigned to a hydrologic unit for each survey. Because the GPS locations obtained in the field will be taken from a moving aircraft, with the antennas aimed forward, the actual GPS coordinates may not be within the stream course or directly over the fish. The point on the stream nearest the observed GPS coordinates will be defined as the fish's location in that stream. This will be calculated with ArcGIS® software. If more than one location is recorded, the final location will be assigned to the recording with the highest signal strength. The precision of aerial radiotracking is variable, but experienced researchers think that an accuracy radius of 0.5-1 km is realistic (Doug Palmer, USFWS, Kenai; Bruce King, ADF&G, Soldotna; personal communication). For Objectives 1 and 2 this precision will be adequate.

Descriptions of seasonal distributions of fish will be presented and summarized by plotting coordinates of all located fish deemed to be alive at the time of the survey onto a digitized map of the drainage using the program ArcGIS® and the Animal Movement Analyst extension (written by Phillip Hooge in 1997). Variables to be measured include:

1. Net distance traveled between tracking events,
2. Direction traveled between tracking events,
3. Number of radio-tagged fish within 0.5, 1.0, and 2.0 kilometers.

Patterns in transmitter locations will be used to infer fish behavior and habitat use and aggregations of fish will be used to characterize significant spawning and overwintering habitats. For example, an aggregation of three or more fish within a 2-km radius during late May would signify a likely spawning aggregation.

Objective 2

When estimating the proportion of fish remaining within a hydrological unit during each period between flights, all fish tagged in that unit need to be accounted for and only those fish deemed to be alive at the time of the survey will be included in the analysis. Each respective proportion and variance will be calculated using (Cochran 1977):

$$\hat{p}_{ij} = \frac{x_{ij}}{n_{ij}} \tag{1}$$

$$\hat{V}(\hat{p}_{ij}) = \frac{\hat{p}_{ij}(1-\hat{p}_{ij})}{n_{ij}-1} \tag{2}$$

where:

$\hat{p}_{ij}$ = the proportion of rainbow trout tagged in hydrological unit *i* that were located alive in hydrological unit *i* during aerial survey *j*;

x_{ij} = the number of rainbow trout tagged in hydrological unit *i* that were located alive in hydrological unit *i* during aerial survey *j*; and,

n_{ij} = the number of rainbow trout tagged in hydrological unit *i* still considered alive at the time of aerial survey *j*.

Confidence intervals around $\hat{p}_{ij}$ will be calculated using exact binomial confidence limits described by Cochran (1977).

RESULTS AND DISCUSSION

Although the capture locations of radio-tagged fish have been previously reported (Schwanke and Thalhauser 2009), for sake of reference, locations are presented in Figure 3.

A total of 16 aerial tracking surveys have been flown, but two of these were incomplete due to inclement weather. In 2008, a complete survey took place on 25 September and an incomplete survey took place on 8 October (Figures 4 and 5). In 2009, aerial tracking surveys were flown on 14 March, 6 May, 13 May, 20 May, 28 May, 4 June, 10 June, 26 June, 30 July, 14 September, 30 October and 20 November (Figures 6–17). The survey on 4 June was incomplete due to high winds. Two surveys have been flown so far in 2010; 15 February and 20 March (Figures 18 and 19).

The presumed number of surviving fish (based on active codes emitting from the radio tags) for each survey has been slightly lower than expected. The initial survival from tagging was as expected (>80%; Schwanke and Thalhauser 2009), but mortality through the course of 18 months was higher than expected. This could possibly be related to tagging relatively large fish which might exhibit higher natural mortality due to their advanced age.

Preliminary results show that none of the radio-tagged fish overwintered near the popular winter subsistence fishing area near the confluence of the Doestock (Figures 6, 18 and 19). Also, preliminary investigations of fish movement suggest overwintering migrations were not extensive (e.g., typically <10km). This suggests sport fishers who target rainbow trout during the summer time (i.e., where the radio tags were deployed; Figure 3) are probably targeting different fish than winter subsistence fishers in the lower river near the Doestock River.

Results of the telemetry flights indicate that overwintering habitat was widespread within the confines of our tagging study area in the Aniak River mainstem and the Upper Aniak River, intermittent in the Kipchuk River and rare to non existent in the Salmon River (Figures 6, 18 and 19). Large aggregations of overwintering fish were found in the mainstem between the Salmon River and Kipchuk River confluences, and in the mainstem above Timber Creek (Figure 6).

Results indicate that most spawning took place from mid-May to early June. Preliminary analyses suggest peak spawning is probably best represented during the 28 May 2009 survey (Figure 10). Spawning habitat appears to be widespread in the Aniak River mainstem and the

Upper Aniak River, limited in the Kipchuk River, and restricted to the lower two miles of the Salmon River. It does not appear that significant movements took place from overwintering areas to spawning areas.

Although the figures do not represent individual fish movements, individual fish movements have been examined and it appears that most fish showed summertime fidelity (August 2008 tagging locations and 30 July 2009 locations) to specific river reaches (e.g., the Salmon River). Also, it appears rainbow trout exhibited overwintering site fidelity. These observations will be confirmed when the actual fish-by-fish analyses are completed, along with spawning site fidelity between 2009 and 2010. These results will be in the Final Report.

ACKNOWLEDGEMENTS

We wish to thank the USFWS, Office of Subsistence Management for providing $38,800 in funding for the second year of this project. This money was administered through the Fisheries Resource Monitoring Program under agreement number 701818J687. We would like to thank Melissa Smith who helped with some of the aerial surveys and Rob Kinkade of Aniak Air Guides who piloted the plane for all the surveys. Matthew Evenson edited and reviewed the annual progress report.

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FIGURES AND TABLES

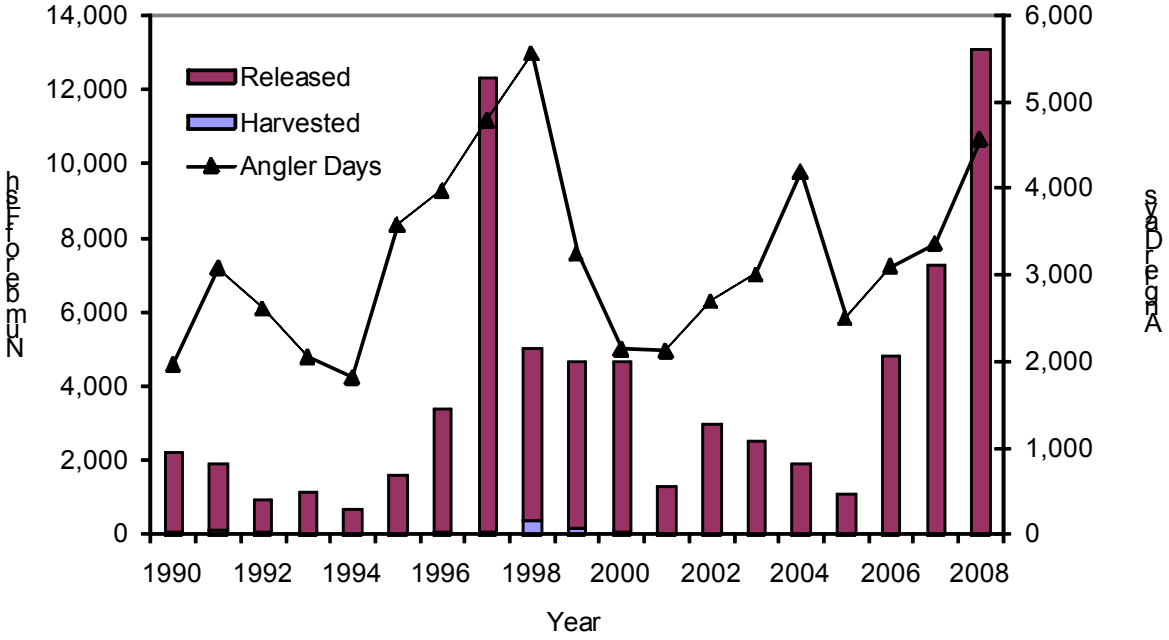

Figure 1.–Total sport fishing effort (number of angler days) along with catch and harvest of rainbow trout in the Aniak River, 1990–2006 (Mills 1991-1994; Howe et al. 1995, 1996, 2001a-d; Jennings et al. 2004, 2006a-b, 2007, 2009a-b, 2010a-b; Walker et al. 2003).

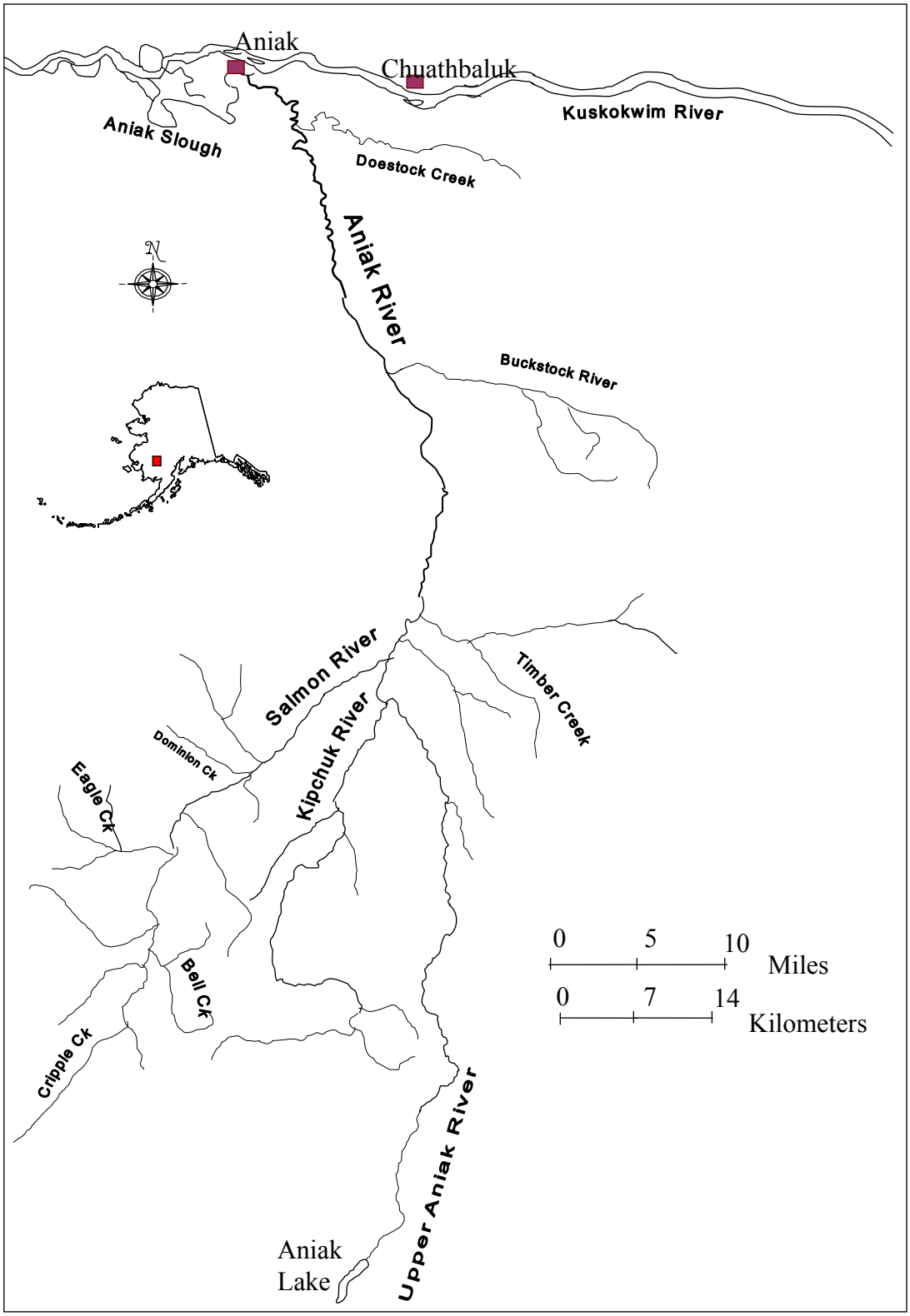

Figure 2.–Map of the Aniak River.

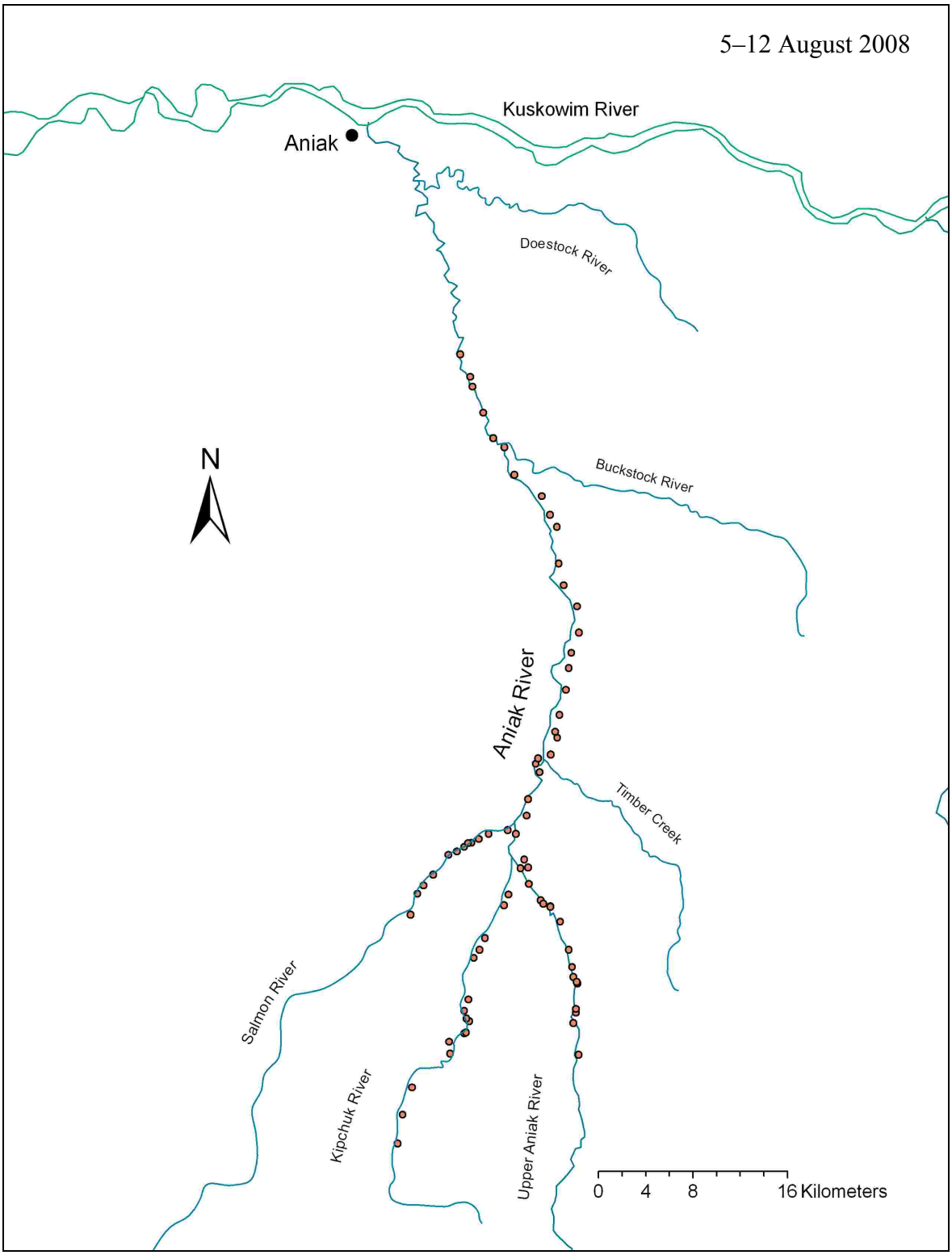

Figure 3.–Map of the Aniak River drainage and the tagging locations of 125 rainbow trout ≥420 mm FL from 5 to 12 August 2008. Each dot may represent more than one fish.

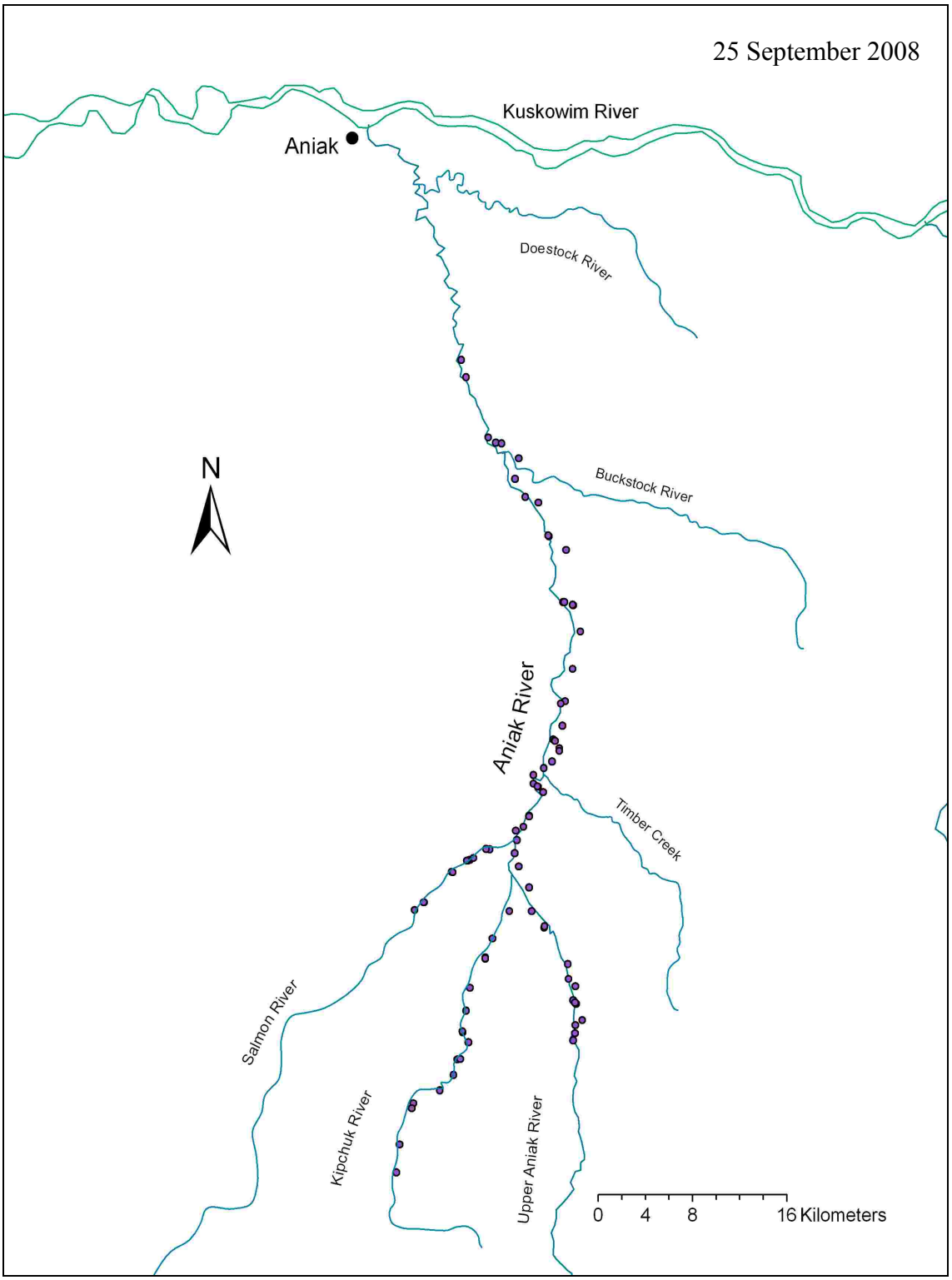

Figure 4.–Map of the Aniak River drainage and the locations of radio-tagged rainbow trout ≥420 mm FL displaying active signals on 25 September 2008. Each dot represents one fish.

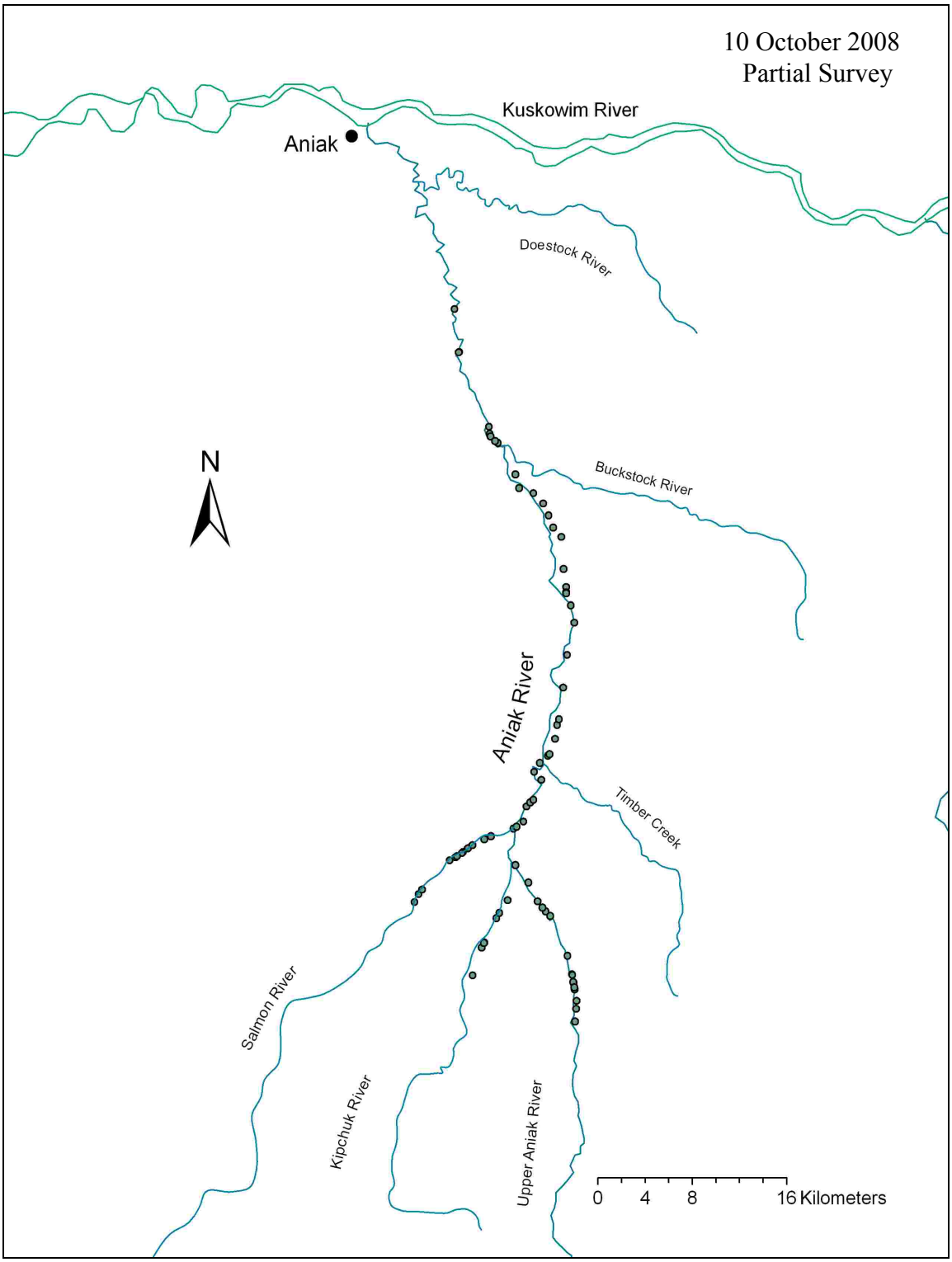

Figure 5.–Map of the Aniak River drainage and the locations of radio-tagged rainbow trout ≥420 mm FL displaying active signals on 10 October 2008. Each dot represents one fish.

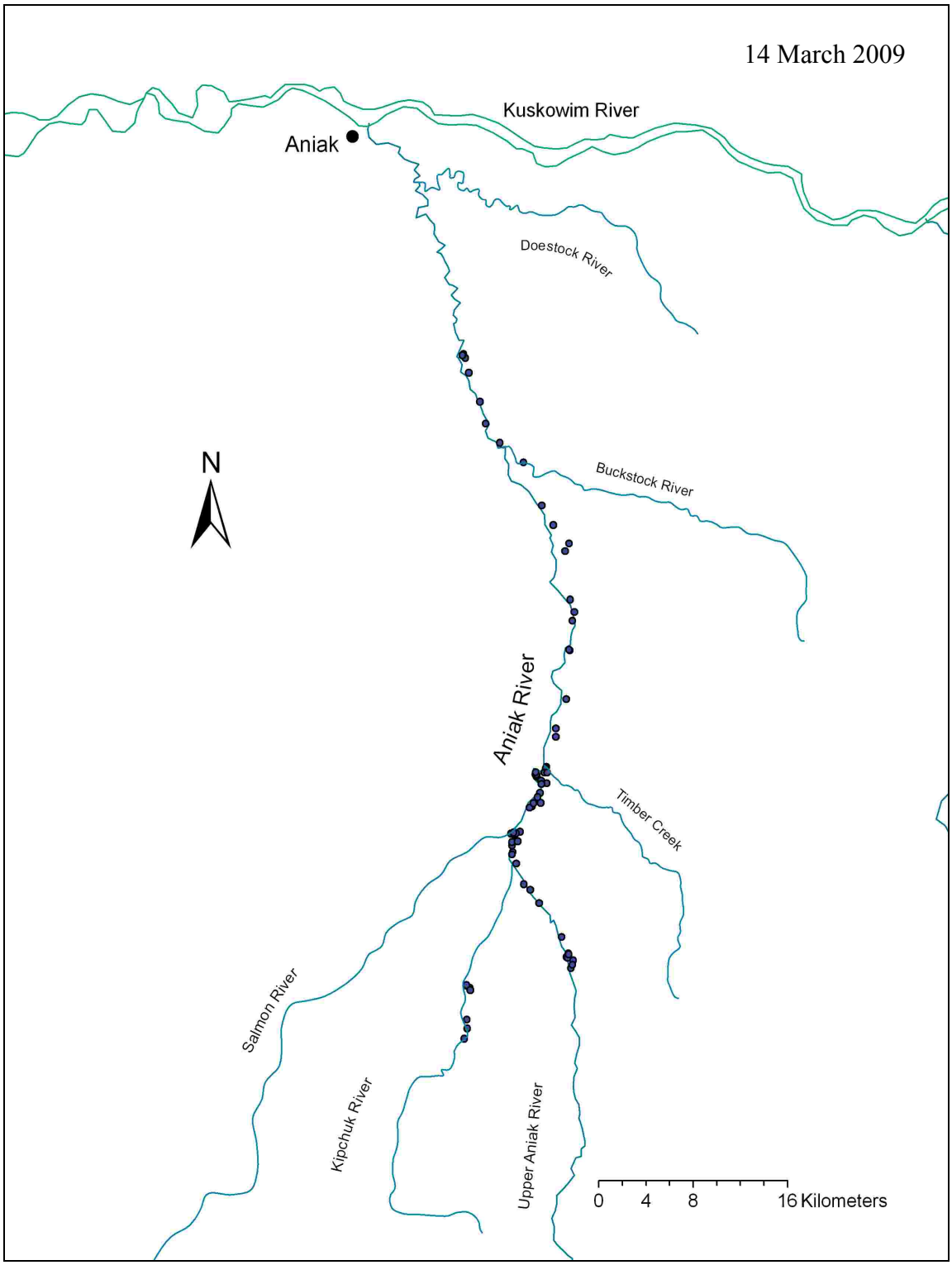

Figure 6.–Map of the Aniak River drainage and the locations of radio-tagged rainbow trout ≥420 mm FL displaying active signals on 14 March 2009. Each dot represents one fish.

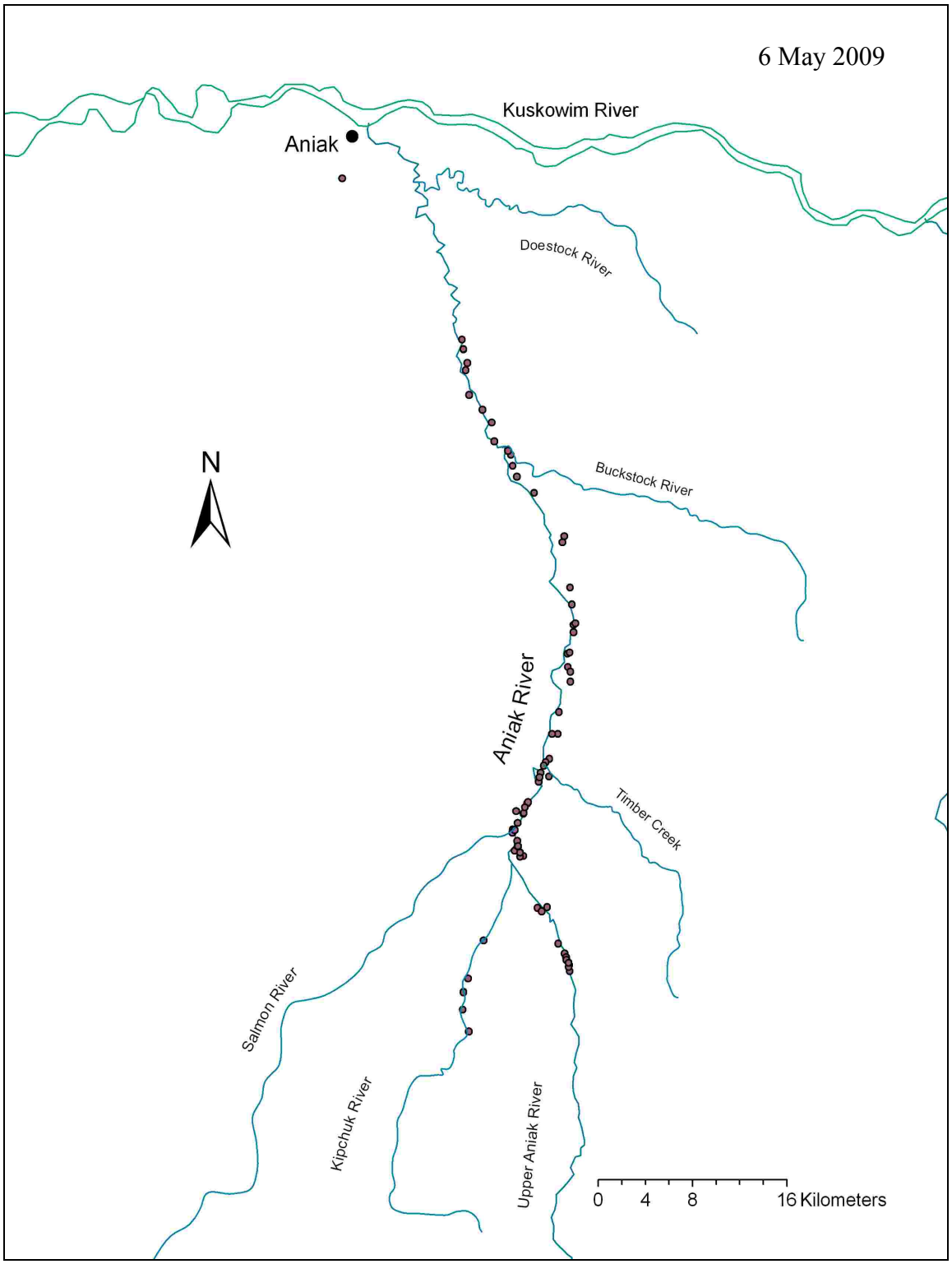

Figure 7.–Map of the Aniak River drainage and the locations of radio-tagged rainbow trout ≥420 mm FL displaying active signals on 6 May 2009. Each dot represents one fish.

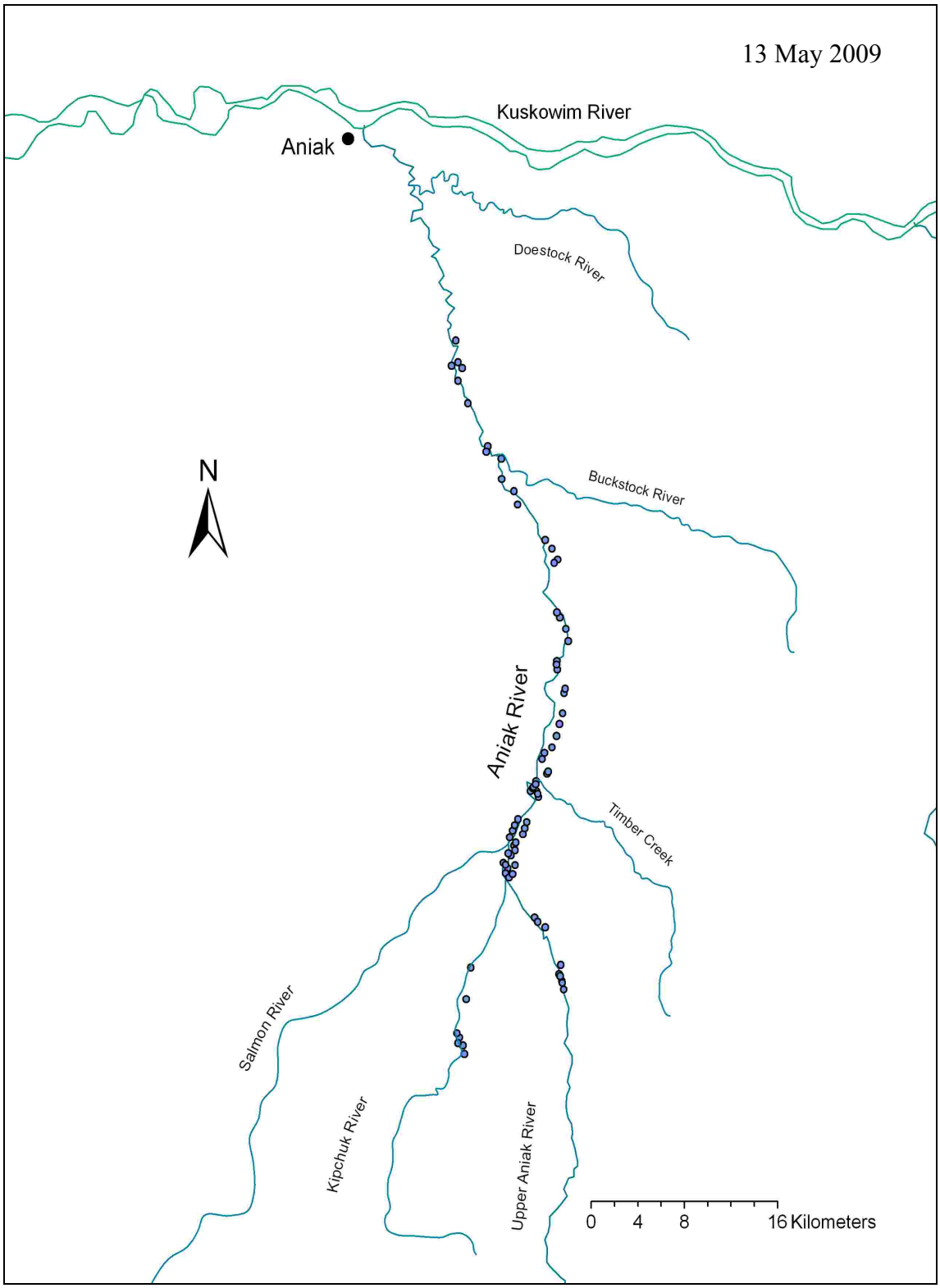

Figure 8.–Map of the Aniak River drainage and the locations of radio-tagged rainbow trout ≥420 mm FL displaying active signals on 13 May 2009. Each dot represents one fish.

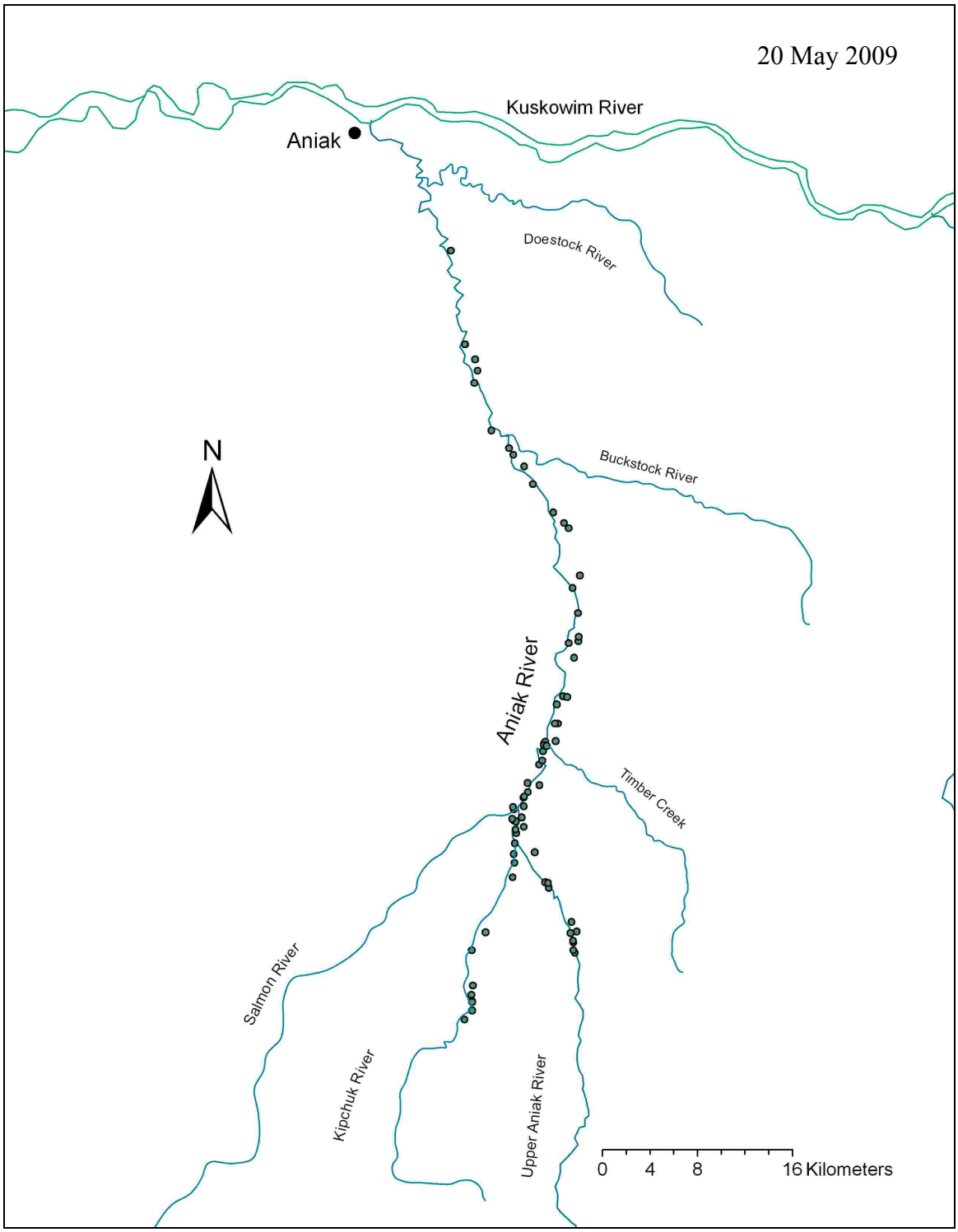

Figure 9.–Map of the Aniak River drainage and the locations of radio-tagged rainbow trout ≥420 mm FL displaying active signals on 20 May 2009. Each dot represents one fish.

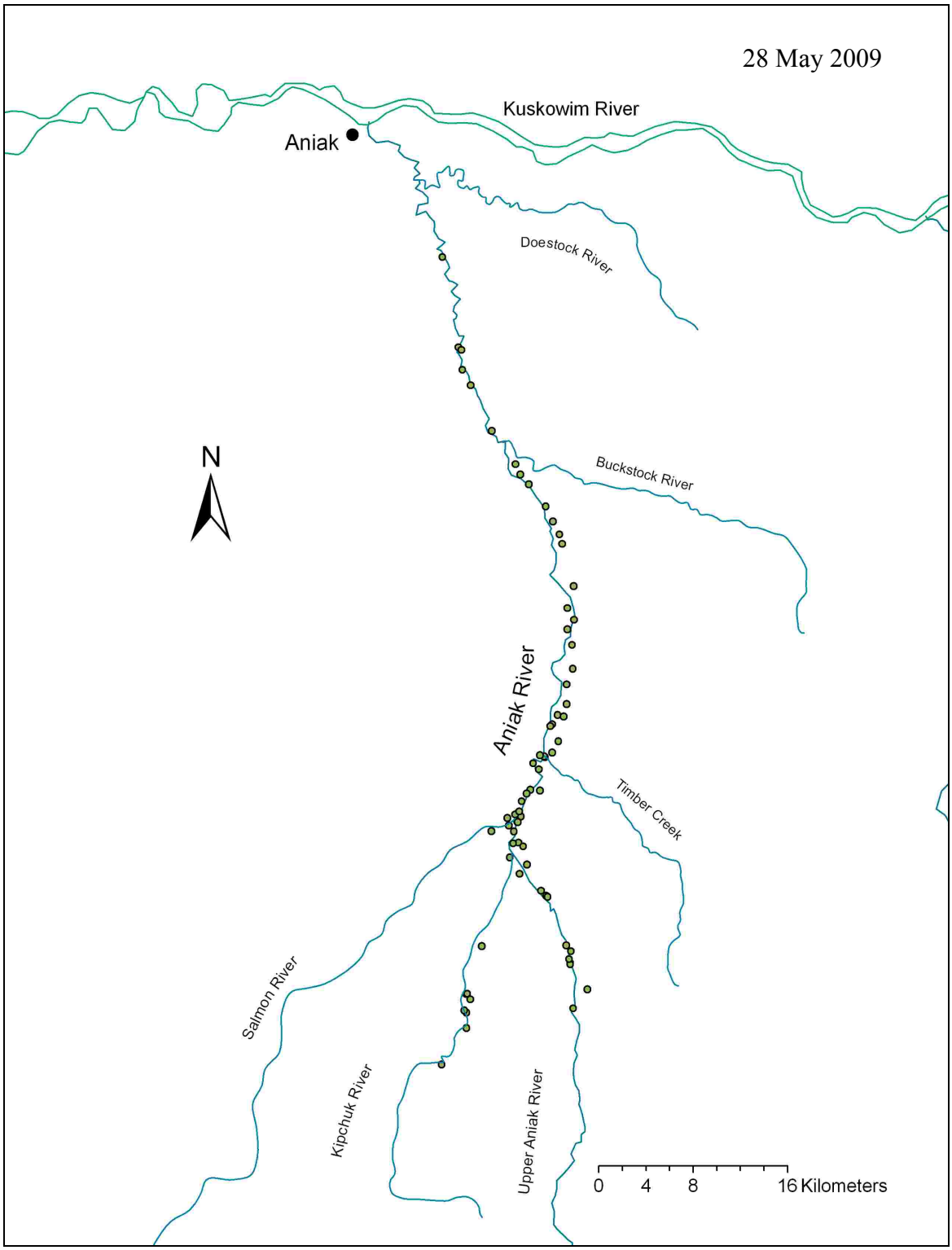

Figure 10.–Map of the Aniak River drainage and the locations of radio-tagged rainbow trout ≥420 mm FL displaying active signals on 28 May 2009. Each dot represents one fish.

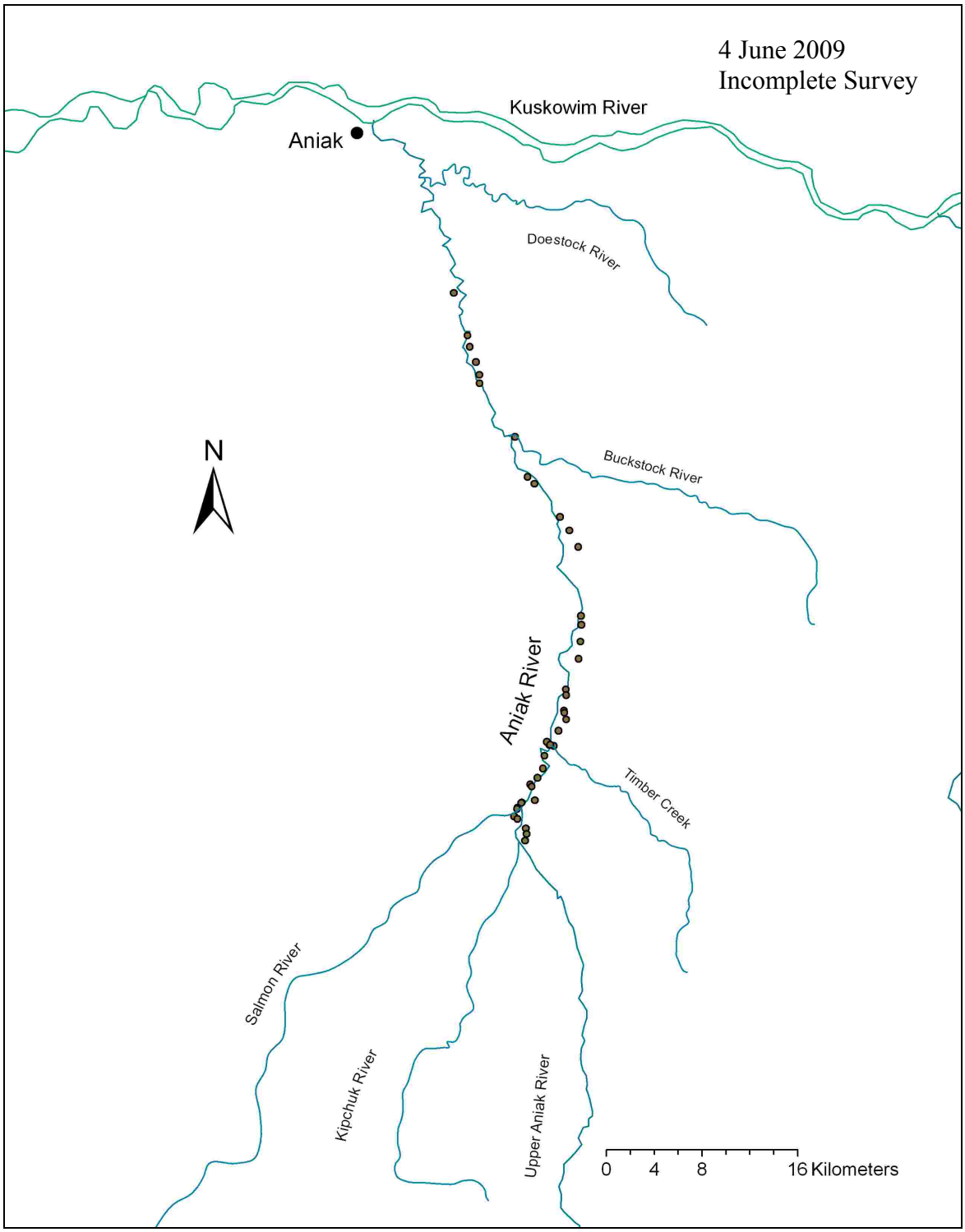

Figure 11.–Map of the Aniak River drainage and the locations of radio-tagged rainbow trout ≥420 mm FL displaying active signals on 6 June 2009. Each dot represents one fish.

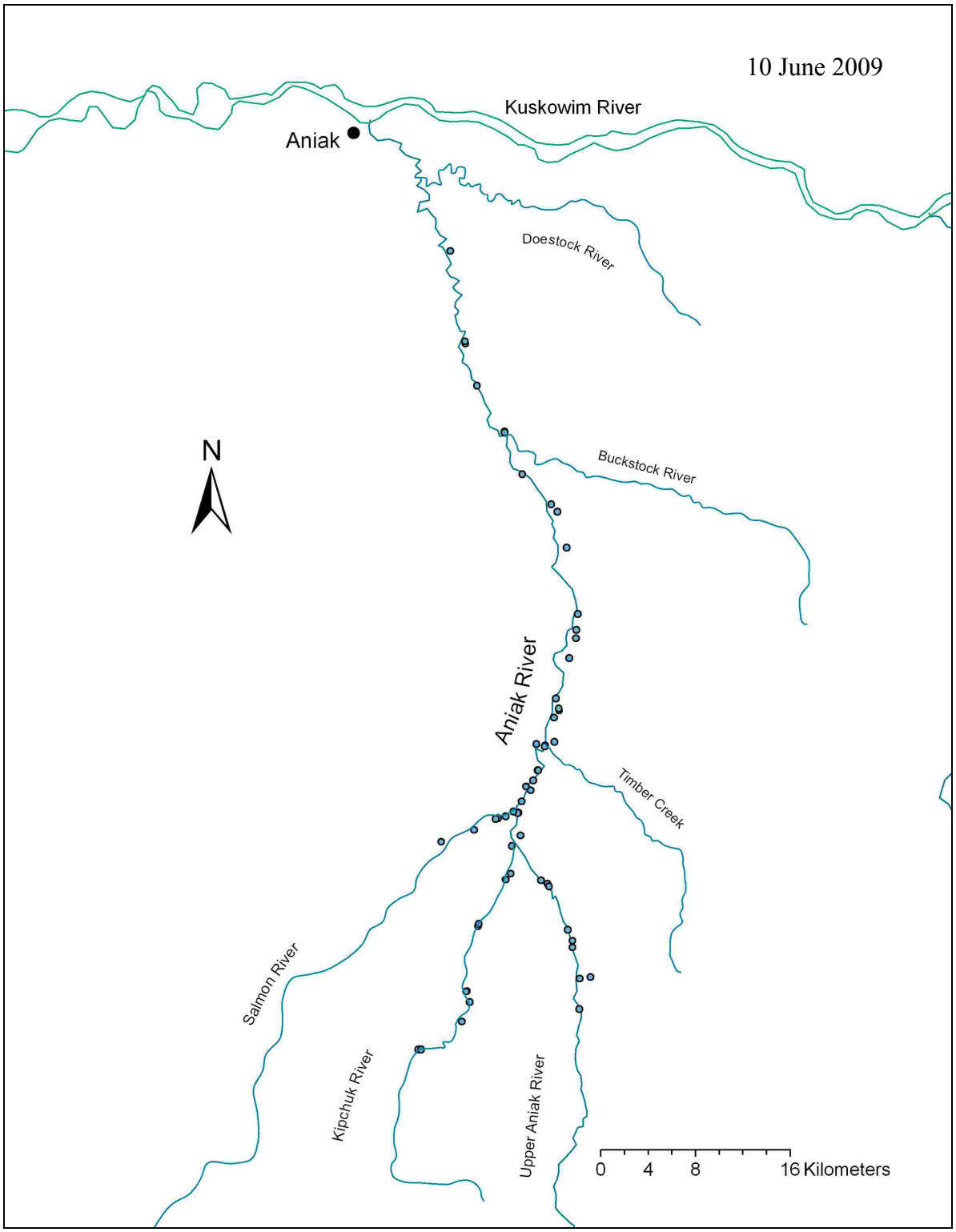

Figure 12.–Map of the Aniak River drainage and the locations of radio-tagged rainbow trout ≥420 mm FL displaying active signals on 10 June 2009. Each dot represents one fish.

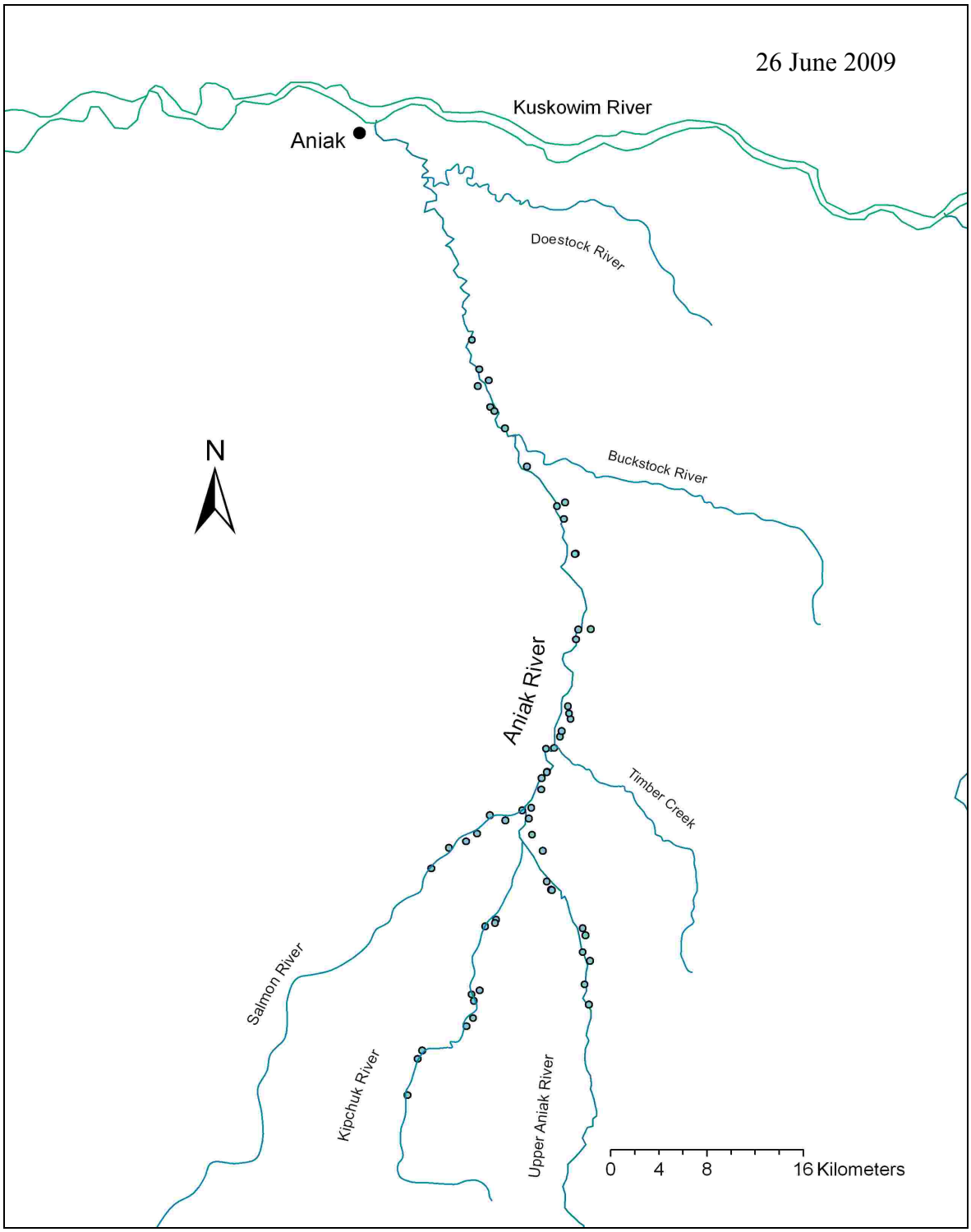

Figure 13.–Map of the Aniak River drainage and the locations of radio-tagged rainbow trout ≥420 mm FL displaying active signals on 26 June 2009. Each dot represents one fish.

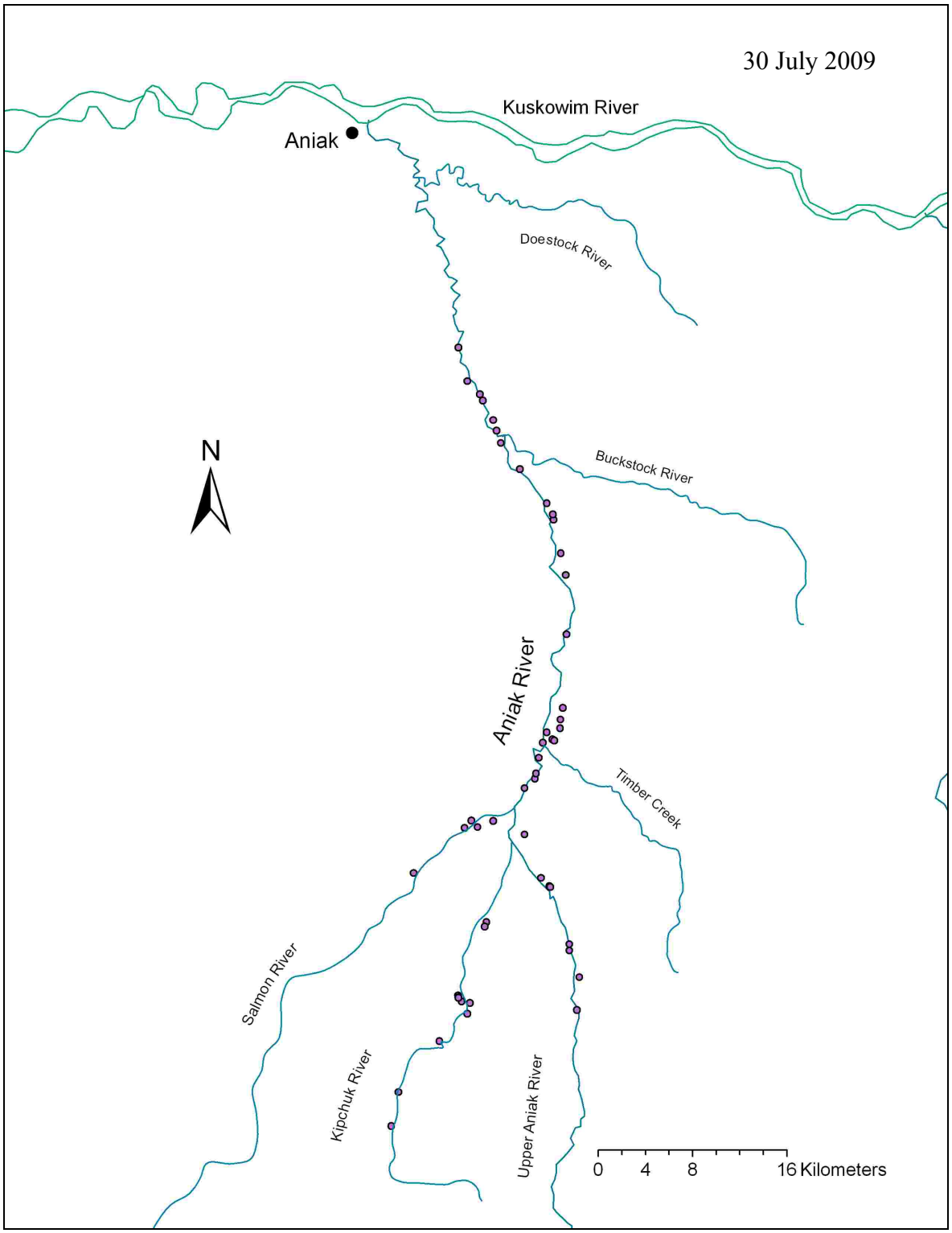

Figure 14.–Map of the Aniak River drainage and the locations of radio-tagged rainbow trout ≥420 mm FL displaying active signals on 30 July 2009. Each dot represents one fish.

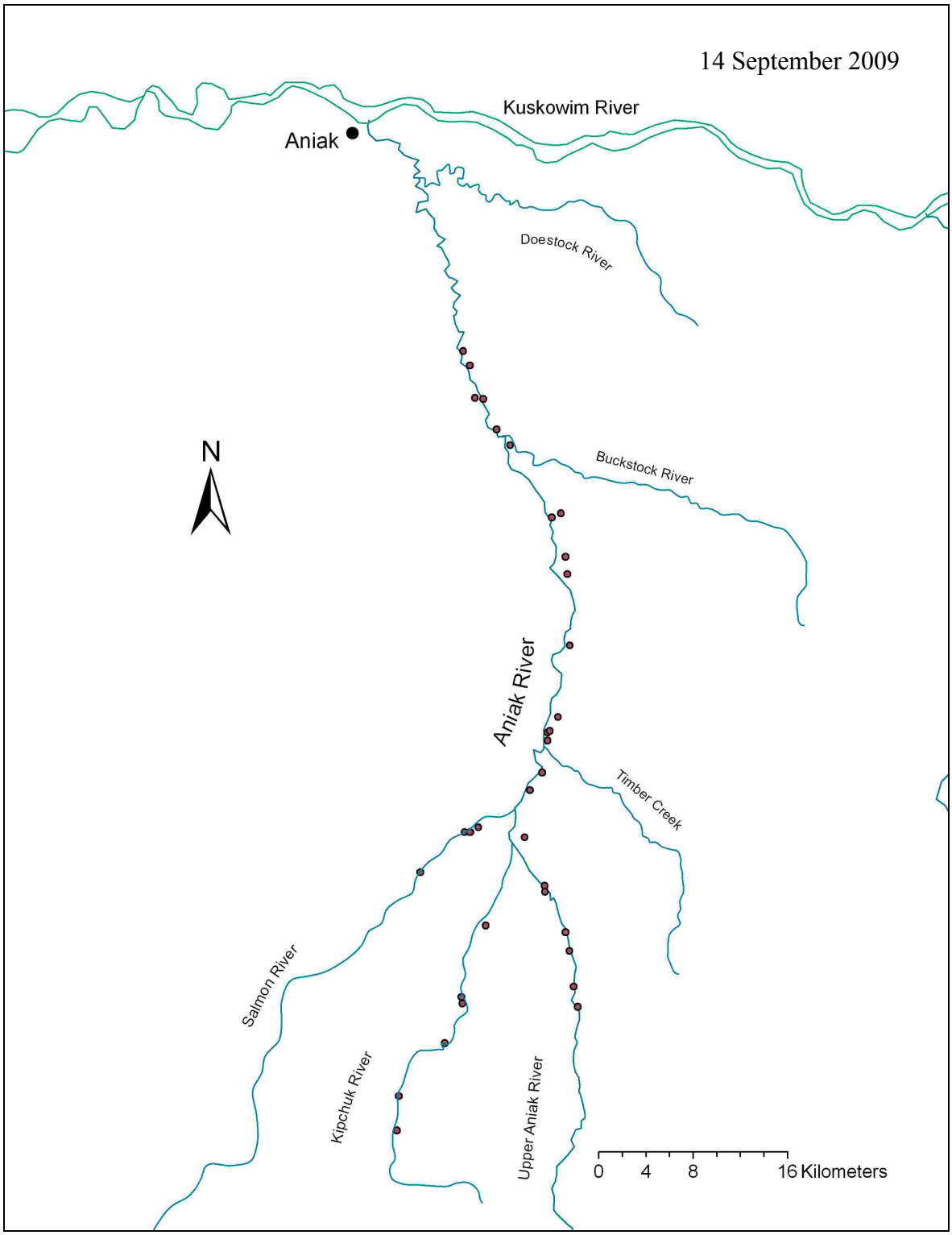

Figure 15.–Map of the Aniak River drainage and the locations of radio-tagged rainbow trout ≥420 mm FL displaying active signals on 9 September 2009. Each dot represents one fish.

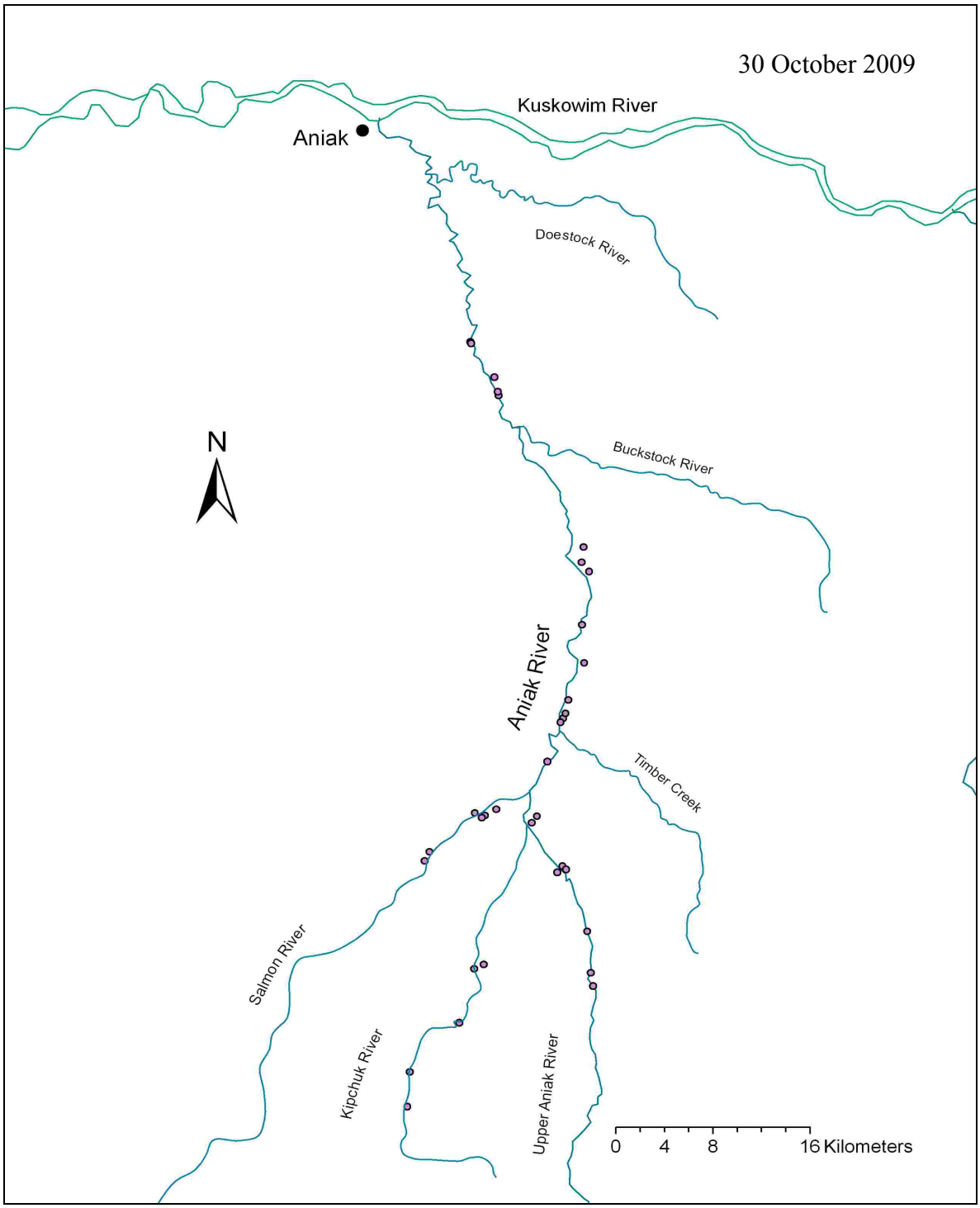

Figure 16.–Map of the Aniak River drainage and the locations of radio-tagged rainbow trout ≥420 mm FL displaying active signals on 30 October 2009. Each dot represents one fish.

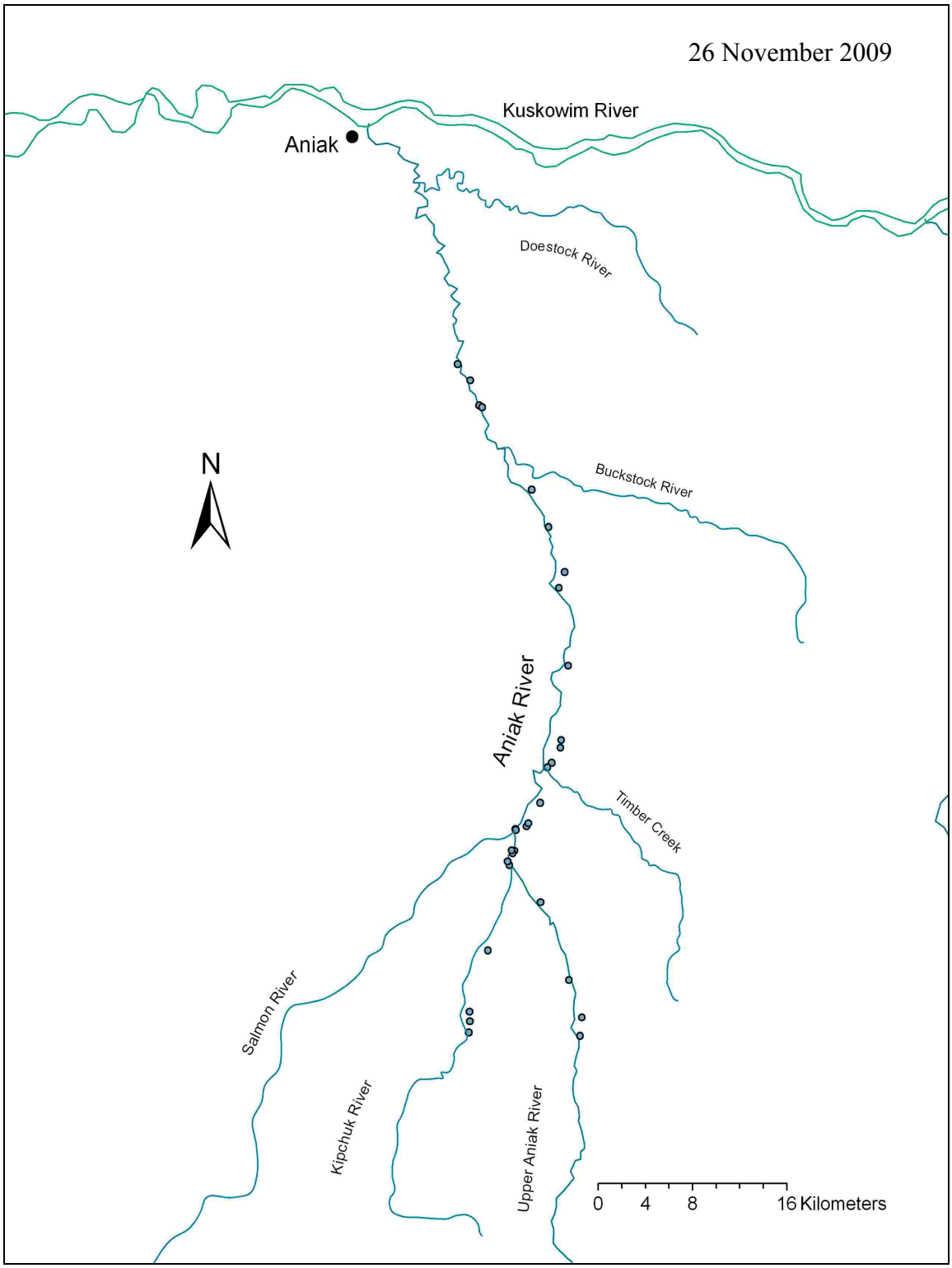

Figure 17.–Map of the Aniak River drainage and the locations of radio-tagged rainbow trout ≥420 mm FL displaying active signals on 26 November 2009. Each dot represents one fish.

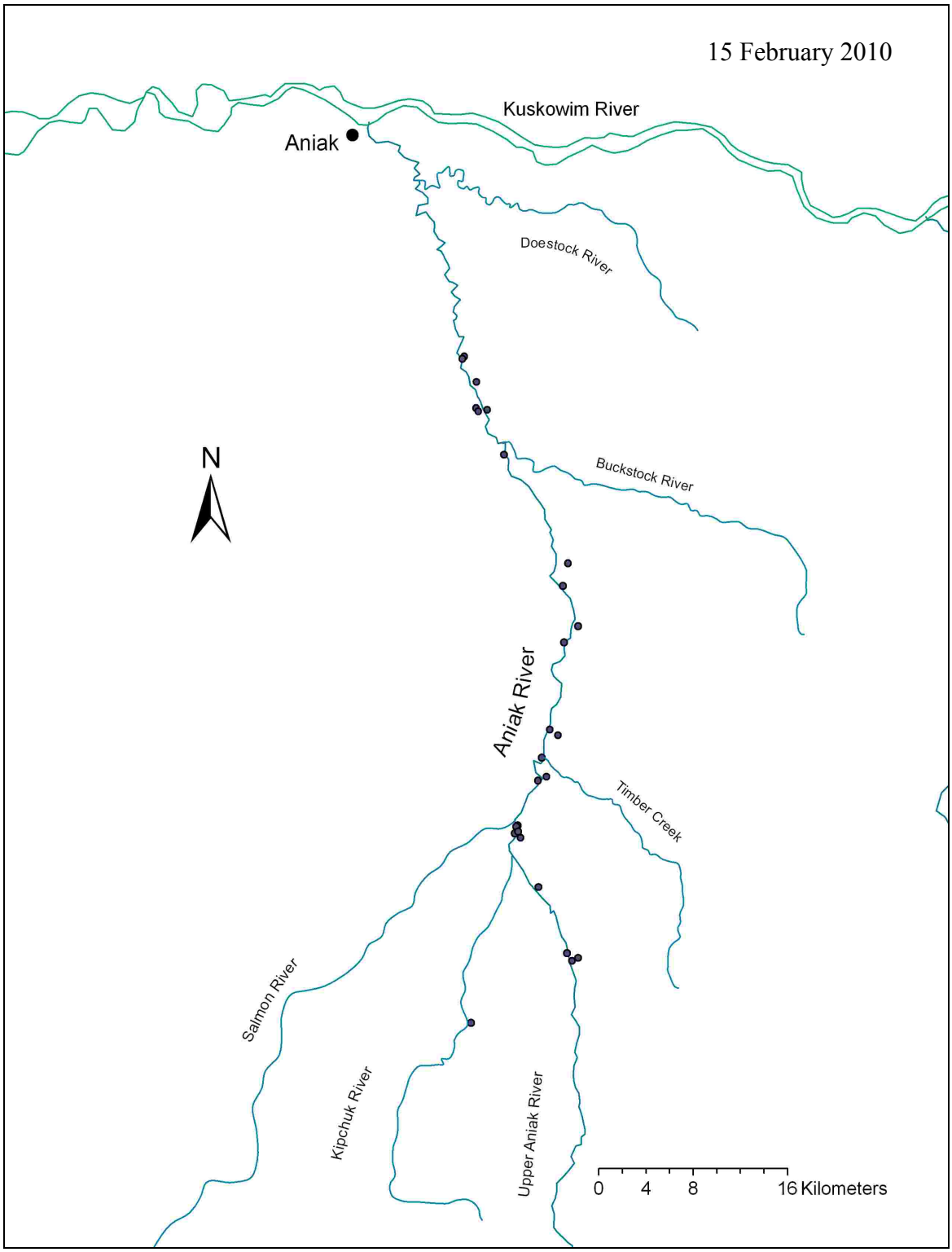

Figure 18.–Map of the Aniak River drainage and the locations of radio-tagged rainbow trout ≥420 mm FL displaying active signals on 15 February 2010. Each dot represents one fish.

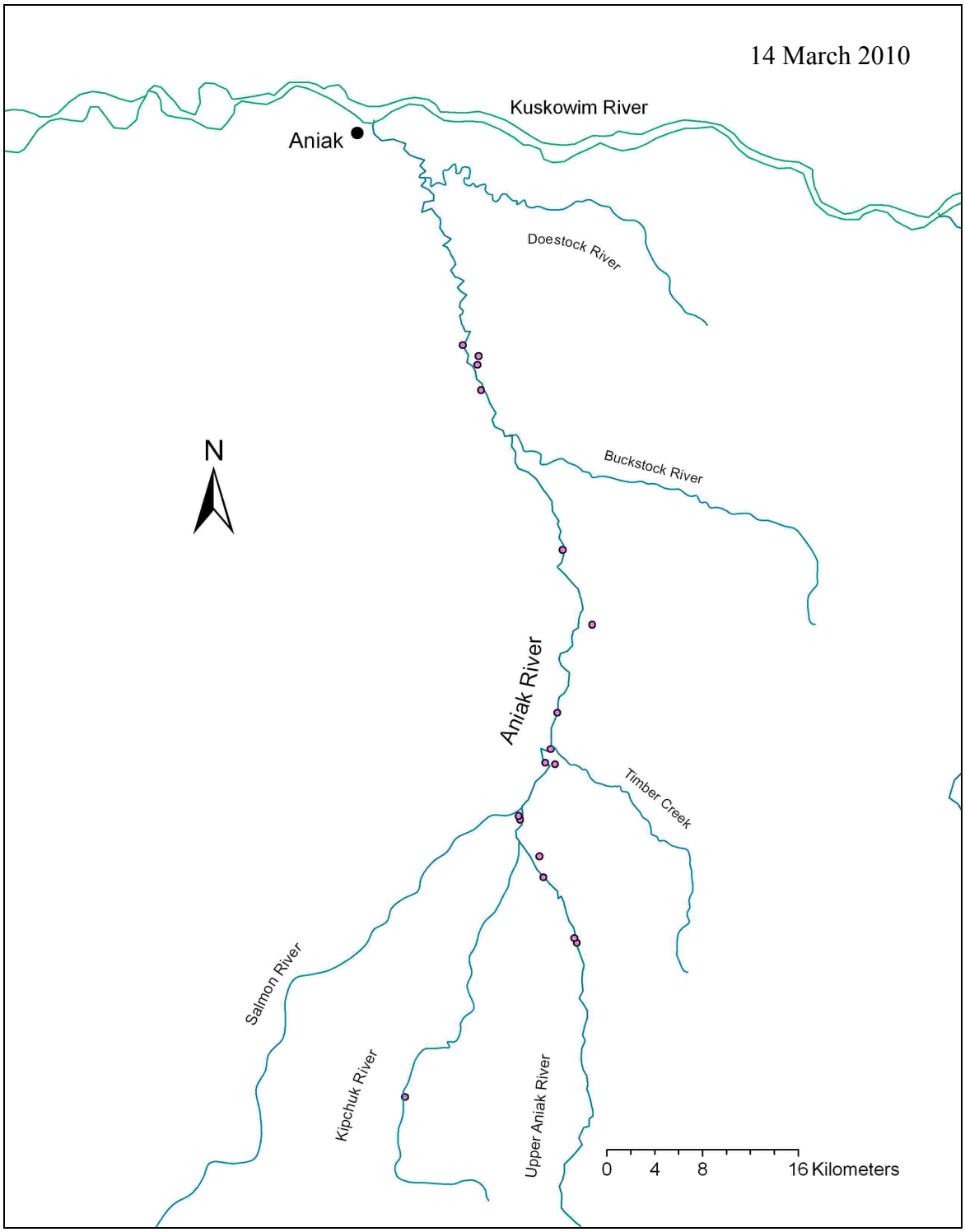

Figure 19.–Map of the Aniak River drainage and the locations of radio-tagged rainbow trout ≥420 mm FL displaying active signals on 14 March 2010. Each dot represents one fish.

Table 1. –Remaining aerial survey schedule, Aniak River.

Time period	Activity
Early May 2010	Locate Spawning Areas
Mid-May 2010	Locate Spawning Areas
Late May 2010	Locate Spawning Areas
Early June 2010	Locate Spawning Areas

Table 2. –Radio tag detection information from all the aerial tracking surveys, Aniak River, 2008–2010.

Aerial Survey Date	No. of Active Signals	No. of Inactive Signals	No. of Fish Undetected
25 September 2008	90	20	15
8 October 2008[a]	77[a]	17[a]	31[a]
14 March 2009	70	50	5
6 May 2009	75	29	21
13 May 2009	79	29	19
20 May 2009	73	37	15
28 May 2009	69	37	17
4 June 2009[a]	41[a]	38[a]	46[a]
10 June 2009	60	45	20
26 June 2009	59	49	17
30 July 2009	50	56	19
14 September 2009	35	71	19
30 October 2009	34	67	24
26 November 2009	33	71	21
15 February 2010	24	75	26
14 March 2010	19	83	23

[a] Incomplete survey due to inclement weather

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