MOVEMENT, DISTRIBUTION, AND RESOURCE USE OF WESTSLOPE CUTTHROAT TROUT IN THE SOUTH FORK CLEARWATER RIVER BASIN

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by

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AUTHORIZATION TO SUBMIT THESIS

This thesis of Marika E. Dobos, submitted for the degree of Master of Science with a Major in Natural Resources and titled “Movement, Distribution, and Resource Use of Westslope Cutthroat Trout in the South Fork Clearwater River Basin,” has been reviewed in final form. Permission, as indicated by the signatures and dates below, is now granted to submit final copies to the College of Graduate Studies for approval.

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ABSTRACT

Although many Westslope Cutthroat Trout *Oncorhynchus clarki lewisi* populations in Idaho are robust and stable, others are depressed. In some systems, such as the South Fork Clearwater River (SFCR) system, environmental conditions (e.g., summer temperatures) are hypothesized to limit populations of Westslope Cutthroat Trout. Radiotelemetry and snorkeling methods were used to describe movement, distribution, and habitat use of Westslope Cutthroat Trout in the SFCR in 2013 and 2014. Sixty-six tags were implanted into fish (155–405 mm). Sedentary and mobile summer movement patterns of Westslope Cutthroat Trout were observed. Sixty-two sites were snorkeled along the mainstem SFCR from 5–14 August 2014 to better describe the distribution of Westslope Cutthroat Trout. Twenty-three Westslope Cutthroat Trout were observed in 12 sites and at low density (mean ± SD; 0.0003 ± 0.0008 fish/m^2). Results indicate that summer temperature was the primary factor limiting the distribution of Westslope Cutthroat Trout in the system.

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DEDICATION

This thesis is dedicated to the memory of my mom, Ampy, and to my brother, Michael.

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INTRODUCTION

Lotic systems are complex environments where inter- and intra-annual variation and interactions exist among a suite of physical and biological factors (Schlosser 1991; Wenger et al. 2011; Petty et al. 2012). A population's distribution encompasses an expanse of different resources (e.g., food, refuge) that meet the needs of all life history stages and serve to maximize growth, reproduction, and survival (Schlosser 1991; Fausch et al. 2002). Suitable resources can be defined at multiple spatial scales that vary through time, and understanding how those resources vary is critical for understanding how they are used by organisms (Fausch et al. 2002; Hillyard and Keeley 2012; Petty et al. 2012). Moreover, resources can be constrained by the physical properties of the environment and influence the long-term persistence of a population (Kruse et al. 1997; Al-Chockhachy et al. 2013).

One of the most important resources influencing fishes is water temperature (Bonneau and Scarnecchia 1996; Isaak and Hubert 2004). Water temperature affects growth and survival through a variety of mechanisms, particularly physiological responses (Dickerson and Vinyard 1998; Isaak and Hubert 2004; Sloat et al. 2005; McMahon et al. 2014). The metabolic rate of fishes increases with temperature requiring more oxygen for biochemical processes (Helfman et al. 2009). At the same time, available dissolved oxygen decreases with increasing stream temperature and thereby limits a fish's activity and ultimately induces stress. Consequently, high water temperatures during the summer can be a critical environmental stressor for coldwater species (Dickerson and Vinyard 1998; Isaak and Hubert 2004; Sloat et al. 2005; McMahon et al. 2007).

Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi* is a coldwater species that is widely distributed across western North America. Typically, Westslope Cutthroat Trout inhabit cold systems with low productivity (Rieman and Apperson 1989; Sloat et al. 2005). The movement and distribution of Westslope Cutthroat Trout are influenced by water temperature, particularly during the summer (Sloat et al. 2005; DuPont et al. 2008). Survival of juvenile Westslope Cutthroat Trout dramatically decreases when exposed to water temperatures greater than 19.6°C (Bear et al. 2007). Adult Westslope Cutthroat Trout are typically found in areas where water temperatures are less than 22.0°C (Eaton et al. 1995; Bjornn and Reiser 1991; Hunt 1992). These temperature thresholds are frequently reached or surpassed during the summer in many systems where Westslope Cutthroat Trout occur. As such, Westslope Cutthroat Trout often move to areas of thermal refuge when stream temperatures are high (Bonneau and Scarnecchia 1996; Baird and Krueger 2003; Stevens and Dupont 2011).

Movement of fluvial Westslope Cutthroat Trout is variable among individuals and across systems (Schmetterling 2001; Schoby and Keeley 2011; Stevens and DuPont 2011; Pierce et al. 2014). Radiotelemetry studies have shown that fluvial Cutthroat Trout exhibit both mobile and sedentary tendencies (Brown and Mackay 1995a; Schmetterling 2001; Hilderbrand and Kershner 2004; Zurstadt and Stephan 2004; Coyler et al. 2005). Extreme movements of fishes tend to occur in response to either life history events (e.g., spawning) or changes in environmental conditions (e.g., temperature; Hilderbrand and Kershner 2000; Skalski and Gilliam 2000). As water temperatures increase during the summer, suitable resource patches can limit the distribution of coldwater species (Ebersole 2001; Poole and Berman 2001; Hillyard and Keeley 2012). Areas used by fishes in lotic systems during periods of high stream temperatures can occur at or near hyporheic exchange in side channels, alcoves, lateral seeps, and deep pools (Ebersole et al. 2001, 2003; Gooseff et al. 2006).

Hyporheic exchange typically occurs in unconfined depositional valleys where interactions of water with subsurface substrate can cool localized areas (Poole and Berman 2001). In the Blackfoot River, Montana, Westslope Cutthroat Trout used deep pools during the summer to escape warm water temperatures (Schmetterling 2001). Stevens and DuPont (2011) found that Westslope Cutthroat Trout in the North Fork Coeur d'Alene River, Idaho, used side-channel habitat in the summer where temperatures were 3.0–8.0°C cooler than in the main channel. High-elevation reaches, tributaries, and thermal gradients where tributaries enter a system can also provide thermal refuge for fishes during the summer (Bonneau and Scarnecchia 1996; Ebersole et al. 2001, 2003; Baird and Krueger 2003; Gooseff et al. 2006). For example, in the Adirondack River, New York, Brook Trout *Salvelinus fontinalis* and Rainbow Trout *O. mykiss* aggregated near tributary confluences where water temperatures were 0.2–3.5°C cooler than habitats lacking tributary influence (Baird and Krueger 2003). Suitable thermal habitat during the summer is dependent on large- (e.g., elevation, geomorphology, gradient, precipitation) and small-scale (e.g., cover, depth) factors that vary among and within systems (Beechie et al. 2006; Stanford 2006). Anthropogenic activities can alter natural flow dynamics and temperature regimes of a system, thereby, influencing movement and distribution of fishes (Poole and Berman 2001).

The South Fork Clearwater River (SFCR) basin in north-central Idaho supports a fluvial Westslope Cutthroat Trout population. Data collected by the Idaho Department of Fish and Game (IDFG) have shown that despite the availability of high-quality physical habitat (i.e., deep pools, instream cover), Westslope Cutthroat Trout are absent or at low density throughout most of the mainstem SFCR (Cochnauer et al. 2001; Schill et al. 2004). Dechert and Woodruff (2003) found that water temperatures along the mainstem SFCR and low-elevation reaches of several of its major tributaries exceeded 22.0°C during the summer. These data suggest that water temperature is likely an important factor influencing the distribution and abundance of Westslope Cutthroat Trout in the SFCR basin. To understand the ecological significance of suitable thermal resources, biologists must consider the dynamics of riverscapes and how fish respond to seasonal changes. In this study, movement, distribution, and resource use of Westslope Cutthroat Trout in the SFCR basin were examined using radiotelemetry and snorkeling techniques. Summer water temperature was hypothesized as the primary factor influencing the movement patterns and distribution of Westslope Cutthroat Trout.

STUDY AREA

The SFCR is a major component of the Clearwater River basin in north-central Idaho (Figure 1). The SFCR basin encompasses 3,052 km^2 extending from the headwaters at 3,048 m above sea level (msl) to 383 msl where the South Fork Clearwater River joins the Middle Fork Clearwater River at Kooskia, Idaho, to form the Clearwater River (Dechart and Woodruff 2003). Major watersheds in the SFCR basin include the Red, American, and Crooked rivers, and Newsome, Tenmile, Johns, and Cottonwood creeks. Land ownership of the SFCR basin includes the U.S. Forest Service (USFS; 68%), private (29%), the U.S. Bureau of Land Management (BLM; 2%), Nez Perce Tribe (NPT; <1%), and the state of Idaho (<1%; Cochnauer and Claire 2001; Dechert and Woodruff 2003).

The main tributaries of the SFCR are generally either confined in steep canyons or have unconfined valleys with large floodplains (Siddall 1992; Dechart and Woodruff 2003; Northwest Power and Conservation Council [NPCC] 2003). Lower sections of the Red, American, and Crooked river basins and Newsome Creek basin flows through unconfined valleys and likely had a high degree of side channels and lateral complexities prior to historical land use practices. Lower reaches of Tenmile and Johns creeks generally have moderate to high stream gradient and are confined to steep canyons of quartzite, gneiss, schist, and granite substrate.

The mainstem SFCR originates at the confluence of the Red and American rivers and contains a mix of valley forms. The cumulative drainage area of the Red River watershed contains 41% (418 km^2) of the upper SFCR basin area upstream of Tenmile Creek (rkm 76.7). Although considered a tributary of the SFCR by name, the lower reaches of the Red River (downstream of rkm 27.6) contributes most of the discharge to the mainstem SFCR and is functionally a “continuation” of the mainstem SFCR. The upper section of the SFCR and lower Red River has low to moderate stream gradient (<8%) and flows through relatively broad valleys. Through the middle section of the mainstem SFCR (rkm 30.0–75.0), stream gradient of the mainstem SFCR is moderate to high (6–18%) and the channel is confined to a steep, canyon-type valley (Dechart and Woodruff 2003; NPCC 2003). The lower section of the SFCR (rkm 0.0–30.0) has low stream gradient (<5%) and flows through unconfined valleys of primarily basalt substrate.

Land use practices have influenced the riverscape through much of the upper SFCR basin, especially in unconfined valleys. With the discovery of gold in 1861, mining activities have altered the natural flow dynamics and degraded the riparian habitat through most of the upper SFCR basin (Siddall 1992; Cochnauer and Claire 2001; Dechert and Woodruff 2003). Waste ponds and tailings from large-scale mining operations remain in the upper watershed and are areas of on-going habitat restoration effort (Siddall 1992). Recreational mining continues today with a number of small suction dredge operations along the SFCR and some major tributaries (Stewart and Sharp 2003). Commercial timber harvest, primarily clearcutting, has been a major land use that started in the 1940s. Timber harvest currently operates at a smaller scale than historical harvest and is regulated by the USFS and BLM. Habitat alterations likely influenced the temperature regime of the SFCR system by increasing water temperatures in degraded areas.

The fish assemblage in the SFCR basin includes steelhead and Bull Trout *Salvelinus confluentus* that are listed as "threatened" under the Endangered Species Act (South Fork Clearwater River Watershed Advisory Group 2006). The construction of the Lewiston Dam in 1927 led to the extirpation of Chinook Salmon *O. tshawytscha* in the Clearwater River basin. In 1982, hatchery programs reintroduced Chinook Salmon (U.S. Fish and Wildlife Service 2009). Other native fishes in the SFCR basin include Pacific Lamprey *Lampetra tridentate*, Mountain Whitefish *Prosopium williamsoni*, Bridgelip Sucker *Catostomus columbianus*, Mountain Sucker *C. platyrhynchus*, Chiselmouth *Acrocheilus alutaceus*, Northern Pikeminnow *Ptychocheilus oregonesis*, Longnose Dace *Rhinichthys cataractae*, Speckled Dace *R. osculus*, Paiute Sculpin *Cottus beldingii*, Shorthead Sculpin *C. confusus*, and Torrent Sculpin *C. rhotheus*, (Siddall 1992; Cochnauer et al. 2001; Dechert and Woodruff 2003). Three nonnative species (Black Bullhead *Ameiurus melas*, Brook Trout, and Smallmouth Bass *Micropterus dolomieu*) have also been observed in the system.

METHODS

Radiotelemetry

Radiotelemetry was used to investigate habitat use and movement of Westslope Cutthroat Trout in the SFCR basin. Fish were captured for radio-tagging using rotary screw traps and angling during May–July in 2013 and June–July in 2014. Three 1.5-m diameter rotary screw traps were operated by IDFG from March–early November 2013–2014 using standard operating procedures described by Volkhardt et al. (2007). Rotary screw traps were located on the Red River 7.8 km upstream of its confluence with the American River, on the American River 3.1 km upstream of its confluence with the Red River, and on Crooked River 0.7 km upstream its confluence with the mainstem SFCR. Angling was conducted along the SFCR on 19 June and 20 June in 2013 and 20 June through 6 July in 2014. Angling was conducted across all habitat types from the origin to the confluence. No Westslope Cutthroat Trout were captured in the low-elevation reaches of the SFCR (i.e., downstream of rkm 40). Snorkeling in low-elevation reaches immediately after angling failed to observe Westslope Cutthroat Trout.

In 2013, three sizes of code-identifying radiotransmitters manufactured by Lotek Wireless, Inc. (Newmarket, Ontario, Canada) were used to tag fish. Water temperature was recorded at the location of relocated fish in 2013 (see methods described below); however, we were unable to determine if fish were using micro-scale thermal refuge. Therefore, two sizes of code-identifying radiotransmitters with temperature sensors (± 0.8°C) were used in 2014 to evaluate whether fish were using thermal refuge at a small scale. Three radiotransmitters recovered in the field from the 2013 tagging effort were reused in 2014. Prior to surgery, all tags were tested for functionality and the temperature-sensing radiotransmitters were tested to ensure they accurately measured temperature. Total length (m) and mass (g) were measured on all fish captured and tagged. Radiotransmitters were surgically implanted through an incision in the peritoneal cavity along the linea alba and anterior to the pelvic girdle (Jakober et al. 1998). The antenna exited the body wall using a modified shielded-needle technique

(Ross and Kleiner 1982; Hillyard and Keeley 2012). Incisions were closed with two interrupted monofilament sutures, and fish were placed in a holding container in the stream for recovery prior to release. Once recovered, fish were released at or near the location of capture. Radiotransmitters were programmed (149.48 MHz in 2013; 150.34 MHz in 2014) with a continuous cycle emitting a signal every 5 or 10 seconds. Battery life varied from 124–678 days for code-identifying-only radiotransmitters and from 160–260 days for the temperature-sensing radiotransmitters. Recommendations by Zale et al. (2005) were used to ensure that radiotransmitters did not exceed 3.0% of the fish's body weight (mean ± SE; 1.55 ± 0.08%).

Seasons were defined as summer (June–August), autumn (September–November), winter (December–February), and spring (March–May). An attempt was made to relocate fish at least once a week during June–August 2013 and 2014. Radio-tagged fish in the SFCR were relocated at least once a month during September 2013–May 2014 or until the battery on the radiotransmitter expired. From November 2013 to April 2014, access in many portions of the SFCR basin was limited by road conditions (i.e., snow); consequently, information on winter and spring movement of fish in tributaries was not available. Lotek model SRX 400 or SRX 600 receivers equipped with a six-element or three-element directional Yagi antenna were used for mobile tracking. Fixed receivers and antennas were also placed at the confluences of Newsome, Tenmile, and Johns creeks to track movement of fish entering or exiting tributaries with difficult access. Radio-tagged fish were initially tracked by vehicle and then on foot. Test trials were conducted to evaluate error in locating radio-transmitters similar to Simpkins and Hubert (1998). Location error was 0.50 m (SE = 0.06 m) at a distance of 5.0 m to the radiotransmitter and decreased to 0.12 m (± 0.03 m) at 2.0 m.

Visually observing several fish with external antennas further verified our accuracy in the field. Fish were considered alive when movement was observed during tracking. When a radio-tagged fish was found in the same area as the previous relocation, we attempted to disturb the fish and (or) snorkel the area to determine the fate of the fish. Locations were marked using a handheld Global Positioning System device and distance of movement between tracking events was measured using a geographical information system (GIS).

Channel-unit type was defined and categorized using a hierarchical classification system as fast-turbulent (i.e., cascade, rapid, riffle), fast-nonturbulent (i.e., run, glide), pocket water, or pool (Hawkins et al. 1993; Jakober et al. 2000). Pocket water was included as a habitat category due to the high frequency of large substrate (greater than 500 mm in diameter) in the SFCR that created multiple localized scour pools. The channel-unit type was characterized at the location of the fish. Maximum depth of the channel-unit was measured to the nearest 0.1 m. Microhabitat use of radio-tagged fish was defined as a 1-m^2 area centered on the location of the fish (Brown and Mackay1995a; Muhlfeld et al. 2001). Presence of cover was noted if a portion of the structure was in the 1-m^2 area. Cover was defined as large wood, undercut bank, overhanging vegetation, or large boulder (≥256 mm in diameter; Petty et al. 2012). Ambient water temperature was measured at the location of a radio-tagged fish at the substrate since the coldest temperatures are normally found in the lower water column (Nielsen et al. 1994). In 2014, the temperature transmitted by the radiotransmitter was also recorded. Average daily discharge (m^3/s) was acquired from the U.S. Geological Survey gaging station located in Stites, Idaho. Onset temperature loggers (± 0.53°C from 0°C to 50°C; Onset Computer Corporation, Pocasset, Massachusetts) were deployed along the SFCR and at the lower reaches of six major tributaries (Figure 1). Temperature was recorded at 1-hr intervals during the summer and autumn in 2013 and 2014.

A linear regression model was used to spatially extrapolate empirical temperature data from the temperature loggers to daily maximum and minimum summer stream temperatures for the stream network of the SFCR system for 2013 and 2014 (Peterson et al. 2007; Ver Hoef and Peterson 2010; Isaak et al. 2014). The SFCR system was delineated into stream segments between nodes where segments converged (i.e., where tributaries entered; Ver Hoef and Peterson 2010). Stream segments varied in length from 67 to 1,987 m. Each segment was attributed with site-specific environmental covariates (Isaak et al. 2014). Measured daily maximum and minimum water temperatures (June–August) were dependent variables in the linear regression models. Elevation, percent canopy, channel gradient, cumulative drainage area, latitude, percentage of the catchment area classified as open water, and base flow index were used as fixed site-specific covariates attributed to the location of each temperature logger (Isaak et al. 2014). In addition to fixed-site variables, mean daily discharge and precipitation, and daily maximum and minimum air temperature were covariates in the model associated with each day during the summer (Hague and Patterson 2014). The models performed extremely well and explained 91.5% of the variability in observed daily maximum water temperatures and 92.0% in observed daily minimum water temperatures. Estimated daily maximum and minimum water temperatures were predicted for all stream segments in the SFCR system for the summers of 2013 and 2014.

Mean maximum predicted and empirical temperature data for the summers of 2013 and 2014 exhibited a nonlinear temperature profile for the SFCR (Figure 2). Water temperatures were the lowest between rkm 30 and 75. Using temperature and geomorphological characteristics of the system (i.e., gradient, substrate type, valley type), the SFCR was divided into three "Regions" (Figure 2). Generally, the Lower Region (rkm 0–30) had the highest mean maximum summer temperatures (mean ± SD; 21.1 ± 1.0°C) and lowest mean gradient (4.7%). The Lower Region predominantly consisted of basalt substrate and had an unconfined valley. The Middle Region (rkm 30–75) had the lowest mean maximum summer temperatures (18.0 ± 1.0°C), highest mean gradient (10.3%), and was confined by steep slopes of granite substrate. Mean maximum summer temperatures in the Upper Region (rkm 75–103) were 19.0 (0.4°C). The Upper Region had a mean gradient of 5.6% with an unconfined valley that consisted of a combination of granite, mica schist, quartz, and gneiss.

Snorkel surveys

Because radiotelemetry data only provided information on the subset of the population that was radio-tagged, snorkeling was used to provide additional insight on the influence of environmental factors on Westslope Cutthroat Trout in the SFCR system. Enumeration of fishes from snorkeling has been widely used to quantify abundance and density of salmonids (Schill and Griffith 1984; Zubik and Fraley 1988; Thurow et al. 2006). Snorkeling also provided information on the large-scale distribution and resource use of Westslope Cutthroat Trout in the system and possible associations with other fishes.

The mainstem SFCR was divided into 1-km segments from the origin to its confluence with the Middle Fork Clearwater River. The sampling frame consisted of 103 segments; 52 segments were systematically selected (Figure 1). Sixty-three sites consisting of a single channel unit (e.g., pool, riffle, run) were randomly sampled. Sites that could not be safely snorkeled due to high current velocity were removed and replaced with a new randomly selected site. At each site, the channel unit was categorized as a pool, riffle, run, or pocket water using the same definitions used for the radiotelemetry portion of the study.

Snorkeling was conducted between 1000 and 1730 hours when light conditions were optimal from 5–18 August in 2014 using standard snorkeling methods described by Thurow (1994). Snorkelers attended a training workshop prior to the snorkeling event to help ensure fish species were correctly identified and lengths were accurately estimated. Maximum visibility was measured at each site as the maximum distance a snorkeler could identify the markings of an imitation fish underwater on the day of the snorkeling event (Schill and Griffith 1984). Snorkelers were spaced laterally across the SFCR either upstream or downstream from the start of the site (Zubik and Fraley 1988). We attempted to observe all fish present in each site by maximizing the number of snorkelers. The number of snorkelers varied from two to nine depending on mean stream width, current velocity, and maximum visibility. Snorkelers identified and enumerated all fishes observed. The lengths of all Rainbow Trout and Westslope Cutthroat Trout were estimated and grouped as either medium (150–300 mm) or large (greater than 300 mm). Westslope Cutthroat Trout and Rainbow Trout less than 150 mm were excluded from the analysis due to uncertainty in species identification (Campton and Utter 1985; Baumsteiger et al. 2005).

Habitat characteristics were quantified for each site. Site length was measured along the thalweg, and three transects were established perpendicular to the direction of the flow at 25, 50, and 75% of the site length (Sindt et al. 2012). Mean wetted width (m) was calculated from the three transect measurements (Meyer and High 2011). Depths were taken at 25, 50, and 75% of the wetted channel widths along each transect. Substrate composition was visually estimated as a percentage of different substrate categories along a 2-m strip centered on each transect. Substrate was categorized using a modified Wentworth scale (Cummins 1962) as silt or sand (< 2 mm in diameter), gravel (2–64 mm), small cobble (65–128 mm), large cobble (129–256 mm), boulder (greater than 256 mm), or bedrock (Brown and Mackay 1995a; Muhlfeld et al. 2001). Cover was categorized the same as for the radiotelemetry portion of the study (i.e., overhanging vegetation, undercut bank, large wood). The area of each piece of cover was estimated as the mean of three width measurements multiplied by the length of the structure (Sindt et al. 2012). Temperature loggers were deployed at each site immediately after snorkeling to record temperature at 1-hr intervals for 24 hours. Using the nearest temperature logger that was continuously recording throughout the summer, the diel maximum and minimum stream temperatures at each site were adjusted to a single, randomly chosen date within the snorkeling period to account for temporal variation in water temperature. Density of Westslope Cutthroat Trout and Rainbow Trout was quantified for each site. The area of a site was calculated as the thalweg length times the mean of the three width measurements. Count of fish was divided by the area of the channel unit to estimate density.

Data analysis

Relocations of radio-tagged fish were imported into ArcMap GIS version 10.1 (Environmental Systems Research Institute, Inc., Redlands, California). The first detection was excluded from the analysis to avoid any influence of surgery on movement. Movement was estimated as the distance moved divided by the time at large. Mean movement by month was summarized from June 2013 through August 2014. Home range was defined as the stream distance between the most upstream and most downstream detections of individual radio-tagged fish in the summer (Vokoun and Rabeni 2005). Linear regression was used to evaluate home range size as a function of body length of radio-tagged fish. Only fish that survived and were tracked throughout the summer were included in the linear regression analysis.

A kernel density estimator was used to examine proportional use of the mainstem SFCR by radio-tagged Westslope Cutthroat Trout (Vokoun 2003). The density estimate is based on a histogram of detections of radio-tagged fish along the mainstem SFCR and lower Red River. Areas that were used more frequently by fish were represented by peaks in the utilization distribution and can identify important areas of use by Westslope Cutthroat Trout. The univariate kernel density estimator was defined as

$$\hat{f}(x) = \frac{1}{nh}\sum_{i=1}^{n} K\left(\frac{x-X_i}{h}\right) \quad [1]$$

where h was the bandwidth and $K(x)$ was the Gaussian kernel function (Vokoun 2003; Vokoun and Rabeni 2005). A Sheather-Jones plug-in method was used to select the appropriate bandwidth (Jones et al. 1996). A kernel density function was estimated for detections in the mainstem SFCR in the months of June, July, and August of 2013 and 2014. The lower 27.6 km of the Red River downstream of the South Fork Red River (a large tributary of Red River) was also included because it functions as the primary extension of the mainstem. The upper Red River (i.e., >27.6 km from the confluence with the American River) is comparable in size (e.g., drainage area = 129.4 km^2) to the American (237.2 km^2) and Crooked (184.7 km^2) rivers and was considered a tributary.

Logistic regression models were developed to predict the probability of occurrence for Westslope Cutthroat Trout in the SFCR using snorkeling data (Porter et al. 2000; Fransen et al. 2006). The occurrence of zeros can result from an ecological effect (true zeros) or error in observing individuals despite their presence (false zeros; Martin et al. 2005). Although we would have liked to repeatedly sample sites to get an estimate of detectability, logistics prevented us from conducting replicate samples. Rather, the number of false zeros in the snorkel data was minimized by implementing prior training such that snorkelers actively sought fish in each site and correctly identified species. In addition, we maximized the number of snorkelers such that the entire site was observed with some overlap among snorkelers. Snorkelers communicated counts during surveys to reduce double- and under-counting fish (Zubik and Fraley 1988).

Prior to generating *a priori* models, a suite of candidate biological and physical variables were evaluated using Pearson's product-moment pairwise correlation coefficients. Ecologically relevant variables that were not highly correlated (Pearson's $r \leq |0.70|$) were retained for *a priori* candidate models (Porter et al. 2000; Sindt et al. 2012). If variables were highly correlated, one was excluded to prevent multicollinearity. However, if ecologically relevant variables were correlated but likely had different influential effects on Westslope Cutthroat Trout, both variables were used. The saturated model was the most parameterized of the candidate models and included maximum and minimum water temperatures, Lower, Middle, and Upper regions; mean depth; estimated proportion of site that had large substrate; area of cover provided by wood; and Rainbow Trout density as explanatory variables. Overdispersion of the saturated model was evaluated using the estimated $\hat{c}$ (Burnham and Anderson 2002); overdispersion was not a concern ($\hat{c}$ = 0.81). An information-theoretic approach using Akaike's information criterion corrected for small samples (AIC_c) was used to rank 23 candidate models (Burnham and Anderson 2002). Top models were those with an AIC_c value that was within 2.0 of the best model (i.e., $\Delta AIC_c \leq 2$). Top models were evaluated using Akaike weights (w_i) and McFaddens's ρ^2 (McFadden 1974; Burnham and

Anderson 2002). The summary statistic ρ^2 is analogous to the r^2 in a linear model but because the dependent variable is binary, the correlations between predictor and dependent variables are lower (Porter et al. 2000). Values between 0.20 and 0.40 were considered to have excellent model fit (Porter et al. 2000). All statistical analyses were performed in R (R Development Core Team 2013).

RESULTS

Radiotelemetry

Sixty-eight Westslope Cutthroat Trout were captured and implanted with radiotransmitters from 30 May–9 July of 2013 (35 fish) and 20 June–6 July of 2014 (33 fish). Total length of radio-tagged fish varied from 170 to 405 mm (mean ± SD; 280.8 ± 55.5 mm) and mass varied from 40 to 548 g (227.0 ± 134.3 g). Forty-five fish (20 in 2013 and 25 in 2014) survived and were tracked through the summers of 2013 and 2014. Eighteen fish (11 in 2013; 7 in 2014) died or shed their tag during the summer. Nine radiotransmitters were recovered in 2013 and three were recovered in 2014. Two radiotransmitters were found inside Mink *Neovision vision* dens and two were found in or near campgrounds. One transmitter was found in regurgitated material from an unknown predator on land. The number of relocations for each radio-tagged fish varied from 1 to 34 (11.1 ± 6.7) during the summer. The number of days between relocations during the summer was anywhere from 1 to 52 d (5.4 ± 5.3 d). Five fish were relocated in the SFCR every month during the winter, three of which had batteries that expired during the spring of 2014. Due to winter conditions, fish that remained in tributaries throughout the winter were not relocated.

Fish used large portions of the SFCR basin throughout the year and movement of radio-tagged fish was variable among seasons. Monthly movement patterns of radio-tagged fish indicated that movement was highly variable in July when temperatures were the warmest (Figure 3). Mean summer movement was 0.07 km/d (SE = 0.03 km/d) and mean movement in July was 0.29 km/d (0.06 km/d). Downstream movement was observed as water temperatures decreased. Mean movement was -0.04 km/d (0.01 km/d) for autumn and -0.02 km/d (0.01 km/d) for winter. Five fish located in tributaries during the summer moved downstream into either the mainstem SFCR or lower Red River in August–September in 2013 and 2014. One fish was observed moving downstream into the mainstem SFCR from the Red River in January 2013. Eight fish in the mainstem SFCR were tracked through January and found to overwinter between rkm 49.0 and 51.7, typically in deep pools and runs. The direction of movement in February and March 2014 was also primarily downstream. Upstream movement occurred in April and May and mean spring movement was 0.01 km/d (0.04 km/d). Out of five radio-tagged fish tracked through the spring, two were detected in the lower 4.8 km of Mill Creek on 3 June. Another fish was assumed to have moved into Mill Creek given its detection history, and two fish remained in the mainstem SFCR throughout the spring. By mid-June 2013, batteries expired in three of the five radiotransmitters that were relocated throughout the prior winter.

Fish were widely distributed throughout the mainstem SFCR upstream of rkm 30.0 and in tributaries during the summer (Figure 4). The mean summer home range of Westslope Cutthroat Trout was 9.0 km (SD = 8.9 km). The length of Westslope Cutthroat Trout was weakly correlated with home range size (r = -0.11; P = 0.03). Two distinct movement patterns of Westslope Cutthroat Trout in the SFCR basin were observed. Twenty-six fish (11 in 2013 and 15 in 2014) remained in the mainstem SFCR or in the lower Red River the entire summer (hereafter termed “mainstem” fish). In contrast, nine radio-tagged fish in 2013 and nine in 2014 moved into tributaries by July (hereafter termed “tributary” fish). Mean length was 306.9 mm (59.3 mm) for mainstem fish and 253.5 mm (40.1 mm) for tributary fish. The mean summer home range was 3.9 km (5.0 km) for mainstem fish and 16.5 km (8.1 km) for tributary fish. Two tributary fish in 2013 and one in 2014 moved back into the mainstem SFCR in August. In July and August, mainstem fish were concentrated between rkm 45.0 and 75.0 where water temperatures were generally the coldest (Figure 4).

Water temperatures increased from late-June through early-July in 2013 and 2014 (Figure 5). Data from the temperature loggers indicated that daily summer maximum temperatures in the SFCR were 10.8–28.4°C in 2013 and 8.6–27.6°C in 2014. Peak stream temperatures occurred on 2 July in 2013 and 30 July in 2014. The mean daily summer maximum temperature in the mainstem SFCR was 20.5°C (SE = 0.6°C) in 2013 and 18.9°C (0.5°C) in 2014. Temperature trends in the tributaries were similar to the mainstem SFCR; however, tributaries were generally cooler than most reaches in the SFCR (Figure 6). Mean daily maximum summer temperatures were high in the lower reaches of Red River (19.8 ± 0.3°C in 2013; 18.3 ± 0.4°C in 2014), American River (20.3 ± 3.6°C in 2013; 18.8 ± 0.5°C in 2014), Crooked River (19.0 ± 0.3°C in 2013; 16.7 ± 0.4°C in 2014), and Newsome Creek (19.3 ± 0.4°C in 2013; 20.3 ± 0.3°C in 2014). Mean daily maximum summer temperatures were much cooler in Johns (16.6 ± 0.4°C in 2013; 14.9 ± 0.4°C in 2014) and Tenmile creeks (15.8 ± 0.3°C in 2013; 16.7 ± 0.2°C in 2014).

During the summer, radio-tagged fish were located in water temperatures between 10.0–25.0°C (mean ± SE; 17.5 ± 0.13°C; Figure 7). In 2014, ambient water temperature and temperature measured by the temperature-sensing radiotransmitters were recorded at 185 relocations. The relationship between ambient water temperature and radiotransmitter temperature in 2014 showed that 68% of the temperatures recorded by the radiotransmitter were at least 0.1°C colder than the ambient water temperature measured at the location of the fish. Ninety percent of the temperatures recorded by the radiotransmitter were within 1.0°C and 70% were within 0.5°C of the ambient water temperature. At two detections, the radiotransmitter temperature was about 2.5°C warmer than the ambient temperature.

Radio-tagged fish occupied a variety of different channel-unit types during the summer (Table 1). In June, fish generally occupied riffle and pool habitats. In July and August, fish were found in pocket water, runs, and pools both in the SFCR and its tributaries. Mainstem fish were associated with large boulders at 27% of the detections during both summers. In 2013, two fish were associated with a combination of large boulders and large wood. One mainstem fish in 2013 used only large wood as a form of cover. In tributaries, 33% percent of summer detections in 2013 and 65% in 2014 were associated with instream cover. Of the fish associated with cover in tributaries, 47% in 2013 and 20% in 2014 were exclusively associated with large boulders. Twenty-five percent of the fish in 2013 and 37% in 2014 were exclusively associated with large wood. Fish detected in tributaries were also found near undercut banks, overhanging vegetation, and various combinations of cover.

Snorkel surveys

Westslope Cutthroat Trout were only observed upstream of rkm 33.7 during snorkel surveys (Figure 8). Twenty-three Westslope Cutthroat Trout were observed at 12 sites in the SFCR and at low density (mean ± SD; 0.0003 ± 0.0008 fish/m^2). The highest density of Westslope Cutthroat Trout (0.005 fish/m^2) was observed at rkm 68.7. Thirteen of the observed Westslope Cutthroat Trout were greater than 300 mm. Other species observed in the SFCR included Rainbow Trout, Chinook Salmon, Mountain Whitefish, *Catostomus* spp., *Rhinichthys* spp, and Northern Pikeminnow. Smallmouth Bass were observed in sites downstream of rkm 20.0 and five Bull Trout were observed at sites near the confluence of Tenmile Creek (rkm 76.6).

Four top logistic models ($\Delta AIC_c \leq 2.0$) relating biotic and abiotic variables to the presence of Westslope Cutthroat Trout in the SFCR were identified (Table 2). Maximum temperature occurred in three of the top models, large substrate occurred in two models, and Rainbow Trout density and Region each occurred in one of the top models. The presence of Westslope Cutthroat Trout was negatively related to maximum temperature and Rainbow Trout density. Westslope Cutthroat Trout were not observed in sites where the maximum diel temperature exceeded 21.7°C. Westslope Cutthroat Trout presence was positively related to large substrate and inversely to the Lower Region.

DISCUSSION

Understanding the movement, distribution, and resource use of fishes is critical for guiding management and conservation efforts. Resource needs and availability of suitable habitat for fishes is dynamic through time and influences their movement and distribution on multiple spatial and temporal scales. General movement patterns of Westslope Cutthroat Trout in the SFCR basin through most of the year were similar to those reported in other studies (Hunt 1992; Brown and Mackay 1995a; Jakober et al. 1998; Schmetterling 2001; Schoby and Keeley 2011). The primary differences between Westslope Cutthroat Trout in the SFCR system and previous research were observed during the summer.

Although few fish were relocated during the winter and spring, findings from this study provide insight on overwintering habitat, tributaries important for spawning, and general movement patterns of fluvial Westslope Cutthroat Trout. The timing of autumn and winter movements of radio-tagged fish in the SFCR basin is similar to that reported by other radiotelemetry studies investigating movement of fluvial Westslope Cutthroat Trout (Brown and Mackay 1995a; Jakober et al. 1998; Schmetterling 2001; Schoby and Keeley 2011). Movement patterns in the SFCR indicated that radio-tagged fish typically moved downstream in late August through September from their summer residence. Five fish that spent the summer in tributaries moved downstream into the mainstem SFCR in autumn or winter. The remaining tributary fish were last detected in low-elevation reaches of tributaries. Unfortunately, road conditions prohibited tracking tributary fish during winter. Along the mainstem, tracking during the winter indicated that one fish moved out of the Red River and into the upper mainstem SFCR.

Deep-pool habitat is thought to be important to winter survival of Westslope Cutthroat Trout. Use of deep overwintering habitat is likely attributed to stable winter conditions and a lower probability of subsurface ice formation (Lindstrom and Hubert 2004). Overwintering in the mainstem SFCR primarily occurred between rkm 49.0 and 55.0 in deep pools and runs. Use of deep pools by Westslope Cutthroat Trout for overwintering habitat was reported in the Ram River basin, Alberta (Brown and Mackay 1995a), and in the Salmon River, Idaho (Schoby and Keeley 2011). Similarly, Westslope Cutthroat Trout used Beaver *Castor canadensis* ponds in tributaries to the Bitteroot River, Montana (Jakober et al. 1998). In the mainstem SFCR during the winter, radio-tagged fish aggregated in deep pools or deep runs.

As many as four radio-tagged fish were detected in the same channel-unit during the winter, primarily between rkm 49.0 and 55.0 in the mainstem SFCR.

In the spring, fluvial Westslope Cutthroat typically migrate into tributaries to spawn (Schmetterling 2001; Schoby and Keeley 2011; Pierce et al. 2014). Although the number of radio-tagged fish was low, upstream movement was observed from April–July in 2013. Two radio-tagged fish were observed and one was assumed to have moved into Mill Creek, a tributary to the mainstem SFCR (rkm 53.6), in May and June. Westslope Cutthroat Trout sometimes travel over 30 km upstream to spawn (Schmetterling 2001; Schoby and Keeley 2011) and distances over 50.0 km have been recorded (Bjornn and Mallet 1964; Pierce et al. 2014). Unfortunately, we were unable to determine the upstream extent of movement in Mill Creek due to access limitations. In addition, several fish captured in screw traps in late spring near the confluences of the Red, American, and Crooked rivers had physical characteristics (i.e., dark coloration, loose skin on bellies, eggs not present during surgery) that indicated post-spawning conditions and downstream movement shortly after spawning. The timing of the suspected spawning movements (May–June) coincided with what has been reported for Westslope Cutthroat Trout in the Flathead (Muhlfeld et al. 2009) and Blackfoot rivers, Montana (Schmetterling 2001; Pierce et al. 2014), Ram River basin (Brown and Mackay 1995b), and upper Salmon River (Schoby and Keely 2011). Although patterns observed during the winter and spring are interesting and contribute to our knowledge on the ecology of Westslope Cutthroat Trout, the most important patterns observed in this study were during the summer.

Westslope Cutthroat Trout is a coldwater species typically found in water temperatures less than 22.0ºC during the summer. Summer water temperatures in the mainstem SFCR and some of its major tributaries (i.e., Red and American rivers, and Newsome Creek) exceeded thermal levels that commonly induce stress and mortality in juvenile (>19.6°C; Bear et al. 2007) and adult (>22.0°C; Bjornn and Reiser 1991) Westslope Cutthroat Trout. Movement and resource use strategies of Westslope Cutthroat Trout during the summer is largely dictated by interactions between water temperatures and stream geomorphology (Poole and Berman 2001).

The riverscape of the SFCR encompasses the entire catchment area including groundwater flow pathways (Stanford 2006). The riverscape can be delineated into multiple hierarchical levels to define the scale of resource use by fishes. Large-scale variables such as drainage area, elevation, channel gradient, substrate type, and valley form can be indicators of available resources for fishes at a reach level. Reaches are broadly defined as confined or unconfined depending on the constraints of the valley (Moore and Gregory 1989; Beechie et al. 2006). Streams confined by steep, rigid canyons are typically straight with little lateral complexity (Moore and Gregory 1989; Montgomery and Buffington 1997). Erosive by nature, stream channels in confined canyons are longitudinally dynamic and are not typically cooled by hyporheic processes via groundwater influence. Instead, such systems rely on cold water from tributaries and from shade (Stanford 2006). Consequently, fish move upstream to cold thermal refuge in high-elevation reaches of the mainstem river or into tributaries (Bjornn and Mallet 1964; Hunt 1992; Brown and Mackay 1995a; Zurstadt and Stephan 2004). The Lochsa, North Fork Clearwater, and St. Joe rivers and Kelly Creek in north-Idaho provide examples of generally confined systems with steep, rigid geomorphic features. In those systems, Hunt (1992) reported that Westslope Cutthroat Trout moved to high-elevation reaches of the mainstem rivers during the summer. Similarly, Westslope Cutthroat Trout in the Middle Fork Salmon River, Idaho, were primarily distributed in high-elevation reaches of the mainstem river or in tributaries during the summer (Bjornn and Mallet 1964; Zurstadt and Stephan 2004). Brown and Mackay (1995a) reported upstream movement of Westslope Cutthroat Trout to high-elevation summer habitat in the North Ram River.

In contrast to confined reaches, unconfined reaches have depositional properties and are characterized by complex channels often consisting of low channel gradient, high sinuousity, abundant side channels, and extensive floodplains (Moore and Gregory 1989; Beechie et al. 2006; Stanford 2006). Hyporheic exchange is common in unconfined valleys and provides thermal refuge for fishes during the summer (Ebersole et al. 2001; Tonina and Buffington 2009). Systems such as the Blackfoot, Coeur d'Alene (Idaho), and upper Salmon rivers, are generally unconfined and have large floodplains with substantial lateral complexity (Gregory and Walling 1973). In unconfined reaches, Westslope Cutthroat Trout are typically sedentary throughout the summer. For example, Stevens and DuPont (2011) found that Westslope Cutthroat Trout used side-channel habitat of the Coeur d'Alene River as thermal refuge during the summer even at low elevations (649 m). Schmetterling (2001) reported that Westslope Cutthroat Trout in the Blackfoot River were largely sedentary and remained in deep pool habitat during periods with warm water temperatures. Similarly, Schoby and Keeley (2011) found that most Westslope Cutthroat Trout distributed throughout the upper mainstem South Fork Salmon River moved only short distances during the summer.

The SFCR basin has unique combinations of both confined reaches in steep canyons and unconfined reaches with large floodplains. As such, mobile and sedentary summer movement patterns would be expected in the SFCR basin given the different geomorphic characteristics. The middle section of the mainstem SFCR (rkm 30.0–75.0) consists of steep canyons of rigid granite substrate and has moderate to high stream gradients. Based on previous results (i.e., Hunt 1992, Zurstadt and Stephan 2004), we might expect that fish would move into high-elevation reaches of the system. However, radio-tagged fish in this section of the SFCR had small summer home ranges and were largely sedentary throughout the summer. A 16.0 km section (rkm 60.0–75.0) of the mainstem SFCR has a mean gradient of 17.4% and might dissuade upstream movement by fish during the summer. Although the high-gradient section might have some influence on the distribution of Westslope Cutthroat Trout during the summer, upstream movement was likely not required by fish in the middle section of the mainstem SFCR because of cool water temperatures. For instance, when the mean maximum water temperature in July and August was 21.0°C or higher in the upper and lower SFCR, maximum water temperatures were 20.0°C or less in the middle section of the SFCR. Cold water temperatures are largely attributed to watersheds that have been preserved in their natural state. The Gospel-Hump Wilderness Area is 83,386 ha located between the Salmon and South Fork Clearwater rivers; contributions from tributaries (e.g., Johns and Temile creeks) in the Gospel-Hump Wilderness Area provide cool water temperatures for fishes in the middle section of the mainstem SFCR during the summer. Warm water temperatures during the summer in the lower and upper sections of the SFCR might also be constraining fish to the middle section.

In contrast to the confined reaches of the SFCR, the lower section of the mainstem SFCR (i.e., downstream of rkm 30.0) has low channel gradient and large floodplains in unconfined valleys. Likewise, the upper section of the mainstem SFCR (upstream of rkm 75.0) and the lower sections of the Red, American, and Crooked Rivers have low to moderate channel gradient and flow through unconfined valleys with large floodplains. Based on previous research of Westslope Cutthroat Trout behavior in such systems (e.g., Schmetterling 2001, Schoby and Keeley 2011, and Stevens and DuPont 2011), we would expect Westslope Cutthroat Trout to remain relatively sedentary. Instead, as water temperatures increased, radio-tagged fish in the upper SFCR basin typically moved long distances upstream in tributaries. Few Westslope Cutthroat Trout used the upper section of the mainstem SFCR, or the lower portions of the Red, American, and Crooked rivers or Newsome Creek in August. Similarly, movement of radio-tagged fish and observations from snorkeling found no evidence that Westslope Cutthroat Trout inhabited the lower section of the SFCR during the summer. It is likely that the low elevation of the lower section attributes to warm summer water temperatures. Also, despite the geomorphology of the lower and upper sections of the SFCR basin, current and historical land use practices (i.e., livestock grazing, mining, timber harvest, log drives) have altered habitat characteristics such that thermal refuge is likely lacking in those areas (Siddall 1992; Dunnigan 1997; Poole and Berman 2001).

Reaches consist of sequences of channel units (e.g., pool, riffle, run) determined by the interactions between flow and the elements of the streambed (Bisson et al. 2006). Nested in channel units are localized features such as depth and cover that fish often select for use. Although water temperatures were likely the primary driver of Westslope Cutthroat Trout movement and distribution in the SFCR basin, local factors may also be important for Westslope Cutthroat Trout at small scales. The abundance and quality of resources (e.g., temperature, cover, food) affect growth and survival of fishes (Hilderbrand and Kershner 2000). Physical structure (i.e., boulders, large wood, overhanging vegetation, undercut banks) can facilitate the formation of deep pools which in turn, provide shade that lowers water temperature and cover from predators (Griffith and Smith 1993; Rosenfeld et al. 2000; Poole and Berman 2001). Depth and cover were found to be the most important factors influencing coastal Cutthroat Trout *O. clarki clarki* in Musqueam Creek, Vancouver (Heggenes et al. 1991). Depth was also important for Westslope Cutthroat Trout in the Coeur d'Alene River (Stevens and DuPont 2011) and in Trestle Creek (Bonneau et al. 1995) in north-Idaho during the summer. Fish in tributaries of the SFCR were more frequently found near cover than fish that remained in the mainstem SFCR. Snorkeling and radiotelemetry indicated that Westslope Cutthroat Trout in the mainstem SFCR were found in various channel-unit types and at various depths but were not often associated with cover. Brown and Mackay (1995a) found that Westslope Cutthroat Trout were not often associated with depth and cover in the North Ram River. Likewise, Westlope Cutthroat Trout were found in a variety of habitat types in north-Idaho streams during the summer (Hunt 1992). Available channel-unit habitat was not quantified in the current study, therefore, use of small-scale habitat should be interpreted with caution.

In addition to water temperature and habitat features, results from snorkeling indicated that Rainbow Trout were found in high density in the mainstem SFCR (mean ± SD; 0.019 ± 0.027) and were negatively related to the presence of Westslope Cutthroat Trout. The success of Rainbow Trout is likely attributed to environmental conditions, specifically temperature (Dunham et al. 2003; Kozfkay et al. 2007). Rainbow Trout tend to be more tolerant of warmer water temperatures than Westslope Cutthroat Trout. Bear et al. (2007) experimentally evaluated the temperature tolerance of Rainbow Trout and Westslope Cutthroat Trout and found that 72.8% of Rainbow Trout survived when held at 24.0°C whereas mortality was 100% for Westslope Cutthroat Trout held at the same temperature. Thus, Rainbow Trout likely have an advantage over Westslope Cutthroat Trout when water temperatures exceed 22.0°C. Although Rainbow Trout and Westslope Cutthroat Trout may use similar resources (i.e., space, food), the negative association found in the mainstem SFCR is likely attributed to warm conditions that are better suited for Rainbow Trout.

Management implications

Overexploitation, habitat degradation, and nonnative trout have been attributed to the decline of Westslope Cutthroat Trout across their distribution (Rankel 1971; Liknes and Graham 1988; Krueger and May 1991; Shepard et al. 1997). Although we did not evaluate angler harvest in the SFCR basin, Westslope Cutthroat Trout are highly susceptible to exploitation (MacPhee et al. 1966; Ball 1971; Johnson and Bjornn 1975). The mainstem SFCR supports a popular trout (Rainbow Trout and Westslope Cutthroat Trout) fishery during the summer and is managed as catch-and-release for Westslope Cutthroat Trout and adipose-intact Rainbow Trout. Three radio-tagged fish in the mainstem SFCR were suspected to have been harvested or died due to handling by anglers. Conversations with anglers also suggest that their awareness of regulations for Westslope Cutthroat Trout and ability to distinguish among trout species was questionable. Managers should consider enhancing educational awareness of regulations by posting signs in areas used by anglers (Schill et al. 2001). Another concern is that some fish move into tributaries as water temperatures in the mainstem SFCR increase. Not only do anglers have easy access to most areas in the SFCR basin via roads, but anglers can harvest two trout per day, including Westslope Cutthroat Trout. Although only two fish were suspected of being harvested in a tributary during the summer, the fate or cause of mortality of 31% of the radio-tagged fish was unknown. Therefore, actual exploitation was unknown and future work should consider evaluating harvest of Westslope Cutthroat Trout in the basin. However, given the movement patterns and distribution of

Westslope Cutthroat Trout during the summer, water temperature was likely the primary limiting factor influencing fluvial fish in the mainstem SFCR.

Large-scale mining and logging operations that began in the mid-1800s have altered the riverscape of the SFCR basin. Disturbance to the floodplain from dredging in unconfined reaches can increase erosion of stream banks, decrease channel roughness and complexity, and cause pools to fill with sediment (Thomas 1985; Harvey and Lisle 1998). Logging and road construction can also result in channelized streams, increased stream bank erosion and sedimentation (Eaglin and Hubert 1993). These factors can have direct effects on the water temperature regime of a system by disrupting hyporheic processes. The spatial temperature model developed during this study indicated that 61% of the mainstem SFCR in 2013 and 74% in 2014 was predicted to have mean summer water temperatures less than 22.0°C. Suitable thermal habitat was primarily in the middle section of the SFCR where the valley form limited major land use change and cold tributaries influenced the temperature regime. In the upper basin where land use has been greatly altered, water temperatures during the summer typically exceeded the thermal limits of Westslope Cutthroat Trout.

Although fish exhibited different patterns of movement among systems during the summer, they all seemed to respond to warm water temperatures. Our observations suggest that the behavior of Westslope Cutthroat Trout reflects the constraints of the system and availability of thermal refuge. Therefore, management and conservation efforts should focus on areas in the upper SFCR basin (e.g., Red, American, and Crooked rivers; Newsome Creek) that have experienced habitat degradation from mining, logging, and grazing practices (Siddall 1992). Several agencies have already begun addressing poor tributary habitat in the SFCR basin by implementing large-scale habitat restoration projects to restore natural flow dynamics in unconfined valleys (Fletcher 2006). Continued restoration in the upper SFCR basin will likely increase deep-water habitat, riparian habitat, and lateral complexities that will improve conditions for Westslope Cutthroat Trout in the entire system. Improving the habitat and water temperature regime of the upper SFCR system will also enhance connectivity in the system and ultimately secure populations of fluvial Westslope Cutthroat Trout in the SFCR basin.

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Table 1. Total number of detections and proportional use of channel-unit type, depth, and cover type by radio-tagged Westslope Cutthroat Trout in the South Fork Clearwater River basin, Idaho by season in 2013 and 2014. Seasons were defined as summer (June–August), autumn (September–November, winter (December–February), and spring (March–May). Data for detections in the mainstem and in the tributary were grouped separately.

	2013				2013–2014		2014			
	Summer		Autumn		Winter		Spring		Summer	
Habitat characteristics	Total or mean	SE	Total or mean	SE	Total or mean	SE	Total or mean	SE	Total or mean	SE
					Mainstem detections					
Number of detections	296		63		13		27		217	
Channel unit type										
Rapid	0.068	0.029	0.011	0.011	0.000	0.000	0.000	0.000	0.099	0.055
Riffle	0.306	0.045	0.139	0.070	0.000	0.000	0.000	0.000	0.176	0.059
Pocket	0.068	0.025	0.110	0.017	0.167	0.000	0.162	0.085	0.150	0.029
Run	0.208	0.049	0.260	0.059	0.417	0.068	0.200	0.200	0.436	0.130
Glide	0.017	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pool	0.333	0.012	0.480	0.119	0.417	0.068	0.638	0.234	0.139	0.033
Depth (m)										
0.0–0.5	0.126	0.032	[a]	[a]	[a]	[a]	[a]	[a]	0.021	0.021
0.6–1.0	0.318	0.079	[a]	[a]	[a]	[a]	[a]	[a]	0.526	0.040
1.1–1.5	0.159	0.046	[a]	[a]	[a]	[a]	[a]	[a]	0.352	0.071
1.6–2.0	0.039	0.031	[a]	[a]	[a]	[a]	[a]	[a]	0.024	0.013
2.1–2.5	0.033	0.033	[a]	[a]	[a]	[a]	[a]	[a]	0.029	0.029
2.6–3.0	0.033	0.033	[a]	[a]	[a]	[a]	[a]	[a]	0.006	0.006
> 3.0	0.292	0.054	[a]	[a]	[a]	[a]	[a]	[a]	0.042	0.033
Cover type										
Large boulder	0.261	0.010	0.058	0.058	[a]	[a]	[a]	[a]	0.257	0.055
Large wood	0.033	0.022	0.000	0.000	[a]	[a]	[a]	[a]	0.002	0.002
Undercut bank	0.013	0.007	0.000	0.000	[a]	[a]	[a]	[a]	0.005	0.005

Table 1. Continued from page 41 (headings on previous page).

Overhanging vegetation	0.000	0.000	0.000	0.000	[a]	[a]	[a]	[a]	0.000	0.000
Combination	0.011	0.002	0.000	0.000	[a]	[a]	[a]	[a]	0.019	0.012
None	0.682	0.020	0.942	0.058	[a]	[a]	[a]	[a]	0.717	0.068
					Tributary detections					
Number of detections	88		14						56	
Channel unit type										
Rapid	0.050	0.040	0.000	0.000	[a]	[a]	[a]	[a]	0.058	0.043
Riffle	0.501	0.090	0.091	0.074	[a]	[a]	[a]	[a]	0.197	0.058
Pocket	0.037	0.023	0.000	0.000	[a]	[a]	[a]	[a]	0.071	0.056
Run	0.059	0.034	0.000	0.000	[a]	[a]	[a]	[a]	0.214	0.132
Glide	0.015	0.009	0.000	0.000	[a]	[a]	[a]	[a]	0.015	0.015
Pool	0.192	0.107	0.573	0.022	[a]	[a]	[a]	[a]	0.302	0.074
Depth (m)										
0.0–0.5	0.512	0.145	[a]	[a]	[a]	[a]	[a]	[a]	0.373	0.141
0.6–1.0	0.252	0.080	[a]	[a]	[a]	[a]	[a]	[a]	0.527	0.059
1.1–1.5	0.064	0.036	[a]	[a]	[a]	[a]	[a]	[a]	0.000	0.000
1.6–2.0	0.128	0.072	[a]	[a]	[a]	[a]	[a]	[a]	0.100	0.082
2.1–2.5	0.044	0.044	[a]	[a]	[a]	[a]	[a]	[a]	0.000	0.000
2.6–3.0	0.000	0.000	[a]	[a]	[a]	[a]	[a]	[a]	0.000	0.000
> 3.0	0.000	0.000	[a]	[a]	[a]	[a]	[a]	[a]	0.000	0.000
Cover type										
Large boulder	0.063	0.049	1.000	0.000	[a]	[a]	[a]	[a]	0.165	0.062
Large wood	0.034	0.018	0.000	0.000	[a]	[a]	[a]	[a]	0.214	0.118
Undercut bank	0.044	0.026	0.000	0.000	[a]	[a]	[a]	[a]	0.068	0.039
Overhanging vegetation	0.000	0.000	0.000	0.000	[a]	[a]	[a]	[a]	0.015	0.015
Combination	0.034	0.018	0.000	0.000	[a]	[a]	[a]	[a]	0.286	0.118
None	0.826	0.088	0.000	0.000	[a]	[a]	[a]	[a]	0.252	0.011

[a] Not available due to ice cover or high flow events.

Table 2. Model selection results from multiple logistic regression models relating biotic and abiotic variables to the presence of Westslope Cutthroat Trout from snorkel surveys in the South Fork Clearwater River (SFCR), Idaho in August of 2014. Variables included maximum temperature (°C), large substrate (%), Lower, Middle and Upper Regions of the SFCR ($Region_i$), mean depth (m), area of wood (m^2), and Rainbow Trout density (RBT; fish/m^2). The parameter estimates, number of parameters (K), Akaike's information criterion corrected for small sample size (AIC_c), measure of each model relative to the best model (ΔAIC_c), model weight (w_i), and McFadden's $\hat{\rho}^2$ are included. Only top models (i.e., models with $\Delta AIC_c \leq 2.0$) and saturated model are presented.

Models	K	AIC_c	ΔAIC_c	w_i	$\hat{\rho}^2$
Top models					
$10.41 - 0.73(Temp_{max}) + 4.17(Substrate_{large})$	3	55.32	0.00	0.22	0.19
$15.24 - 0.81(Temp_{max})$	2	55.92	0.39	0.18	0.15
$- 19.57 + 18.70(Region_M) + 18.39(Region_U)$	3	57.37	1.58	0.11	0.16
$12.07 - 0.82(Temp_{max}) + 4.93(Substrate_{large}) - 10.68(RBT)$	4	56.61	2.05	0.09	0.20
Saturated model					
$-5.05 - 0.25(Temp_{max}) - 1.22(Temp_{min}) + 16.67(Region_M) + 14.64(Region_U) + 0.18(Depth_{mean}) + 6.05(Substrate_{large}) - 0.09(Wood) - 19.80(RBT)$	10	60.99	8.72	0.00	0.29

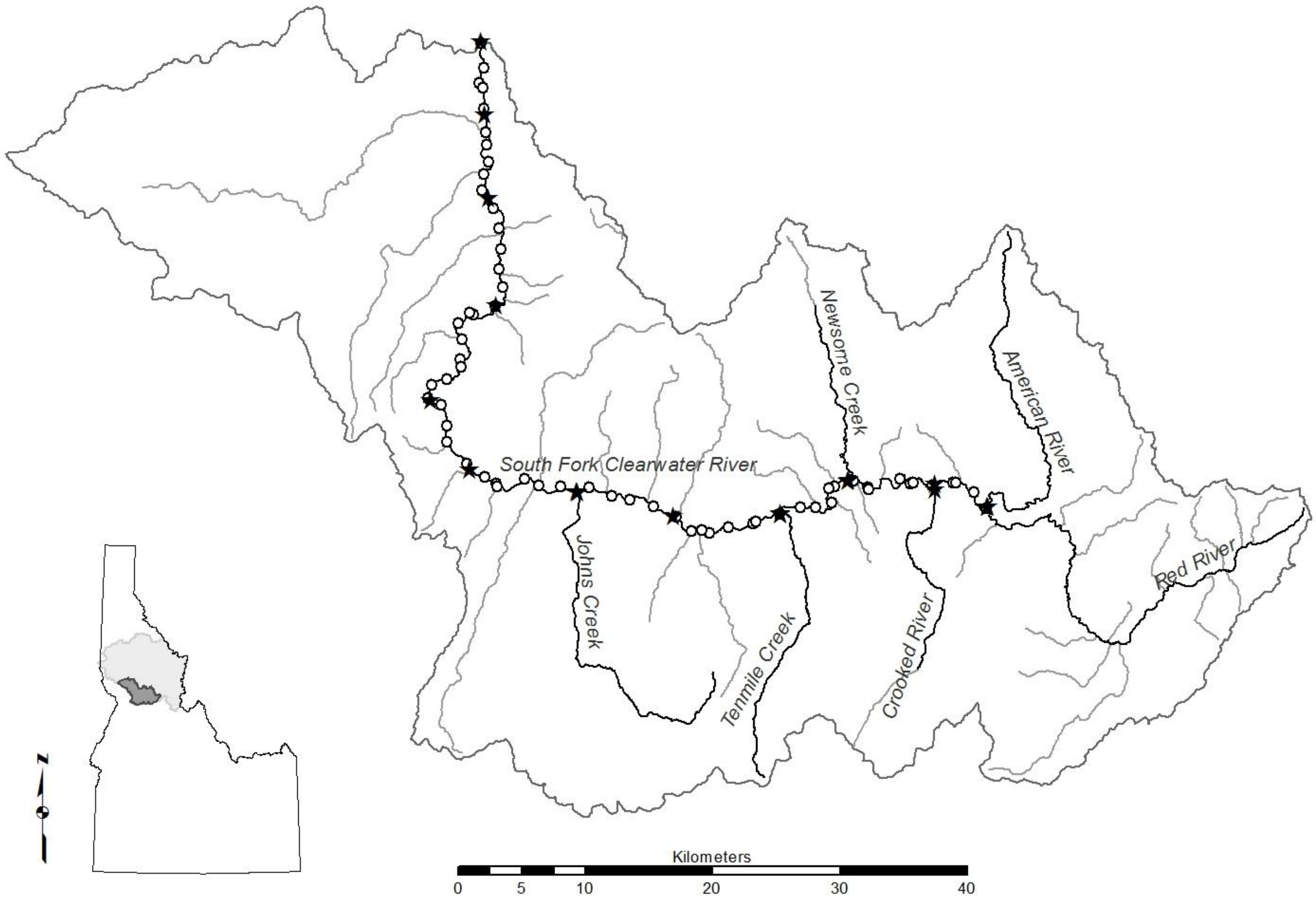

Figure 1. Location of sites snorkeled (open circles; August 2014) and temperature loggers (stars) in the South Fork Clearwater River basin, Idaho. The mainstem and primary tributaries were tracked June 2013–October 2014 to evaluate movement, distribution, and habitat use of radio-tagged fish in the basin.

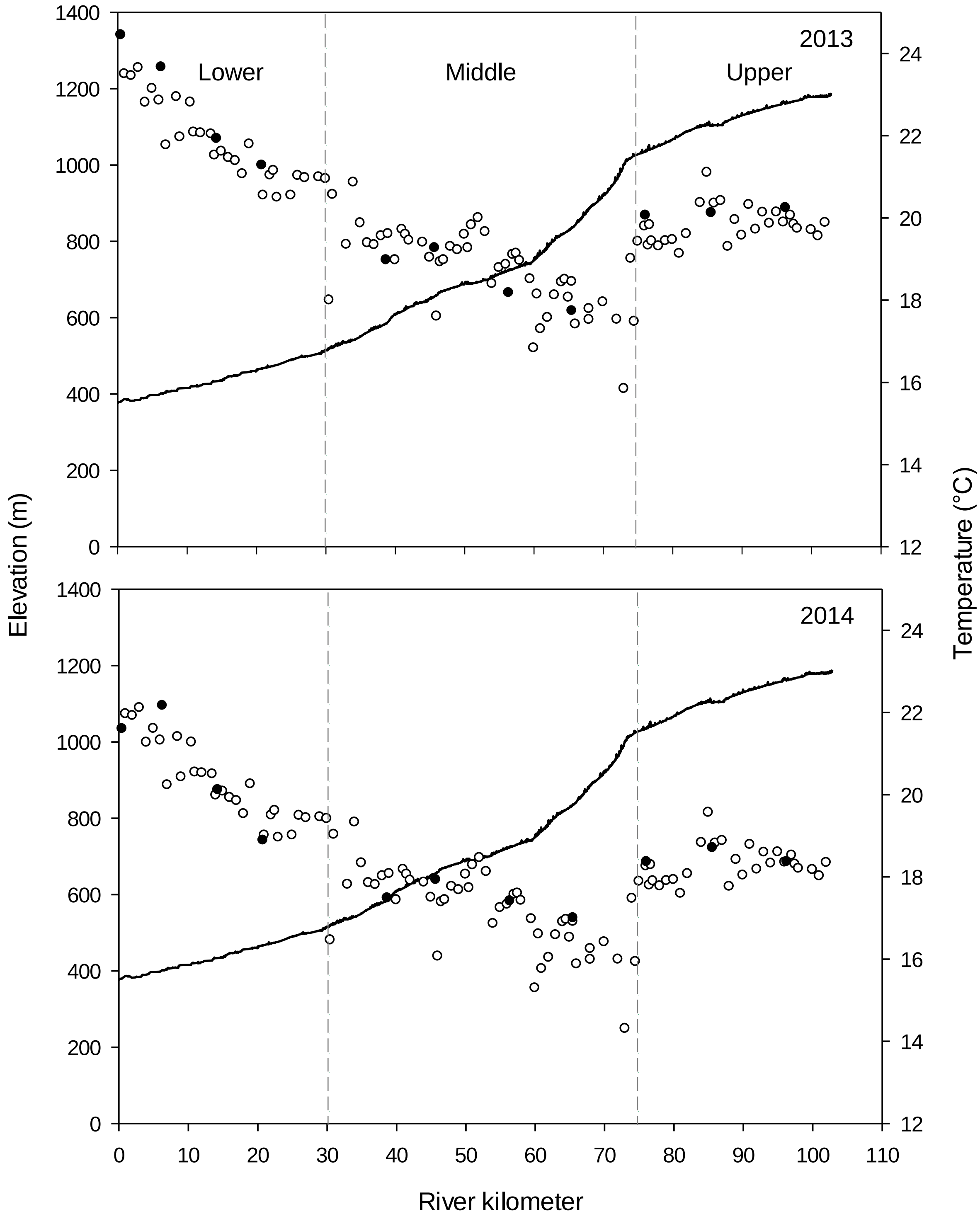

Figure 2. Elevation and mean summer (June–August) maximum temperature profiles consisting of measured (solid) and predicted (open) temperatures in 2013 and 2014 in the South Fork Clearwater River, Idaho. Locations of breaks for Lower, Upper and Middle Regions are also provided.

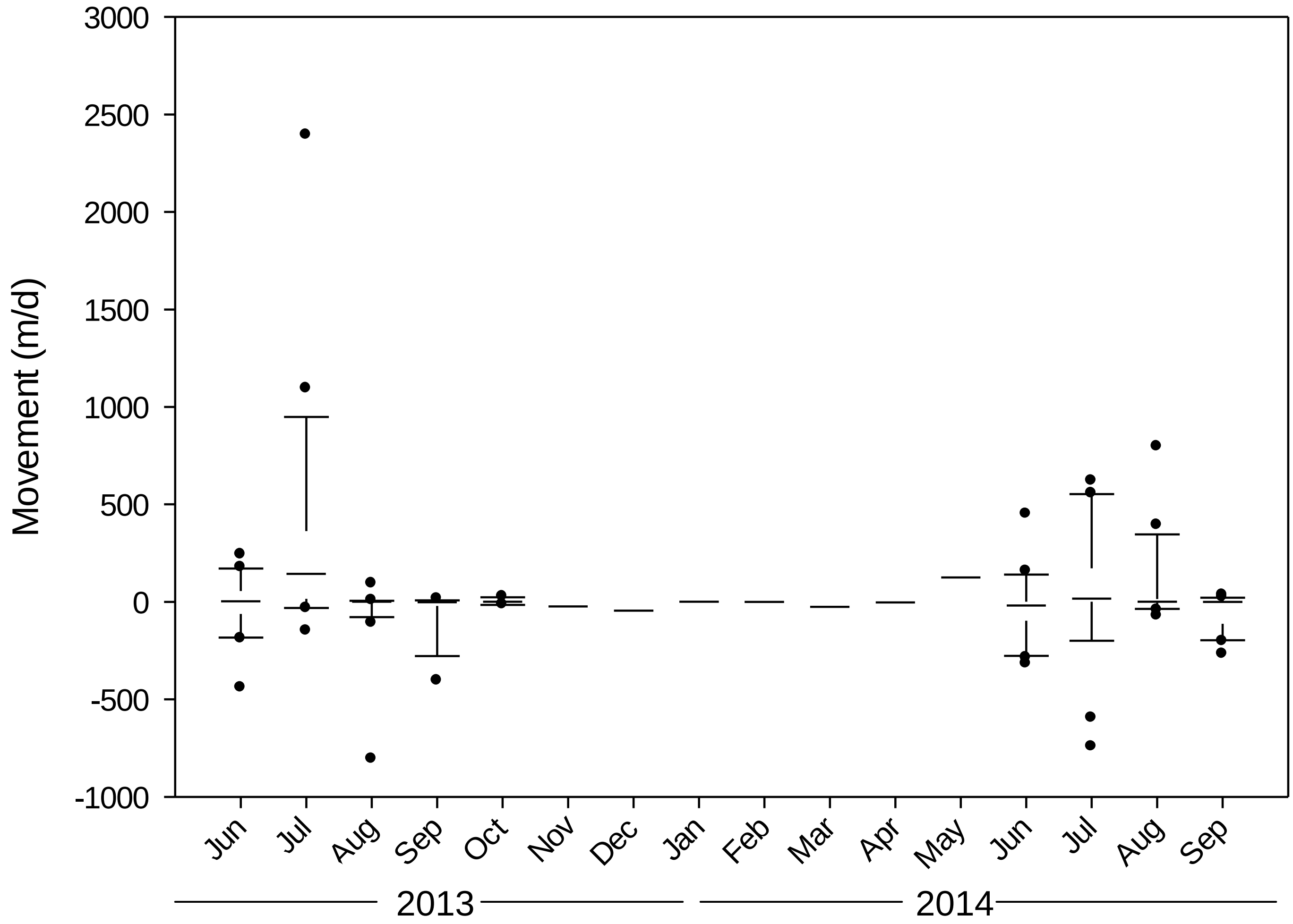

Figure 3. Movement rates of radio-tagged Westslope Cutthroat Trout by month in the South Fork Clearwater River basin in 2013 and 2014. Positive values indicate upstream movements, whereas negative values indicate downstream movement. Boxplots are shown with medians, first and third quartiles, and outliers (black points).

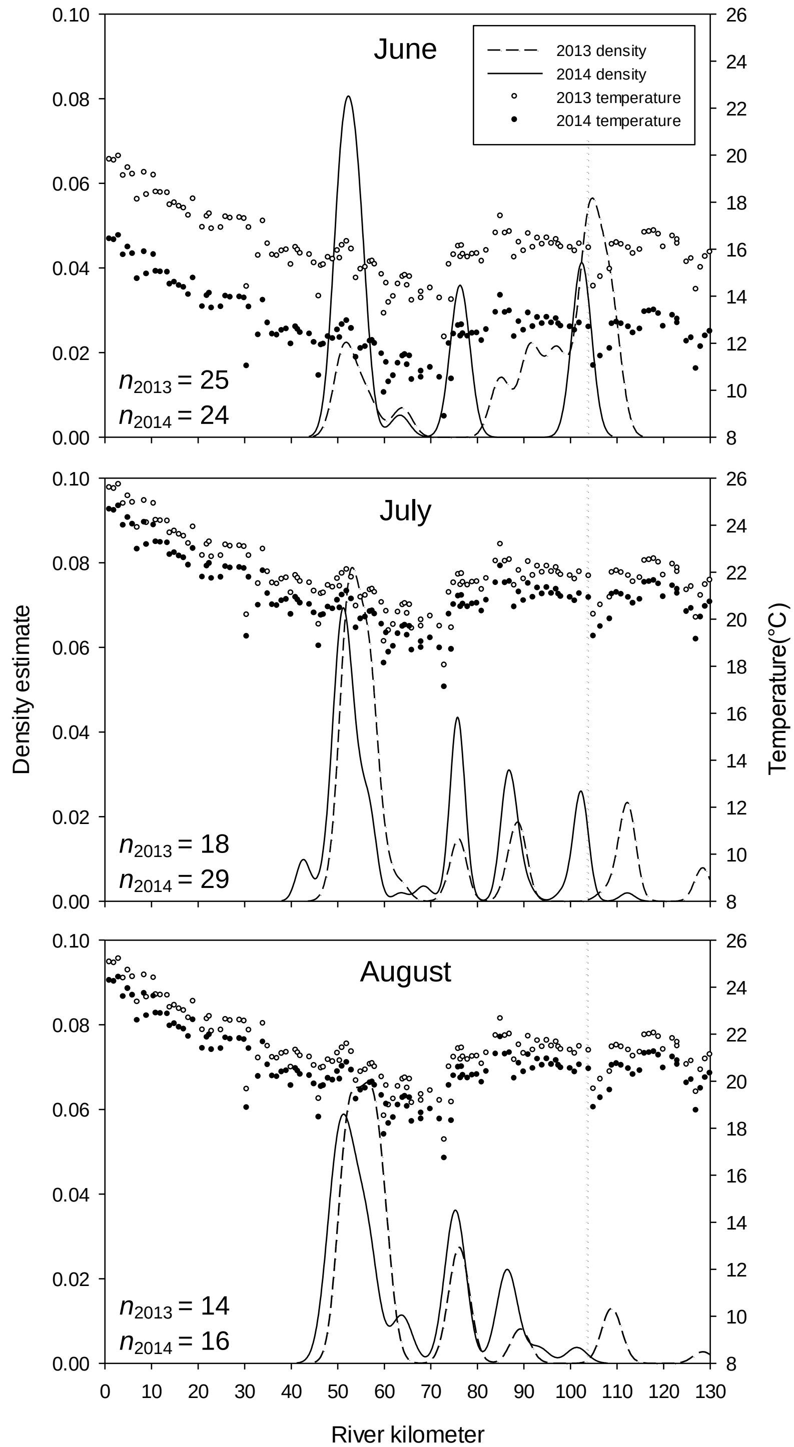

Figure 4. Monthly kernel density estimates for summer detections of radio-tagged Westslope Cutthroat Trout in the mainstem South Fork Clearwater River and lower Red River (starting at rkm 103 [dotted]), Idaho, in 2013 (dashed) and 2014 (solid). The number of fish detected by year and month and predicted monthly mean maximum water temperature for 2013 (open) and 2014 (closed) are included.

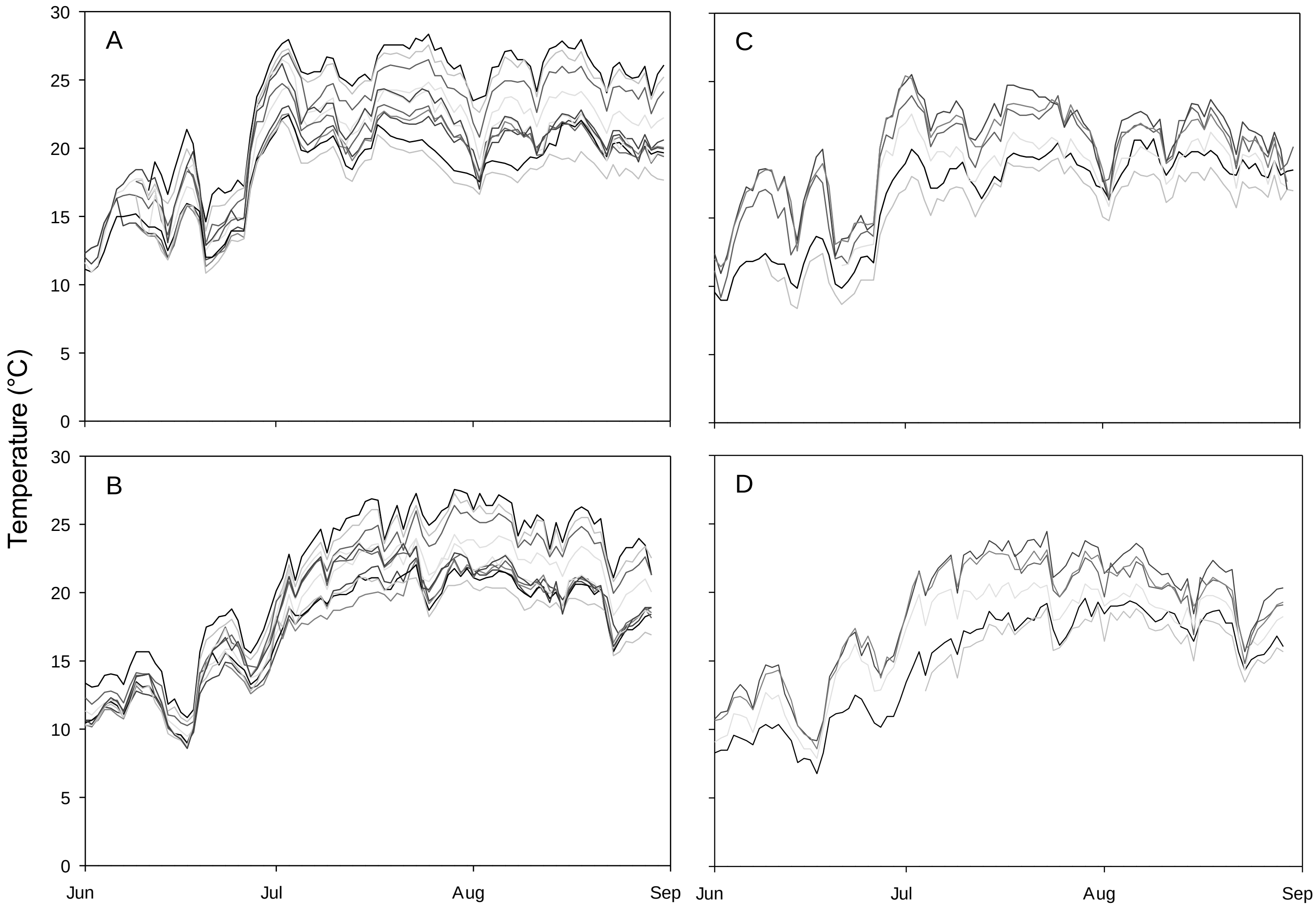

Figure 5. Daily maximum water temperatures in the South Fork Clearwater River, Idaho (June–August) in 2013 (A) and 2014 (B) and in six major tributaries in 2013 (C) and 2014 (D). Each line represents a different site where temperature was recorded.

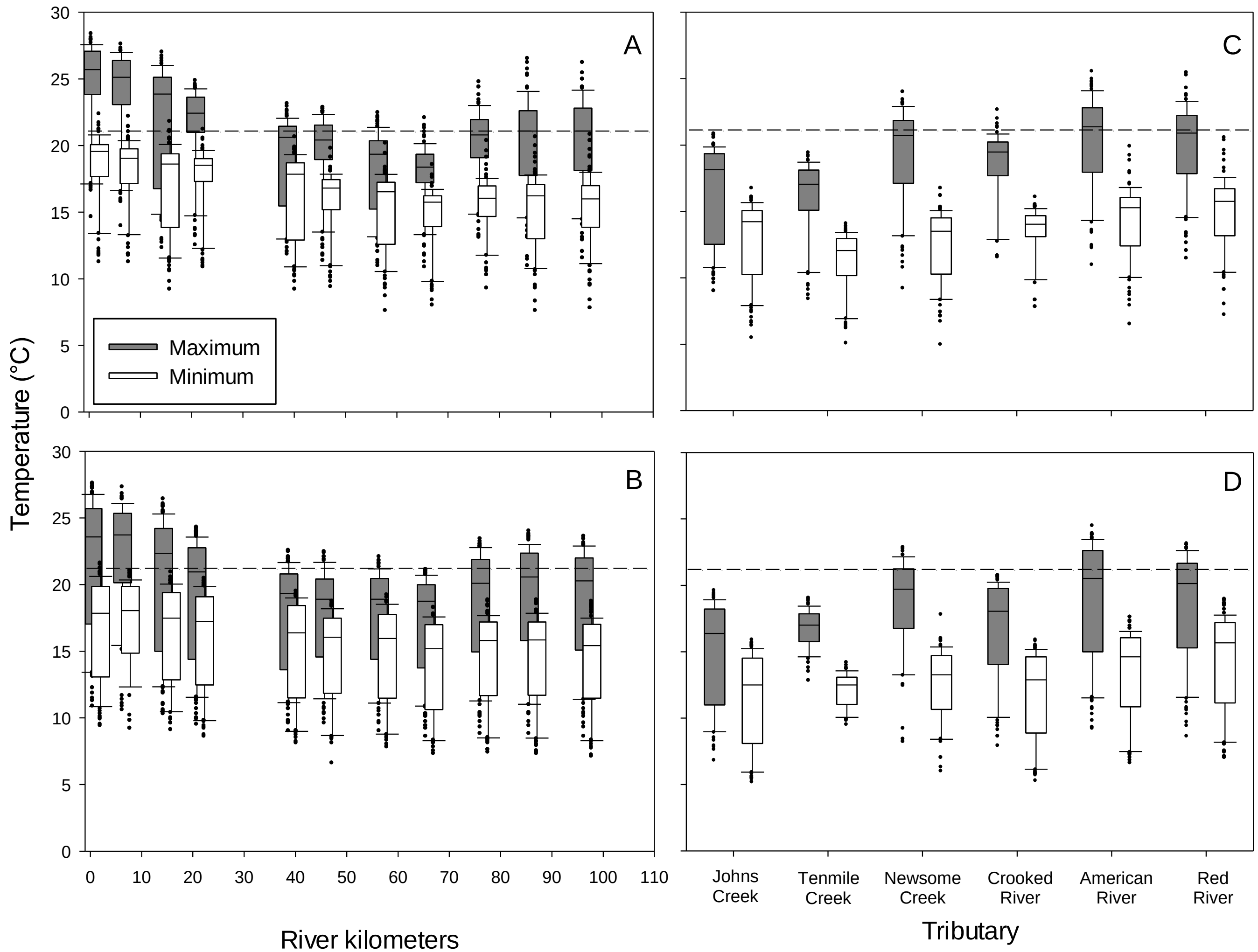

Figure 6. Variation of daily maximum temperatures in the South Fork Clearwater River, Idaho (June–August) in 2013 (A) and 2014 (B) and for six major tributaries in 2013 (C) and 2014 (D). Boxplots are shown with medians, first and third quartiles, and outliers (black points). The upper thermal limit (22.0°C) of adult Westslope Cutthroat Trout is represented by the dashed line.

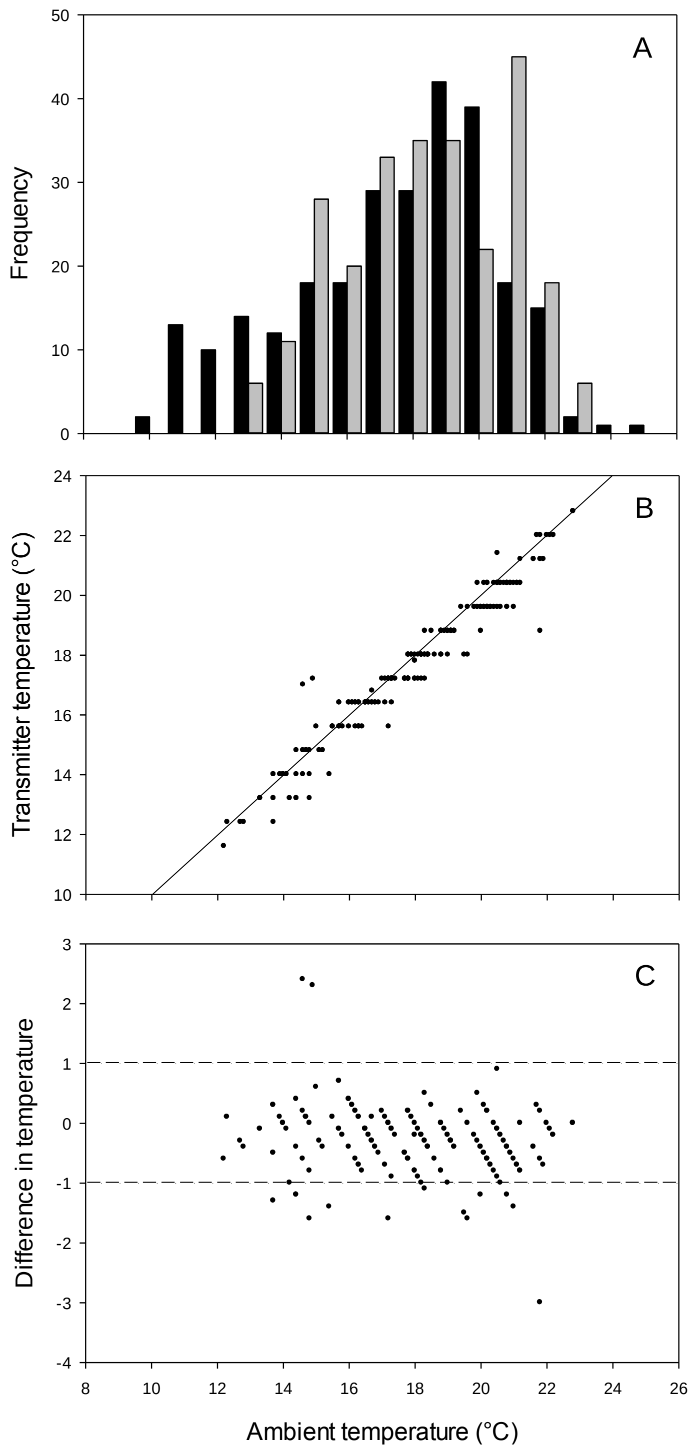

Figure 7. Ambient temperature for all fish detected in the South Fork Clearwater River, Idaho (black bars) and in tributaries (grey bars) from June–August in 2013 and 2014 (A), the relationship between ambient water temperature and transmitter temperature for detections in 2014 (B), and the difference between ambient and transmitter temperature as a function of ambient water temperature (C).

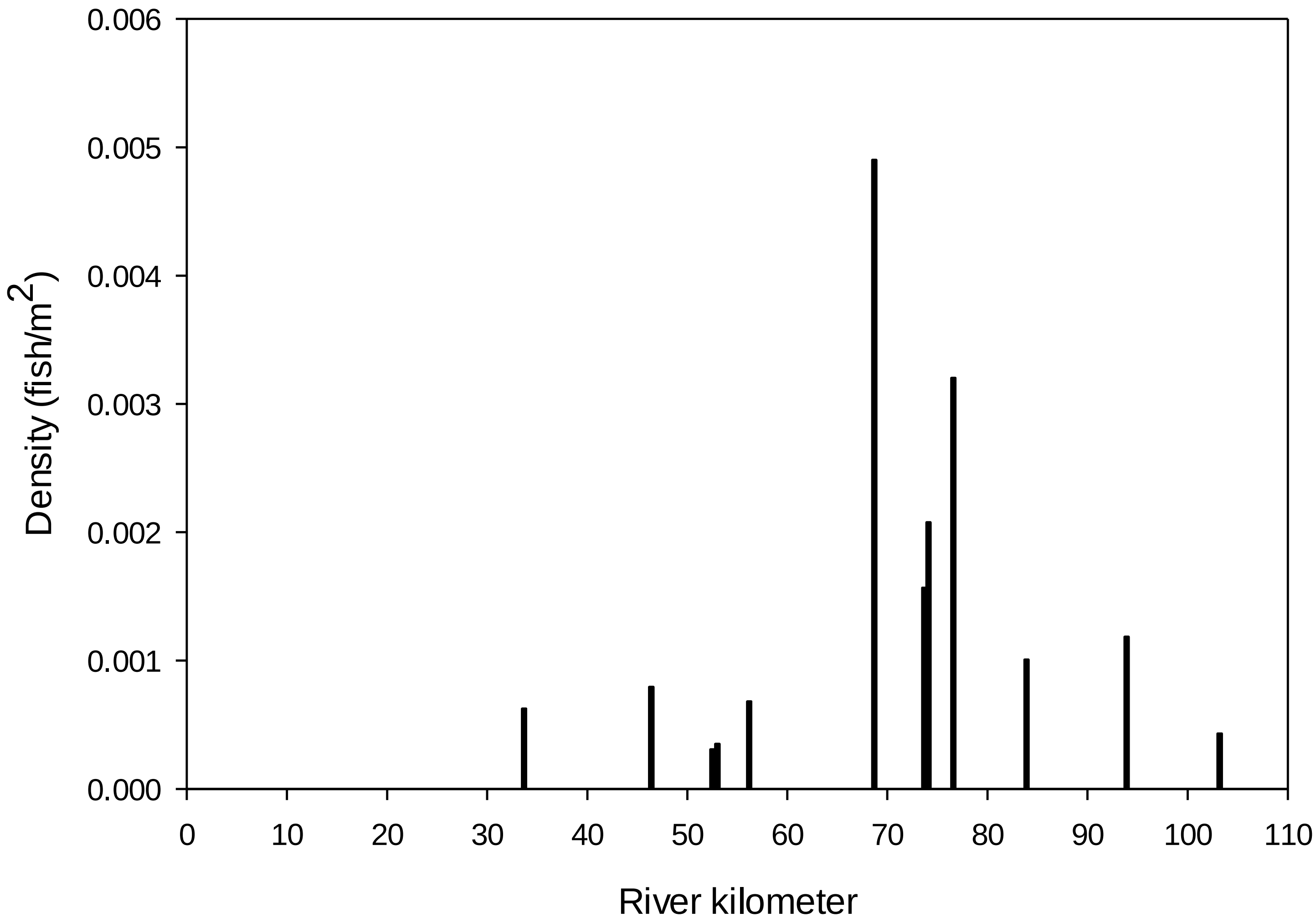

Figure 8. Densities of Westslope Cutthroat Trout observed at snorkel sites along the mainstem South Fork Clearwater River, Idaho, in August 2014.

APPENDICES

Appendix A. Radiotransmitter code, detection number, date, and stream name of each relocation of radio-tagged Westslope Cutthroat Trout in the South Fork Clearwater River basin, Idaho (June 2013–October 2014). River kilometer (starting from the confluence of the stream indicated) and World Geodetic System 1984 coordinates (Universal Transverse Mercator projection using zone 11) for each relocation are included.

Code	Date	Detection	Stream	River kilometer	Easting	Northing
1	6/24/2014	1	South Fork Clearwater River	51.0	580843	5075290
1	6/26/2014	2	South Fork Clearwater River	51.0	580852	5075230
1	7/4/2014	3	South Fork Clearwater River	42.6	576030	5080220
1	7/9/2014	4	South Fork Clearwater River	42.6	576044	5080190
1	7/15/2014	5	South Fork Clearwater River	42.6	576014	5080170
1	7/19/2014	6	South Fork Clearwater River	42.6	576029	5080210
1	7/22/2014	7	South Fork Clearwater River	42.5	576022	5080240
1	7/25/2014	8	South Fork Clearwater River	46.8	577717	5076930
1	7/31/2014	9	South Fork Clearwater River	46.9	577769	5076890
1	8/2/2014	10	South Fork Clearwater River	47.8	578493	5076660
1	8/9/2014	11	South Fork Clearwater River	48.7	579126	5076020
2	6/24/2014	1	South Fork Clearwater River	51.0	580883	5075300
2	6/26/2014	2	South Fork Clearwater River	50.9	580831	5075180
2	7/4/2014	3	South Fork Clearwater River	51.1	580962	5075290
2	7/9/2014	4	South Fork Clearwater River	51.1	580942	5075310
2	7/14/2014	5	South Fork Clearwater River	51.1	580961	5075320
2	7/15/2014	6	South Fork Clearwater River	51.1	580960	5075340
2	7/19/2014	7	South Fork Clearwater River	51.7	581436	5075670
2	7/22/2014	8	South Fork Clearwater River	54.7	583812	5075120
2	7/25/2014	9	South Fork Clearwater River	53.1	582616	5076100
2	7/31/2014	10	South Fork Clearwater River	52.6	582162	5076080
2	8/2/2014	11	South Fork Clearwater River	52.7	582196	5076130
2	8/9/2014	12	South Fork Clearwater River	52.6	582160	5076090
2	8/24/2014	13	South Fork Clearwater River	51.1	580963	5075310
2	10/4/2014	14	South Fork Clearwater River	51.1	580923	5075280

Appendix A. Continued from previous page.

3	6/24/2014	1	South Fork Clearwater River	51.0	580840	5075280
4	7/4/2014	1	South Fork Clearwater River	49.5	579739	5075640
4	7/9/2014	2	South Fork Clearwater River	49.5	579751	5075660
4	7/15/2014	3	South Fork Clearwater River	49.5	579749	5075640
4	7/19/2014	4	South Fork Clearwater River	49.5	579737	5075650
4	7/22/2014	5	South Fork Clearwater River	49.5	579731	5075650
4	7/25/2014	6	South Fork Clearwater River	49.5	579740	5075650
4	7/31/2014	7	South Fork Clearwater River	49.5	579718	5075650
4	8/2/2014	8	South Fork Clearwater River	49.5	579726	5075640
4	8/9/2014	9	South Fork Clearwater River	49.5	579737	5075650
4	8/24/2014	10	South Fork Clearwater River	50.1	580154	5075450
5	6/24/2014	1	South Fork Clearwater River	75.6	601314	5073010
5	6/26/2014	2	South Fork Clearwater River	75.7	601375	5073040
5	7/1/2014	3	South Fork Clearwater River	75.7	601395	5073060
5	7/4/2014	4	South Fork Clearwater River	75.7	601412	5073030
5	7/9/2014	5	South Fork Clearwater River	75.7	601399	5073070
6	6/26/2014	1	South Fork Clearwater River	101.9	617902	5073800
6	7/1/2014	2	South Fork Clearwater River	102.0	617912	5073770
6	7/2/2014	3	South Fork Clearwater River	101.9	617892	5073810
6	7/17/2014	4	American River	9.6	623446	5075550
6	7/21/2014	5	American River	9.6	623452	5075540
6	7/24/2014	6	American River	9.6	623456	5075540
6	8/3/2014	7	American River	9.6	623463	5075540
6	8/24/2014	8	American River	9.7	623437	5075620
6	8/30/2014	9	American River	9.6	623444	5075540
6	10/4/2014	10	American River	6.0	621678	5074030
7	7/1/2014	1	South Fork Clearwater River	102.6	618379	5073700
7	7/2/2014	2	South Fork Clearwater River	102.7	618385	5073810
7	7/8/2014	3	South Fork Clearwater River	102.6	618355	5073690
8	7/1/2014	1	South Fork Clearwater River	86.1	607791	5075900

Appendix A. Continued from previous page.

8	7/2/2014	2	South Fork Clearwater River	86.1	607759	5075890
8	7/9/2014	3	South Fork Clearwater River	86.1	607800	5075900
8	7/15/2014	4	South Fork Clearwater River	86.1	607807	5075900
8	7/19/2014	5	South Fork Clearwater River	86.2	607814	5075890
8	7/22/2014	6	South Fork Clearwater River	86.1	607794	5075900
8	7/25/2014	7	South Fork Clearwater River	86.1	607809	5075890
8	7/31/2014	8	South Fork Clearwater River	86.2	607820	5075890
8	8/3/2014	9	South Fork Clearwater River	86.2	607813	5075890
8	8/9/2014	10	South Fork Clearwater River	86.2	607818	5075900
8	8/24/2014	11	South Fork Clearwater River	86.1	607798	5075890
8	8/30/2014	12	South Fork Clearwater River	86.1	607789	5075900
8	10/4/2014	13	South Fork Clearwater River	85.6	607262	5076000
10	6/24/2014	1	South Fork Clearwater River	102.6	618395	5073720
10	6/26/2014	2	South Fork Clearwater River	102.6	618387	5073710
10	7/2/2014	3	South Fork Clearwater River	102.0	617947	5073730
11	6/24/2014	1	South Fork Clearwater River	102.7	618379	5073790
11	6/26/2014	2	South Fork Clearwater River	102.7	618374	5073780
11	7/1/2014	3	South Fork Clearwater River	102.7	618379	5073790
11	7/2/2014	4	South Fork Clearwater River	102.7	618386	5073810
11	7/17/2014	5	American River	8.9	623259	5074870
11	7/21/2014	6	American River	8.9	623272	5074880
11	7/24/2014	7	American River	8.9	623268	5074890
11	8/3/2014	8	American River	8.9	623309	5074880
11	8/24/2014	9	American River	8.8	623234	5074840
11	8/30/2014	10	American River	8.9	623269	5074910
12	6/26/2014	1	South Fork Clearwater River	102.8	618474	5073860
12	7/1/2014	2	Red River	0.0	618494	5073870
12	7/2/2014	3	American River	0.1	618462	5073930
12	7/8/2014	4	American River	0.1	618460	5073930
12	7/10/2014	5	American River	0.0	618456	5073920

Appendix A. Continued from previous page.

12	7/19/2014	6	Red River	9.4	624029	5072420
12	7/24/2014	7	Red River	27.4	628648	5063280
12	8/3/2014	8	Red River	36.3	633341	5067980
12	8/12/2014	9	Red River	38.5	634998	5068110
12	8/30/2014	10	Red River	38.5	634925	5068070
12	10/4/2014	11	Red River	34.0	632178	5066620
13	6/26/2014	1	South Fork Clearwater River	102.0	617934	5073730
13	7/1/2014	2	South Fork Clearwater River	102.1	617977	5073680
13	7/8/2014	3	South Fork Clearwater River	101.8	617847	5073960
13	7/17/2014	4	Crooked River	7.8	612296	5071790
13	7/21/2014	5	Crooked River	7.8	612289	5071820
13	7/24/2014	6	Crooked River	7.8	612296	5071790
13	8/3/2014	7	Crooked River	7.8	612287	5071810
13	8/9/2014	8	Crooked River	7.8	612305	5071830
13	8/30/2014	9	South Fork Clearwater River	101.3	617561	5074230
13	10/4/2014	10	South Fork Clearwater River	94.2	612562	5075700
14	6/26/2014	1	South Fork Clearwater River	102.0	617944	5073720
14	7/1/2014	2	South Fork Clearwater River	102.1	617967	5073690
14	7/2/2014	3	South Fork Clearwater River	102.1	617979	5073690
14	7/10/2014	4	East Fork American River	0.0	622286	5080160
14	7/17/2014	5	East Fork American River	0.0	622287	5080160
14	7/21/2014	6	East Fork American River	0.2	622261	5080330
14	7/24/2014	7	East Fork American River	0.2	622264	5080330
14	8/3/2014	8	East Fork American River	0.2	622273	5080370
14	8/24/2014	9	American River	12.8	623149	5077810
14	8/30/2014	10	American River	12.8	623156	5077820
14	10/4/2014	11	American River	12.5	623060	5077590
15	7/4/2014	1	South Fork Clearwater River	100.7	617411	5074810
15	7/8/2014	2	Crooked River	2.3	614389	5073890
15	7/10/2014	3	Crooked River	7.9	612258	5071720

Appendix A. Continued from previous page.

15	7/17/2014	4	Crooked River	15.0	615012	5066540
15	7/21/2014	5	Crooked River	15.0	615011	5066540
15	7/24/2014	6	Crooked River	15.0	615008	5066550
15	8/3/2014	7	Crooked River	15.0	615027	5066480
15	8/9/2014	8	Crooked River	18.8	612815	5063780
15	8/30/2014	9	Crooked River	20.2	613362	5062260
15	10/5/2014	10	Crooked River	15.5	614997	5066020
16	7/2/2014	1	South Fork Clearwater River	88.2	609236	5075250
16	7/4/2014	2	South Fork Clearwater River	89.2	610015	5075580
16	7/8/2014	3	South Fork Clearwater River	98.3	615964	5075750
16	7/17/2014	4	Crooked River	11.7	613478	5068680
16	7/21/2014	5	Crooked River	11.7	613489	5068690
16	7/24/2014	6	Crooked River	11.7	613485	5068700
16	8/3/2014	7	Crooked River	11.7	613491	5068690
16	8/9/2014	8	Crooked River	12.5	613327	5067960
16	8/30/2014	9	Crooked River	11.7	613478	5068690
16	10/4/2014	10	Crooked River	2.3	614339	5073940
17	6/26/2014	1	South Fork Clearwater River	50.9	580809	5075160
17	7/4/2014	2	South Fork Clearwater River	51.0	580855	5075210
17	7/9/2014	3	South Fork Clearwater River	53.7	582974	5075690
17	7/15/2014	4	South Fork Clearwater River	55.9	584825	5075370
17	7/19/2014	5	South Fork Clearwater River	56.0	584871	5075410
17	7/22/2014	6	South Fork Clearwater River	56.0	584945	5075440
17	7/25/2014	7	South Fork Clearwater River	56.0	584944	5075440
17	8/2/2014	8	South Fork Clearwater River	56.1	584953	5075450
17	8/9/2014	9	South Fork Clearwater River	55.9	584847	5075400
17	8/24/2014	10	South Fork Clearwater River	56.0	584869	5075390
17	8/30/2014	11	South Fork Clearwater River	56.0	584859	5075410
17	10/4/2014	12	South Fork Clearwater River	56.1	584967	5075440
18	6/26/2014	1	South Fork Clearwater River	51.0	580858	5075220

Appendix A. Continued from previous page.

18	7/4/2014	2	South Fork Clearwater River	52.1	581769	5075750
18	7/9/2014	3	South Fork Clearwater River	52.0	581736	5075810
18	7/15/2014	4	South Fork Clearwater River	52.3	581929	5075830
18	7/19/2014	5	South Fork Clearwater River	52.1	581771	5075760
18	7/22/2014	6	South Fork Clearwater River	52.1	581773	5075740
18	7/25/2014	7	South Fork Clearwater River	52.0	581756	5075750
18	7/31/2014	8	South Fork Clearwater River	52.1	581781	5075750
18	8/2/2014	9	South Fork Clearwater River	52.0	581733	5075750
18	8/9/2014	10	South Fork Clearwater River	51.2	580978	5075350
18	8/24/2014	11	South Fork Clearwater River	52.1	581774	5075750
19	6/24/2014	1	South Fork Clearwater River	63.3	591343	5074570
19	6/26/2014	2	South Fork Clearwater River	50.9	580819	5075170
20	7/9/2014	1	South Fork Clearwater River	75.8	601423	5073080
20	7/15/2014	2	South Fork Clearwater River	75.8	601425	5073070
20	7/19/2014	3	South Fork Clearwater River	75.8	601441	5073070
20	7/22/2014	4	South Fork Clearwater River	75.7	601381	5073030
20	7/31/2014	5	South Fork Clearwater River	74.5	600357	5072740
20	8/2/2014	6	South Fork Clearwater River	74.5	600370	5072740
20	8/9/2014	7	South Fork Clearwater River	74.4	600326	5072720
20	8/24/2014	8	South Fork Clearwater River	74.7	600538	5072760
20	8/30/2014	9	South Fork Clearwater River	74.7	600537	5072760
20	10/4/2014	10	South Fork Clearwater River	74.7	600532	5072780
21	7/9/2014	1	South Fork Clearwater River	75.8	601477	5073110
21	7/15/2014	2	South Fork Clearwater River	75.8	601446	5073090
21	7/19/2014	3	South Fork Clearwater River	75.8	601450	5073080
21	7/22/2014	4	South Fork Clearwater River	75.8	601440	5073090
21	7/25/2014	5	South Fork Clearwater River	75.8	601439	5073080
21	7/31/2014	6	South Fork Clearwater River	75.8	601438	5073080
21	8/3/2014	7	South Fork Clearwater River	75.8	601438	5073090
21	8/9/2014	8	South Fork Clearwater River	75.8	601427	5073100

Appendix A. Continued from previous page.

21	10/4/2014	9	South Fork Clearwater River	77.6	602631	5073880
22	7/15/2014	1	South Fork Clearwater River	75.7	601409	5073060
22	7/19/2014	2	South Fork Clearwater River	75.8	601423	5073050
22	7/22/2014	3	South Fork Clearwater River	75.8	601411	5073080
22	7/25/2014	4	South Fork Clearwater River	75.7	601416	5073060
22	7/31/2014	5	South Fork Clearwater River	75.7	601418	5073050
22	8/3/2014	6	South Fork Clearwater River	75.7	601408	5073050
22	8/9/2014	7	South Fork Clearwater River	75.7	601403	5073060
22	8/24/2014	8	South Fork Clearwater River	75.8	601428	5073050
22	8/30/2014	9	South Fork Clearwater River	75.7	601419	5073050
22	10/4/2014	10	South Fork Clearwater River	75.7	601415	5073060
23	7/9/2014	1	South Fork Clearwater River	54.5	583603	5075290
23	7/15/2014	2	South Fork Clearwater River	57.3	586129	5075090
27	7/1/2014	1	South Fork Clearwater River	87.8	609041	5075490
27	7/2/2014	2	South Fork Clearwater River	87.7	609041	5075590
27	7/9/2014	3	South Fork Clearwater River	87.8	609072	5075440
27	7/15/2014	4	South Fork Clearwater River	87.3	608727	5075660
27	7/19/2014	5	South Fork Clearwater River	75.8	601422	5073060
27	8/20/2014	6	Newsome Creek	12.5	606171	5084050
27	10/4/2014	7	South Fork Clearwater River	87.9	609040	5075400
28	7/9/2014	1	South Fork Clearwater River	74.7	600563	5072800
28	7/15/2014	2	South Fork Clearwater River	69.1	595633	5072220
28	7/19/2014	3	South Fork Clearwater River	67.8	594527	5072260
28	7/31/2014	4	South Fork Clearwater River	63.5	591514	5074590
28	8/9/2014	5	South Fork Clearwater River	63.8	591604	5074330
28	8/24/2014	6	South Fork Clearwater River	63.8	591656	5074370
28	8/30/2014	7	South Fork Clearwater River	63.8	591675	5074370
28	10/4/2014	8	South Fork Clearwater River	64.1	591898	5074180
30	7/4/2014	1	South Fork Clearwater River	49.1	579529	5075860
30	7/9/2014	2	South Fork Clearwater River	48.9	579338	5076100

Appendix A. Continued from previous page.

30	7/15/2014	3	South Fork Clearwater River	50.0	580090	5075460
30	7/19/2014	4	South Fork Clearwater River	49.3	579574	5075700
30	7/22/2014	5	South Fork Clearwater River	49.3	579617	5075710
30	7/25/2014	6	South Fork Clearwater River	49.3	579589	5075700
30	7/31/2014	7	South Fork Clearwater River	49.2	579538	5075770
30	8/2/2014	8	South Fork Clearwater River	49.3	579565	5075720
30	8/9/2014	9	South Fork Clearwater River	49.2	579535	5075800
30	8/24/2014	10	South Fork Clearwater River	49.2	579544	5075800
30	10/4/2014	11	South Fork Clearwater River	49.2	579550	5075760
31	6/26/2014	1	South Fork Clearwater River	51.0	580856	5075230
31	7/4/2014	2	South Fork Clearwater River	51.1	580956	5075270
31	7/9/2014	3	South Fork Clearwater River	51.2	580973	5075350
31	7/14/2014	4	South Fork Clearwater River	51.2	580987	5075350
31	7/15/2014	5	South Fork Clearwater River	51.1	580949	5075320
31	7/19/2014	6	South Fork Clearwater River	51.1	580961	5075330
31	7/22/2014	7	South Fork Clearwater River	51.1	580951	5075310
31	7/25/2014	8	South Fork Clearwater River	51.2	580976	5075350
31	7/31/2014	9	South Fork Clearwater River	51.3	581062	5075430
31	8/2/2014	10	South Fork Clearwater River	51.3	581050	5075440
31	8/9/2014	11	South Fork Clearwater River	51.2	581008	5075380
31	8/24/2014	12	South Fork Clearwater River	51.2	580977	5075350
31	10/4/2014	13	South Fork Clearwater River	51.2	581042	5075400
32	6/26/2014	1	South Fork Clearwater River	50.9	580832	5075180
32	7/4/2014	2	South Fork Clearwater River	51.2	581043	5075410
32	7/9/2014	3	South Fork Clearwater River	51.2	581032	5075400
32	7/14/2014	4	South Fork Clearwater River	51.3	581051	5075410
32	7/19/2014	5	South Fork Clearwater River	51.2	581027	5075400
32	7/22/2014	6	South Fork Clearwater River	51.2	580977	5075350
34	7/9/2014	1	South Fork Clearwater River	86.4	608039	5075940
34	7/15/2014	2	South Fork Clearwater River	86.4	608048	5075980

Appendix A. Continued from previous page.

34	7/19/2014	3	South Fork Clearwater River	87.0	608424	5075870
34	7/22/2014	4	South Fork Clearwater River	87.0	608440	5075850
34	7/25/2014	5	South Fork Clearwater River	89.1	610038	5075490
34	7/31/2014	6	South Fork Clearwater River	91.3	611177	5075280
34	8/3/2014	7	South Fork Clearwater River	93.1	612042	5076330
34	8/24/2014	8	South Fork Clearwater River	86.9	608414	5075870
34	8/30/2014	9	South Fork Clearwater River	86.9	608420	5075880
34	10/4/2014	10	South Fork Clearwater River	87.0	608428	5075880
480011	6/4/2013	1	Red River	1.7	618931	5072860
480011	6/8/2013	2	Red River	6.3	622288	5072810
480011	6/9/2013	3	Red River	1.6	618847	5072870
480011	6/12/2013	4	Red River	1.6	618861	5072860
480011	6/14/2013	5	Red River	1.6	618852	5072880
480011	6/17/2013	6	Red River	1.6	618860	5072880
480011	6/18/2013	7	Red River	1.7	618907	5072880
480011	6/22/2013	8	Red River	1.6	618855	5072870
480011	6/25/2013	9	Red River	1.7	618903	5072860
480011	6/27/2013	10	Red River	1.7	618906	5072860
480011	7/7/2013	11	Red River	25.6	627624	5063330
480011	7/17/2013	12	Red River	25.6	627626	5063330
480011	7/23/2013	13	Red River	25.6	627630	5063330
480011	7/30/2013	14	Red River	25.6	627630	5063330
480011	8/5/2013	15	Red River	25.6	627622	5063330
480012	6/1/2013	1	Red River	6.1	622167	5072640
480012	6/3/2013	2	Red River	6.2	622190	5072730
480012	6/4/2013	3	Red River	6.3	622280	5072790
480012	6/9/2013	4	Red River	6.3	622274	5072800
480012	6/12/2013	5	Red River	6.3	622280	5072800
480012	6/14/2013	6	Red River	6.3	622298	5072830
480012	6/17/2013	7	Red River	6.3	622287	5072800

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480012	6/18/2013	8	Red River	6.3	622276	5072780
480012	6/25/2013	9	Red River	6.3	622186	5072980
480012	6/27/2013	10	Red River	6.3	622268	5072800
480012	7/9/2013	11	South Fork Red River	3.8	629348	5059970
480012	7/13/2013	12	South Fork Red River	2.8	629527	5060800
480012	7/16/2013	13	South Fork Red River	2.9	629524	5060780
480012	7/23/2013	14	South Fork Red River	2.8	629534	5060810
480012	7/30/2013	15	South Fork Red River	2.8	629533	5060800
480012	8/5/2013	16	South Fork Red River	2.8	629532	5060810
480012	8/10/2013	17	South Fork Red River	2.9	629525	5060790
480012	8/13/2013	18	South Fork Red River	2.9	629511	5060770
480012	8/15/2013	19	South Fork Red River	2.9	629494	5060800
480012	8/20/2013	20	South Fork Red River	2.9	629484	5060790
480012	10/19/2013	21	South Fork Red River	2.4	629431	5061260
480013	6/2/2013	1	South Fork Clearwater River	96.2	614134	5075560
480013	6/3/2013	2	South Fork Clearwater River	96.2	614076	5075550
480013	6/4/2013	3	South Fork Clearwater River	96.3	614164	5075570
480013	6/8/2013	4	South Fork Clearwater River	96.2	614121	5075550
480013	6/14/2013	5	South Fork Clearwater River	97.1	614863	5075970
480013	6/17/2013	6	South Fork Clearwater River	97.1	614812	5075990
480013	6/18/2013	7	South Fork Clearwater River	97.2	614926	5075970
480013	6/25/2013	8	South Fork Clearwater River	97.0	614740	5075990
480013	6/28/2013	9	South Fork Clearwater River	97.1	614820	5076000
480013	7/3/2013	10	American River	2.6	619736	5074930
480013	7/13/2013	11	American River	8.6	623197	5074360
480013	7/16/2013	12	American River	8.0	622654	5074280
480013	7/23/2013	13	American River	8.6	623226	5074330
480013	8/10/2013	14	American River	8.4	623113	5074390
480013	8/13/2013	15	American River	8.5	623153	5074380
480013	8/15/2013	16	American River	8.5	623148	5074400

Appendix A. Continued from previous page.

480013	9/8/2013	17	American River	8.7	623145	5074710
480014	6/3/2013	1	South Fork Clearwater River	91.2	611108	5075440
480014	6/4/2013	2	South Fork Clearwater River	91.2	611115	5075450
480014	6/8/2013	3	South Fork Clearwater River	91.2	611098	5075450
480014	6/9/2013	4	South Fork Clearwater River	91.3	611139	5075400
480014	6/12/2013	5	South Fork Clearwater River	91.2	611147	5075420
480014	6/14/2013	6	South Fork Clearwater River	91.2	611123	5075440
480014	6/17/2013	7	South Fork Clearwater River	91.4	611233	5075310
480014	6/22/2013	8	South Fork Clearwater River	91.2	611160	5075420
480014	6/25/2013	9	South Fork Clearwater River	91.3	611143	5075400
480014	6/27/2013	10	South Fork Clearwater River	91.0	611037	5075670
480014	7/5/2013	11	South Fork Clearwater River	89.2	610036	5075550
480014	7/7/2013	12	South Fork Clearwater River	89.3	609991	5075630
480014	7/9/2013	13	South Fork Clearwater River	89.3	610008	5075660
480014	7/12/2013	14	South Fork Clearwater River	89.3	609988	5075600
480014	7/15/2013	15	South Fork Clearwater River	89.2	610037	5075570
480014	7/22/2013	16	South Fork Clearwater River	89.2	610033	5075560
480014	7/29/2013	17	South Fork Clearwater River	89.2	610027	5075570
480014	8/8/2013	18	South Fork Clearwater River	89.2	610031	5075570
480014	8/12/2013	19	South Fork Clearwater River	89.2	610022	5075570
480014	8/16/2013	20	South Fork Clearwater River	89.2	610030	5075570
480015	6/3/2013	1	South Fork Clearwater River	84.9	606699	5075790
480015	6/9/2013	2	South Fork Clearwater River	84.9	606662	5075730
480015	6/12/2013	3	South Fork Clearwater River	84.9	606715	5075800
480015	6/14/2013	4	South Fork Clearwater River	85.0	606738	5075780
480015	6/18/2013	6	South Fork Clearwater River	85.1	606887	5075870
480015	6/22/2013	7	South Fork Clearwater River	85.0	606757	5075820
480015	6/25/2013	8	South Fork Clearwater River	85.0	606739	5075810
480015	6/27/2013	9	South Fork Clearwater River	84.9	606713	5075790
480015	7/5/2013	10	Newsome Creek	5.0	607360	5078350

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480015	7/10/2013	11	Newsome Creek	5.1	607330	5078420
480015	7/12/2013	12	Newsome Creek	5.0	607366	5078310
480015	7/16/2013	13	Newsome Creek	5.0	607375	5078320
480015	7/23/2013	14	Newsome Creek	4.9	607376	5078300
480015	7/30/2013	15	Newsome Creek	4.9	607332	5078280
480015	8/6/2013	16	South Fork Clearwater River	77.7	602688	5073850
480015	8/8/2013	17	South Fork Clearwater River	75.0	600797	5072910
480015	8/16/2013	18	South Fork Clearwater River	75.1	600858	5072970
480015	8/19/2013	19	South Fork Clearwater River	75.0	600859	5072960
480015	8/29/2013	20	South Fork Clearwater River	75.1	600864	5072980
480015	9/7/2013	21	South Fork Clearwater River	75.1	600870	5072980
480016	6/1/2013	1	American River	2.2	619378	5075030
480016	6/2/2013	2	South Fork Clearwater River	102.8	618474	5073880
480016	6/3/2013	3	South Fork Clearwater River	102.8	618458	5073870
480016	6/4/2013	4	Red River	0.5	618766	5073870
480016	6/8/2013	5	Red River	0.5	618741	5073800
480016	6/9/2013	6	Red River	0.6	618727	5073780
480016	6/12/2013	7	Red River	0.5	618756	5073820
480016	6/14/2013	8	Red River	0.5	618746	5073830
480016	6/17/2013	9	Red River	0.6	618722	5073730
480016	6/18/2013	10	Red River	0.6	618735	5073790
480016	6/22/2013	12	Red River	0.7	618686	5073660
480016	6/25/2013	13	Red River	0.6	618738	5073760
480016	6/27/2013	14	Red River	0.6	618728	5073760
480017	6/1/2013	1	American River	2.4	619602	5074980
480017	6/3/2013	2	American River	2.4	619636	5074990
480017	6/4/2013	3	American River	2.1	619333	5075030
480017	6/8/2013	4	American River	2.3	619537	5075000
480017	6/9/2013	5	American River	2.3	619537	5075000
480017	6/12/2013	6	American River	2.3	619525	5075010

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480017	6/14/2013	7	American River	2.3	619525	5075010
480017	6/17/2013	8	American River	2.3	619511	5075020
480017	6/18/2013	9	American River	2.3	619540	5075040
480017	6/25/2013	10	American River	2.3	619499	5075050
480017	8/5/2013	11	American River	16.0	621956	5080060
480017	8/10/2013	12	American River	16.0	621961	5080060
480017	8/13/2013	13	American River	16.0	621957	5080060
480017	8/15/2013	14	American River	16.0	621960	5080070
480017	8/20/2013	15	American River	16.0	621966	5080060
480017	8/30/2013	16	American River	16.1	621930	5080130
480017	9/1/2013	99	American River	8.6	623106	5074610
480017	9/7/2013	17	American River	16.1	621934	5080120
480017	9/14/2013	18	American River	16.0	621961	5080070
480017	9/22/2013	19	American River	16.0	621959	5080060
480018	6/25/2013	1	South Fork Clearwater River	55.1	584154	5075450
480018	7/3/2013	2	South Fork Clearwater River	55.1	584152	5075020
480018	7/6/2013	3	South Fork Clearwater River	55.1	584141	5075020
480018	7/7/2013	4	South Fork Clearwater River	55.1	584105	5074980
480018	7/8/2013	5	South Fork Clearwater River	55.1	584140	5074930
480018	7/11/2013	6	South Fork Clearwater River	55.4	584364	5075100
480018	7/15/2013	7	South Fork Clearwater River	60.0	588513	5074970
480018	7/20/2013	8	South Fork Clearwater River	60.1	588565	5074910
480018	7/22/2013	9	South Fork Clearwater River	60.1	588557	5074910
480018	7/29/2013	10	South Fork Clearwater River	60.1	588582	5074910
480018	8/6/2013	11	South Fork Clearwater River	60.1	588560	5074900
480018	8/8/2013	12	South Fork Clearwater River	60.1	588573	5074900
480018	8/12/2013	13	South Fork Clearwater River	60.1	588563	5074920
480018	8/16/2013	14	South Fork Clearwater River	60.1	588570	5074920
480018	8/19/2013	15	South Fork Clearwater River	60.0	588550	5074960
480018	8/29/2013	16	South Fork Clearwater River	60.1	588571	5074900

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480018	9/7/2013	17	South Fork Clearwater River	60.1	588567	5074910
480018	9/15/2013	18	South Fork Clearwater River	60.1	588571	5074900
480018	9/21/2013	19	South Fork Clearwater River	60.1	588578	5074910
480019	6/23/2013	1	South Fork Clearwater River	51.1	580941	5075280
480019	6/25/2013	2	South Fork Clearwater River	51.1	580940	5075300
480019	7/3/2013	3	South Fork Clearwater River	48.7	579097	5076010
480019	7/7/2013	4	South Fork Clearwater River	51.0	580871	5075310
480019	7/8/2013	5	South Fork Clearwater River	51.2	581024	5075390
480019	7/11/2013	6	South Fork Clearwater River	51.1	580956	5075320
480019	7/15/2013	7	South Fork Clearwater River	51.1	580967	5075320
480019	7/19/2013	8	South Fork Clearwater River	51.1	580968	5075330
480019	7/22/2013	9	South Fork Clearwater River	51.2	581033	5075390
480019	7/29/2013	10	South Fork Clearwater River	51.2	581002	5075380
480019	8/5/2013	11	South Fork Clearwater River	51.3	581071	5075420
480019	8/8/2013	12	South Fork Clearwater River	51.3	581071	5075420
480019	8/12/2013	13	South Fork Clearwater River	51.3	581064	5075420
480019	8/16/2013	14	South Fork Clearwater River	51.3	581066	5075420
480019	8/19/2013	15	South Fork Clearwater River	51.3	581058	5075410
480019	8/29/2013	16	South Fork Clearwater River	51.3	581109	5075440
480019	9/7/2013	17	South Fork Clearwater River	51.3	581085	5075430
480019	9/15/2013	18	South Fork Clearwater River	51.3	581090	5075430
480019	9/21/2013	19	South Fork Clearwater River	51.3	581097	5075440
480020	6/25/2013	1	Crooked River	0.7	614388	5075040
480020	6/27/2013	2	Crooked River	0.7	614381	5075030
480020	7/4/2013	3	Crooked River	8.4	612170	5071270
480020	8/20/2013	4	Crooked River	17.0	614441	5064800
480020	8/30/2013	5	Crooked River	17.0	614450	5064800
480020	9/7/2013	6	Crooked River	4.4	614254	5072990
480020	9/15/2013	7	Crooked River	4.1	614268	5073100
480020	9/21/2013	8	Crooked River	4.1	614238	5073140

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480020	10/6/2013	9	Crooked River	4.1	614233	5073130
480020	10/13/2013	10	Crooked River	4.1	614241	5073140
480020	10/19/2013	11	Crooked River	4.1	614241	5073130
480021	5/31/2013	1	Red River	3.6	620258	5072120
480021	6/1/2013	2	American River	0.3	618428	5074130
480022	6/3/2013	1	Crooked River	0.2	614349	5075460
480022	6/4/2013	2	Crooked River	0.2	614342	5075480
480022	6/8/2013	3	Crooked River	0.2	614349	5075460
480022	6/9/2013	4	Crooked River	0.2	614337	5075480
480022	6/12/2013	5	Crooked River	0.2	614361	5075470
480022	6/14/2013	6	Crooked River	0.2	614346	5075470
480022	6/17/2013	7	Crooked River	0.2	614382	5075470
480022	6/18/2013	8	Crooked River	0.2	614347	5075460
480022	7/4/2013	9	Crooked River	3.9	614328	5073160
480022	7/5/2013	10	Crooked River	3.0	614360	5073620
480022	7/10/2013	11	Crooked River	2.9	614379	5073690
480022	7/12/2013	12	Crooked River	2.9	614374	5073670
480022	7/16/2013	13	Crooked River	3.0	614305	5073640
480022	7/23/2013	14	Crooked River	5.7	613845	5072150
480022	7/30/2013	15	Crooked River	3.0	614351	5073620
480022	8/13/2013	16	Crooked River	3.0	614357	5073640
480022	8/15/2013	17	Crooked River	3.0	614370	5073650
480023	6/8/2013	1	Red River	3.8	620366	5072300
480023	6/9/2013	2	Red River	3.9	620384	5072320
480023	6/12/2013	3	Red River	3.9	620383	5072310
480023	6/14/2013	4	Red River	2.8	619554	5072400
480023	6/17/2013	5	Red River	1.6	618875	5072870
480023	6/18/2013	6	Red River	1.6	618859	5072720
480023	6/22/2013	7	Red River	1.6	618852	5072870
480023	6/25/2013	8	Red River	1.7	618881	5072870

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480023	6/27/2013	9	Red River	1.7	618923	5072850
480023	7/3/2013	10	Red River	4.3	620577	5072550
480023	7/7/2013	11	Red River	9.4	624024	5072420
480023	7/9/2013	12	Red River	7.0	622932	5073090
480023	7/13/2013	13	Red River	8.3	623401	5072770
480023	7/16/2013	14	Red River	8.3	623403	5072760
480023	7/23/2013	15	Red River	9.5	624119	5072390
480023	7/30/2013	16	Red River	9.6	624248	5072390
480023	8/5/2013	17	Red River	6.2	622198	5072730
480023	8/10/2013	18	Red River	5.4	621649	5072370
480023	8/13/2013	19	Red River	6.3	622286	5072810
480023	8/15/2013	20	Red River	5.4	621650	5072350
480023	8/20/2013	21	Red River	7.0	622924	5073080
480023	9/1/2013	22	Red River	7.0	622926	5073080
480023	9/8/2013	23	Red River	7.0	622917	5073070
480024	8/5/2013	1	American River	11.2	623434	5076620
480024	8/20/2013	2	American River	11.2	623419	5076620
480024	8/30/2013	3	American River	11.2	623432	5076620
480024	10/19/2013	4	American River	8.6	623155	5074690
480025	6/23/2013	1	South Fork Clearwater River	54.9	583895	5074990
480025	6/25/2013	2	South Fork Clearwater River	54.9	583946	5075040
480025	7/7/2013	3	South Fork Clearwater River	54.8	583879	5075010
480025	7/11/2013	4	South Fork Clearwater River	55.0	584007	5075000
480025	7/15/2013	5	South Fork Clearwater River	55.4	584383	5075110
480025	7/20/2013	6	South Fork Clearwater River	55.4	584378	5075120
480025	7/22/2013	7	South Fork Clearwater River	55.4	584381	5075100
480025	7/29/2013	8	South Fork Clearwater River	55.4	584399	5075120
480025	8/5/2013	9	South Fork Clearwater River	55.4	584386	5075110
480025	8/8/2013	10	South Fork Clearwater River	55.4	584393	5075110
480025	8/12/2013	11	South Fork Clearwater River	55.4	584408	5075120

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480025	8/16/2013	12	South Fork Clearwater River	55.4	584390	5075110
480025	8/19/2013	13	South Fork Clearwater River	55.4	584404	5075120
480025	8/29/2013	14	South Fork Clearwater River	55.4	584390	5075120
480025	9/15/2013	15	South Fork Clearwater River	55.4	584380	5075110
480026	6/14/2013	1	South Fork Clearwater River	99.9	617059	5075160
480026	6/18/2013	2	South Fork Clearwater River	99.6	616879	5075430
480026	6/25/2013	3	South Fork Clearwater River	97.6	615355	5075920
480026	7/10/2013	4	Crooked River	10.7	612872	5069200
480026	7/12/2013	5	Crooked River	10.7	612871	5069190
480026	7/16/2013	6	Crooked River	10.8	612913	5069220
480026	7/23/2013	7	Crooked River	10.8	612914	5069200
480026	7/30/2013	8	Crooked River	10.8	612908	5069180
480026	8/13/2013	9	Crooked River	10.7	612853	5069250
480026	8/20/2013	10	Crooked River	10.7	612826	5069200
480026	8/30/2013	11	Crooked River	10.7	612841	5069190
480026	9/7/2013	12	Crooked River	10.7	612822	5069220
480027	1/20/2014	1	Red River	0.4	618768	5073900
480027	3/1/2014	2	Red River	0.4	618756	5073990
480027	4/5/2014	3	South Fork Clearwater River	95.4	613452	5075840
480027	4/19/2014	4	South Fork Clearwater River	95.4	613449	5075870
480028	6/25/2013	1	South Fork Clearwater River	51.1	580928	5075280
480028	7/3/2013	2	South Fork Clearwater River	50.3	580317	5075440
480028	7/5/2013	3	South Fork Clearwater River	54.1	583327	5075450
480028	7/7/2013	4	South Fork Clearwater River	56.0	584950	5075430
480028	7/8/2013	5	South Fork Clearwater River	57.2	585971	5075110
480028	7/22/2013	6	Johns Creek	0.3	586370	5074820
480028	7/29/2013	7	Johns Creek	0.3	586366	5074840
480028	8/19/2013	8	Johns Creek	0.3	586351	5074810
480028	9/15/2013	9	South Fork Clearwater River	59.5	587992	5075030
480028	9/21/2013	10	South Fork Clearwater River	57.5	586311	5075120

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480028	10/5/2013	11	South Fork Clearwater River	57.5	586314	5075140
480028	10/12/2013	12	South Fork Clearwater River	57.4	586253	5075090
480028	10/18/2013	13	South Fork Clearwater River	57.4	586244	5075110
480028	11/16/2013	14	South Fork Clearwater River	49.0	579407	5075980
480028	12/19/2013	15	South Fork Clearwater River	49.1	579500	5075900
480028	1/20/2014	16	South Fork Clearwater River	49.5	579716	5075650
480028	3/1/2014	17	South Fork Clearwater River	49.5	579740	5075650
480029	6/23/2013	1	South Fork Clearwater River	51.0	580911	5075260
480029	6/25/2013	2	South Fork Clearwater River	51.0	580907	5075270
480029	7/6/2013	3	South Fork Clearwater River	52.0	581732	5075800
480029	7/7/2013	4	South Fork Clearwater River	52.1	581785	5075750
480029	7/8/2013	5	South Fork Clearwater River	52.1	581768	5075740
480029	7/11/2013	6	South Fork Clearwater River	52.1	581765	5075740
480029	7/15/2013	7	South Fork Clearwater River	52.1	581779	5075740
480029	7/20/2013	8	South Fork Clearwater River	52.1	581783	5075740
480029	7/22/2013	9	South Fork Clearwater River	52.1	581785	5075740
480029	7/29/2013	10	South Fork Clearwater River	52.1	581781	5075740
480029	8/5/2013	11	South Fork Clearwater River	52.1	581763	5075740
480029	8/8/2013	12	South Fork Clearwater River	52.1	581765	5075740
480029	8/12/2013	13	South Fork Clearwater River	52.1	581783	5075740
480029	8/16/2013	14	South Fork Clearwater River	52.1	581774	5075750
480029	8/19/2013	15	South Fork Clearwater River	52.1	581782	5075750
480029	8/29/2013	16	South Fork Clearwater River	52.1	581798	5075750
480029	9/7/2013	17	South Fork Clearwater River	52.1	581798	5075740
480029	9/15/2013	18	South Fork Clearwater River	52.1	581799	5075760
480029	9/21/2013	19	South Fork Clearwater River	52.1	581806	5075760
480029	10/5/2013	20	South Fork Clearwater River	52.1	581829	5075760
480029	10/12/2013	21	South Fork Clearwater River	52.1	581822	5075760
480029	10/18/2013	22	South Fork Clearwater River	52.1	581830	5075750
480029	11/16/2013	23	South Fork Clearwater River	51.7	581440	5075680

Appendix A. Continued from previous page.

480029	12/19/2013	24	South Fork Clearwater River	49.1	579500	5075890
480029	1/20/2014	25	South Fork Clearwater River	49.0	579428	5075940
480029	3/1/2014	26	South Fork Clearwater River	49.5	579743	5075650
480029	4/5/2014	27	South Fork Clearwater River	49.1	579491	5075880
480029	4/19/2014	28	South Fork Clearwater River	48.5	579066	5076180
480029	5/4/2014	29	South Fork Clearwater River	48.5	579111	5076130
480029	5/18/2014	30	South Fork Clearwater River	48.6	579108	5076100
480029	6/3/2014	31	Mill Creek	0.5	582767	5075270
480031	6/23/2013	1	South Fork Clearwater River	51.2	581041	5075410
480031	7/3/2013	2	South Fork Clearwater River	51.7	581399	5075620
480031	7/7/2013	3	South Fork Clearwater River	52.6	582166	5076120
480031	7/8/2013	4	South Fork Clearwater River	52.7	582254	5076170
480031	7/11/2013	5	South Fork Clearwater River	52.6	582190	5076090
480031	7/15/2013	6	South Fork Clearwater River	52.7	582246	5076170
480031	7/20/2013	7	South Fork Clearwater River	52.7	582195	5076120
480031	7/22/2013	8	South Fork Clearwater River	52.7	582194	5076130
480031	7/29/2013	9	South Fork Clearwater River	58.6	587296	5075370
480031	8/6/2013	10	South Fork Clearwater River	58.7	587308	5075360
480031	8/8/2013	11	South Fork Clearwater River	58.7	587333	5075380
480031	8/12/2013	12	South Fork Clearwater River	58.7	587334	5075370
480031	8/16/2013	13	South Fork Clearwater River	58.7	587369	5075360
480031	8/19/2013	14	South Fork Clearwater River	58.7	587342	5075370
480031	8/29/2013	15	South Fork Clearwater River	58.6	587289	5075390
480031	9/7/2013	16	South Fork Clearwater River	58.6	587276	5075370
480031	9/15/2013	17	South Fork Clearwater River	58.7	587339	5075370
480031	9/21/2013	18	South Fork Clearwater River	58.7	587317	5075380
480031	10/5/2013	19	South Fork Clearwater River	58.3	586961	5075350
480031	10/12/2013	20	South Fork Clearwater River	58.7	587301	5075370
480031	10/18/2013	21	South Fork Clearwater River	58.7	587303	5075380
480031	11/16/2013	22	South Fork Clearwater River	57.0	585848	5075130

Appendix A. Continued from previous page.

480031	12/19/2013	23	South Fork Clearwater River	51.1	580916	5075340
480031	1/20/2014	24	South Fork Clearwater River	51.0	580904	5075270
480031	3/1/2014	25	South Fork Clearwater River	47.8	578538	5076420
480031	4/19/2014	26	South Fork Clearwater River	49.0	579415	5075980
480031	5/4/2014	27	South Fork Clearwater River	49.0	579394	5075990
480031	5/18/2014	28	South Fork Clearwater River	49.0	579397	5075990
480031	6/3/2014	29	South Fork Clearwater River	49.9	579995	5075460
480031	6/10/2014	30	South Fork Clearwater River	54.5	583684	5075220
480031	6/11/2014	31	South Fork Clearwater River	54.6	583732	5075190
480031	6/13/2014	32	South Fork Clearwater River	54.5	583660	5075240
480031	6/16/2014	33	South Fork Clearwater River	54.7	583787	5075160
480032	6/25/2013	1	South Fork Clearwater River	52.0	581647	5075790
480032	7/3/2013	2	South Fork Clearwater River	53.1	582614	5076110
480032	7/7/2013	3	South Fork Clearwater River	52.0	581735	5075750
480032	7/8/2013	4	South Fork Clearwater River	52.1	581759	5075740
480032	7/11/2013	5	South Fork Clearwater River	52.0	581755	5075730
480032	7/15/2013	6	South Fork Clearwater River	52.1	581763	5075740
480032	7/20/2013	7	South Fork Clearwater River	52.0	581750	5075740
480032	7/22/2013	8	South Fork Clearwater River	52.1	581768	5075730
480032	8/5/2013	9	South Fork Clearwater River	52.0	581708	5075740
480032	8/16/2013	10	South Fork Clearwater River	52.1	581769	5075740
480032	8/19/2013	11	South Fork Clearwater River	52.1	581778	5075740
480032	8/29/2013	12	South Fork Clearwater River	52.1	581772	5075740
480032	9/7/2013	13	South Fork Clearwater River	52.1	581766	5075740
480032	9/15/2013	14	South Fork Clearwater River	52.0	581752	5075760
480032	9/21/2013	15	South Fork Clearwater River	52.1	581763	5075750
480032	10/5/2013	16	South Fork Clearwater River	52.0	581700	5075740
480032	10/12/2013	17	South Fork Clearwater River	52.0	581713	5075750
480032	10/18/2013	18	South Fork Clearwater River	52.1	581814	5075760
480032	11/16/2013	19	South Fork Clearwater River	51.2	580966	5075360

Appendix A. Continued from previous page.

480034	6/22/2013	1	Red River	5.5	621691	5072330
480034	6/25/2013	2	Red River	5.4	621663	5072350
480034	6/27/2013	3	Red River	5.4	621648	5072350
480034	7/9/2013	4	Red River	34.1	632292	5066750
480034	7/13/2013	5	South Fork Red River	4.8	628968	5059220
480036	6/12/2013	1	American River	0.5	618579	5074280
480036	6/14/2013	2	American River	0.4	618509	5074210
480036	6/17/2013	3	American River	0.6	618712	5074340
480036	6/18/2013	4	American River	0.4	618482	5074200
480036	6/22/2013	5	American River	0.4	618495	5074200
480036	6/25/2013	6	American River	0.8	618823	5074420
480036	7/4/2013	7	American River	0.4	618484	5074190
480037	6/12/2013	1	Red River	1.6	618779	5072870
480037	6/14/2013	2	Red River	1.9	619098	5072910
480037	6/17/2013	3	Red River	4.2	620550	5072560
480037	6/18/2013	4	Red River	4.8	621032	5072560
480037	6/25/2013	5	Red River	4.6	620896	5072640
480037	6/28/2013	6	Red River	4.8	621041	5072560
480037	7/3/2013	7	Red River	9.7	624283	5072380
480037	7/7/2013	8	Red River	9.7	624270	5072310
480037	7/9/2013	9	Red River	9.6	624234	5072410
480037	7/13/2013	10	Red River	9.8	624226	5072290
480037	7/16/2013	11	Red River	9.8	624228	5072280
480037	7/23/2013	12	Red River	9.8	624227	5072190
480037	7/30/2013	13	Red River	9.8	624219	5072260
480038	6/17/2013	1	American River	2.2	619393	5075030
480038	6/18/2013	2	South Fork Clearwater River	98.1	615819	5075770
480038	6/22/2013	3	South Fork Clearwater River	93.1	612054	5076330
480038	6/25/2013	4	South Fork Clearwater River	93.6	612062	5075940
480038	6/27/2013	5	South Fork Clearwater River	90.9	611016	5075720

Appendix A. Continued from previous page.

480038	7/7/2013	6	South Fork Clearwater River	87.3	608706	5075660
480038	7/9/2013	7	South Fork Clearwater River	87.3	608661	5075710
480038	7/12/2013	8	South Fork Clearwater River	87.3	608693	5075680
480038	7/15/2013	9	South Fork Clearwater River	87.3	608671	5075680
480039	6/22/2013	1	South Fork Clearwater River	63.8	591658	5074400
480039	6/25/2013	2	South Fork Clearwater River	63.8	591649	5074390
480039	6/27/2013	3	South Fork Clearwater River	63.8	591679	5074370
480039	7/5/2013	4	South Fork Clearwater River	74.1	600053	5072490
480039	7/7/2013	5	South Fork Clearwater River	76.1	601662	5073280
480039	7/9/2013	6	South Fork Clearwater River	76.0	601636	5073250
480039	7/12/2013	7	South Fork Clearwater River	76.0	601642	5073250
480039	7/15/2013	8	South Fork Clearwater River	76.0	601596	5073200
480039	7/20/2013	9	South Fork Clearwater River	76.0	601629	5073250
480039	7/22/2013	10	South Fork Clearwater River	76.1	601647	5073260
480039	7/29/2013	11	South Fork Clearwater River	76.5	602063	5073320
480039	8/6/2013	12	South Fork Clearwater River	76.5	602040	5073340
480039	8/8/2013	13	South Fork Clearwater River	76.5	602056	5073320
480039	8/12/2013	14	South Fork Clearwater River	76.5	602039	5073330
480039	8/16/2013	15	South Fork Clearwater River	76.5	602065	5073320
480039	8/19/2013	16	South Fork Clearwater River	76.6	602136	5073290
480039	8/30/2013	17	South Fork Clearwater River	76.6	602110	5073300
480039	9/7/2013	18	South Fork Clearwater River	76.6	602120	5073280
480039	9/15/2013	19	South Fork Clearwater River	76.6	602116	5073290
480039	9/21/2013	20	South Fork Clearwater River	76.6	602124	5073300
480039	10/5/2013	21	South Fork Clearwater River	76.5	602052	5073330
480039	10/12/2013	22	South Fork Clearwater River	76.5	602060	5073330
480039	11/16/2013	23	South Fork Clearwater River	76.5	602044	5073340
480039	12/19/2013	24	South Fork Clearwater River	76.5	602068	5073340
480039	1/20/2014	25	South Fork Clearwater River	76.5	602063	5073350
480039	3/1/2014	26	South Fork Clearwater River	76.5	602056	5073330

Appendix A. Continued from previous page.

480039	4/5/2014	27	South Fork Clearwater River	76.5	602043	5073350
480039	4/19/2014	28	South Fork Clearwater River	76.5	602057	5073330
480039	5/4/2014	29	South Fork Clearwater River	76.5	602044	5073350
480039	5/18/2014	30	South Fork Clearwater River	76.5	602046	5073350
480039	6/3/2014	31	South Fork Clearwater River	76.5	602056	5073340
480039	6/11/2014	32	South Fork Clearwater River	76.5	602038	5073340
480039	6/13/2014	33	South Fork Clearwater River	76.5	602065	5073340
480039	6/16/2014	34	South Fork Clearwater River	76.5	602039	5073360
480039	6/18/2014	35	South Fork Clearwater River	76.6	602079	5073330
480039	7/4/2014	36	South Fork Clearwater River	76.5	602046	5073340
480039	7/31/2014	37	South Fork Clearwater River	76.5	602062	5073340
480040	6/25/2013	1	South Fork Clearwater River	64.0	591846	5074200
480040	7/5/2013	2	South Fork Clearwater River	63.7	591610	5074440
480040	7/7/2013	3	South Fork Clearwater River	63.7	591577	5074470
480041	6/23/2013	1	South Fork Clearwater River	57.1	585901	5075090
480041	7/3/2013	2	South Fork Clearwater River	57.1	585888	5075100
480041	7/5/2013	3	South Fork Clearwater River	57.1	585880	5075100
480041	7/7/2013	4	South Fork Clearwater River	57.1	585957	5075130
480041	7/8/2013	5	South Fork Clearwater River	57.2	586000	5075130
480041	7/11/2013	6	South Fork Clearwater River	57.2	585980	5075100
480041	7/15/2013	7	South Fork Clearwater River	57.2	585975	5075090
480041	7/20/2013	8	South Fork Clearwater River	57.1	585905	5075080
480041	7/22/2013	9	South Fork Clearwater River	57.1	585939	5075100
480041	7/29/2013	10	South Fork Clearwater River	57.1	585900	5075110
480041	8/5/2013	11	South Fork Clearwater River	57.1	585887	5075110
480041	8/8/2013	12	South Fork Clearwater River	57.0	585872	5075100
480041	8/12/2013	13	South Fork Clearwater River	57.1	585879	5075110
480041	8/16/2013	14	South Fork Clearwater River	57.1	585888	5075110
480041	8/19/2013	15	South Fork Clearwater River	57.1	585889	5075110
480041	8/29/2013	16	South Fork Clearwater River	57.1	585886	5075110

Appendix A. Continued from previous page.

480041	9/7/2013	17	South Fork Clearwater River	57.1	585904	5075100
480041	9/15/2013	18	South Fork Clearwater River	57.1	585889	5075110
480041	9/21/2013	19	South Fork Clearwater River	57.1	585899	5075100
480041	10/5/2013	20	South Fork Clearwater River	57.1	585877	5075110
480041	10/12/2013	21	South Fork Clearwater River	57.1	585890	5075100
480041	10/18/2013	22	South Fork Clearwater River	57.1	585877	5075120
480042	6/23/2013	1	South Fork Clearwater River	57.4	586237	5075100
480042	6/25/2013	2	South Fork Clearwater River	57.4	586239	5075110
480043	6/23/2013	1	South Fork Clearwater River	53.7	582976	5075660
480043	6/25/2013	2	South Fork Clearwater River	53.7	583031	5075750
480043	7/3/2013	3	South Fork Clearwater River	53.8	583080	5075610
480043	7/5/2013	4	South Fork Clearwater River	53.8	583070	5075630
480043	7/6/2013	5	South Fork Clearwater River	53.8	583069	5075600
480043	7/7/2013	6	South Fork Clearwater River	53.7	582986	5075700
480043	7/8/2013	7	South Fork Clearwater River	53.8	583079	5075610
480043	7/11/2013	8	South Fork Clearwater River	53.8	583073	5075620
480043	7/15/2013	9	South Fork Clearwater River	53.8	583064	5075600
480043	7/20/2013	10	South Fork Clearwater River	53.8	583056	5075630
480043	7/22/2013	11	South Fork Clearwater River	53.8	583071	5075620
480043	7/29/2013	12	South Fork Clearwater River	53.8	583065	5075630
480043	8/5/2013	13	South Fork Clearwater River	53.8	583070	5075620
480043	8/8/2013	14	South Fork Clearwater River	53.8	583074	5075620
480043	8/12/2013	15	South Fork Clearwater River	53.8	583073	5075610
480043	8/16/2013	16	South Fork Clearwater River	53.8	583077	5075600
480043	8/19/2013	17	South Fork Clearwater River	53.8	583079	5075620
480043	8/29/2013	18	South Fork Clearwater River	53.8	583083	5075610
480043	9/7/2013	19	South Fork Clearwater River	53.8	583079	5075620
480043	9/15/2013	20	South Fork Clearwater River	53.8	583085	5075610
480043	9/21/2013	21	South Fork Clearwater River	53.8	583075	5075620
480043	10/5/2013	22	South Fork Clearwater River	54.7	583772	5075160

Appendix A. Continued from previous page.

480043	10/12/2013	23	South Fork Clearwater River	54.7	583805	5075100
480043	10/18/2013	24	South Fork Clearwater River	54.7	583780	5075150
480043	11/16/2013	25	South Fork Clearwater River	54.7	583782	5075150
480043	12/19/2013	26	South Fork Clearwater River	54.6	583763	5075190
480043	1/20/2014	27	South Fork Clearwater River	54.7	583805	5075130
480043	3/1/2014	28	South Fork Clearwater River	54.6	583745	5075170
480043	4/5/2014	29	South Fork Clearwater River	53.7	583010	5075660
480043	4/19/2014	30	South Fork Clearwater River	53.7	582966	5075660
480043	5/4/2014	31	South Fork Clearwater River	53.7	582952	5075700
480043	6/10/2014	32	South Fork Clearwater River	53.8	583042	5075640
480043	6/11/2014	33	South Fork Clearwater River	53.8	583049	5075640
480043	6/13/2014	34	South Fork Clearwater River	53.8	583042	5075650
480043	6/16/2014	35	South Fork Clearwater River	53.8	583065	5075640
480043	6/18/2014	36	South Fork Clearwater River	53.8	583094	5075610
480043	6/24/2014	37	South Fork Clearwater River	53.8	583060	5075680
480043	7/4/2014	38	South Fork Clearwater River	53.8	583043	5075650
480043	7/9/2014	39	South Fork Clearwater River	53.8	583079	5075630
480043	7/14/2014	40	South Fork Clearwater River	53.8	583071	5075630
480043	7/15/2014	41	South Fork Clearwater River	53.8	583059	5075620
480043	7/19/2014	42	South Fork Clearwater River	53.7	583015	5075680
480043	7/22/2014	43	South Fork Clearwater River	53.8	583075	5075620
480043	7/31/2014	44	South Fork Clearwater River	53.8	583067	5075630
480043	8/2/2014	45	South Fork Clearwater River	53.8	583079	5075620
480043	8/9/2014	46	South Fork Clearwater River	53.8	583057	5075630
480043	8/24/2014	47	South Fork Clearwater River	53.8	583069	5075620
480043	10/5/2014	48	South Fork Clearwater River	54.7	583789	5075080
480044	6/23/2013	1	South Fork Clearwater River	51.0	580911	5075260
480044	6/25/2013	2	South Fork Clearwater River	51.1	580933	5075270
480044	7/3/2013	3	South Fork Clearwater River	49.0	579428	5075940
480045	6/23/2013	1	South Fork Clearwater River	51.1	580955	5075310

Appendix A. Continued from previous page.

480045	6/25/2013	2	South Fork Clearwater River	51.1	580947	5075310
480045	7/3/2013	3	South Fork Clearwater River	56.8	585643	5075170
480045	7/5/2013	4	South Fork Clearwater River	57.0	585865	5075130
480045	7/7/2013	5	South Fork Clearwater River	57.1	585887	5075120
480045	7/8/2013	6	South Fork Clearwater River	57.1	585927	5075100
480045	7/11/2013	7	South Fork Clearwater River	57.0	585859	5075160
480045	7/15/2013	8	South Fork Clearwater River	57.0	585868	5075110
480045	7/20/2013	9	South Fork Clearwater River	57.1	585884	5075130
480045	7/22/2013	10	South Fork Clearwater River	57.0	585866	5075110
480045	7/29/2013	11	South Fork Clearwater River	57.1	585883	5075100
480045	8/8/2013	12	South Fork Clearwater River	57.0	585862	5075130
480045	8/12/2013	13	South Fork Clearwater River	57.1	585891	5075110
480045	8/16/2013	14	South Fork Clearwater River	57.0	585772	5075140
480045	8/19/2013	15	South Fork Clearwater River	57.1	585876	5075110
480045	8/29/2013	16	South Fork Clearwater River	57.1	585948	5075100
480045	9/7/2013	17	South Fork Clearwater River	57.0	585871	5075110
480045	9/15/2013	18	South Fork Clearwater River	57.2	585981	5075090
480045	9/21/2013	19	South Fork Clearwater River	55.4	584378	5075110
480045	10/5/2013	20	South Fork Clearwater River	51.1	580954	5075330
480045	10/12/2013	21	South Fork Clearwater River	51.0	580906	5075270
480045	10/18/2013	22	South Fork Clearwater River	50.9	580817	5075190
480045	11/16/2013	23	South Fork Clearwater River	51.0	580902	5075270
480045	12/19/2013	24	South Fork Clearwater River	49.5	579734	5075660
480045	1/20/2014	25	South Fork Clearwater River	49.5	579732	5075650
480045	3/1/2014	26	South Fork Clearwater River	49.5	579732	5075650
480045	4/5/2014	27	South Fork Clearwater River	45.2	576787	5078030
480045	4/19/2014	28	South Fork Clearwater River	45.0	576710	5078070
480045	5/4/2014	29	South Fork Clearwater River	45.0	576709	5078070
480045	5/18/2014	30	South Fork Clearwater River	48.6	579108	5076100
480045	6/3/2014	31	Mill Creek	0.5	582768	5075270

Appendix A. Continued from previous page.

480045	6/16/2014	32	Mill Creek	4.2	581139	5072290
480045	6/18/2014	33	Mill Creek	1.1	582528	5074830
480045	7/9/2014	34	South Fork Clearwater River	57.0	585850	5075090
480045	7/15/2014	35	South Fork Clearwater River	57.0	585860	5075110
480045	7/19/2014	36	South Fork Clearwater River	57.0	585859	5075110
480045	7/22/2014	37	South Fork Clearwater River	57.0	585866	5075120
480045	7/25/2014	38	South Fork Clearwater River	57.0	585864	5075120
480045	7/31/2014	39	South Fork Clearwater River	57.2	585969	5075140
480045	8/9/2014	40	South Fork Clearwater River	57.2	586045	5075070
480045	8/24/2014	41	South Fork Clearwater River	57.1	585877	5075110
480045	8/30/2014	42	South Fork Clearwater River	57.1	585880	5075110
480045	10/5/2014	43	South Fork Clearwater River	57.1	585878	5075110
4800222	7/8/2014	1	Crooked River	9.6	612417	5070220
4800222	7/10/2014	2	Crooked River	13.5	614525	5067570
4800222	7/17/2014	3	Crooked River	18.2	614032	5063810
4800222	7/21/2014	4	Crooked River	18.2	614030	5063810
4800222	7/24/2014	5	Crooked River	18.2	614030	5063810
4800222	8/30/2014	6	Crooked River	18.3	614030	5063800
4800222	10/5/2014	7	Crooked River	18.2	614040	5063810

Appendix B. Descriptive information of sites that were snorkeled in the South Fork Clearwater River, Idaho in August 2014. World Geodetic System 1984 coordinates (Universal Transverse Mercator projection using zone 11) represent the upstream terminus of the site.

River kilometer	Region	Date	Easting	Northing	Channel-unit type	Length (m)	Mean width (m)	Mean depth (m)	Maximum depth (m)
0.4	1	8/18/2014	578732	5110050	run	196.5	33.0	0.6	1.4
2.6	1	8/18/2014	578855	5108260	run	66.1	29.5	0.4	0.8
3.8	1	8/18/2014	578620	5107070	riffle	45.8	32.7	0.3	0.5
4.3	1	8/18/2014	578854	5106700	run	77.1	31.5	0.3	0.7
6.0	1	8/18/2014	578920	5105000	run	124.4	36.0	1.4	1.7
8.0	1	8/18/2014	579134	5103170	riffle	105.8	28.8	0.3	0.7
8.5	1	8/18/2014	579145	5102240	run	83.6	38.3	0.4	0.7
10.9	1	8/18/2014	579321	5100880	run	87.3	23.3	0.6	1.1
12.0	1	8/18/2014	579036	5099800	pool	166.4	35.3	0.7	1.3
13.4	1	8/18/2014	578763	5098650	run	83.2	25.2	0.4	0.8
16.2	1	8/18/2014	579723	5097330	riffle	46.2	47.2	0.3	0.8
18.2	1	8/18/2014	580225	5095620	pool	125.3	31.8	0.8	2.3
20.6	1	8/18/2014	580270	5094010	run	85.6	31.8	0.5	1.3
22.3	1	8/18/2014	580145	5092520	riffle	32.5	36.0	0.3	0.9
23.0	1	8/19/2014	580431	5091050	pool	73.3	34.2	0.8	2.0
26.3	1	8/19/2014	579705	5089550	run	156.3	39.5	0.6	1.4
28.5	1	8/19/2014	577748	5089080	pool	51.7	19.0	1.4	2.6
28.7	1	8/19/2014	578127	5088980	riffle	60.7	22.2	0.2	0.5
30.4	2	8/19/2014	576921	5088210	run	49.0	13.7	0.9	2.5
32.0	2	8/19/2014	577304	5086950	pool	132.3	24.2	1.3	3.0
33.7	2	8/19/2014	577138	5084850	riffle	65.9	36.0	0.3	1.0
34.3	2	8/19/2014	577039	5085440	riffle	54.3	21.0	0.2	0.5
36.9	2	8/19/2014	575762	5083860	pool	234.1	18.2	1.7	3.2
38.4	2	8/19/2014	574742	5083290	run	203.2	25.7	0.6	1.3
40.8	2	8/19/2014	575701	5081730	pool	166.2	31.2	0.7	1.3
42.6	2	8/5/2014	576051	5080090	run	142.4	23.7	0.6	1.2

Appendix B. Continued from previous page.

43.8	2	8/5/2014	576095	5078890	run	173.2	25.0	1.1	2.0
46.4	2	8/5/2014	577598	5077120	pocket	125.2	21.5	0.9	1.1
48.5	2	8/5/2014	579096	5076110	pool	111.4	18.5	1.3	1.9
48.7	2	8/8/2014	579980	5075570	run	138.0	23.3	1.0	2.2
50.0	2	8/8/2014	580142	5075450	run	231.1	35.3	0.8	1.8
52.5	2	8/8/2014	582112	5076010	riffle	87.3	37.0	0.3	0.8
53.0	2	8/10/2014	583342	5075440	run	128.6	17.5	0.7	1.5
56.2	2	8/10/2014	585099	5075460	pool	106.6	20.7	1.2	3.0
58.2	2	8/10/2014	587245	5075390	pocket	56.0	25.5	0.5	1.2
60.6	2	8/10/2014	589038	5074700	pocket	81.7	22.2	0.5	1.5
62.4	2	8/10/2014	590500	5074460	riffle	90.6	16.5	0.6	1.7
63.7	2	8/10/2014	592341	5073900	pocket	103.4	19.3	0.4	1.1
66.7	2	8/10/2014	594073	5072950	pool	55.2	14.8	1.0	2.5
68.6	2	8/15/2014	596054	5072060	pocket	100.4	12.0	0.8	1.5
68.7	2	8/15/2014	595311	5072100	run	120.4	13.3	1.1	2.1
70.2	2	8/15/2014	596700	5071850	run	39.7	12.7	0.9	1.6
72.1	2	8/15/2014	598204	5072280	run	58.1	14.7	0.8	1.4
73.7	2	8/15/2014	600345	5072740	run	101.8	14.8	0.8	1.6
74.1	2	8/15/2014	600122	5072610	pool	39.3	18.2	1.2	2.1
76.6	3	8/15/2014	602201	5073330	riffle	49.9	24.2	0.4	1.0
78.3	3	8/15/2014	603861	5073800	pocket	92.0	16.5	0.5	1.5
80.4	3	8/15/2014	605021	5073790	run	57.3	17.5	0.6	1.3
82.7	3	8/15/2014	606227	5074250	riffle	64.5	21.0	0.2	0.6
83.9	3	8/15/2014	606124	5075370	run	85.0	20.2	0.4	0.7
84.5	3	8/19/2014	606549	5075450	pool	39.9	22.5	1.1	3.0
86.4	3	8/19/2014	608067	5075990	run	90.7	13.7	0.6	1.5
88.1	3	8/19/2014	609187	5075250	run	61.3	15.5	0.4	0.8
88.7	3	8/19/2014	609055	5075390	run	45.9	16.3	0.3	0.7
92.6	3	8/19/2014	611732	5076210	run	38.8	18.5	0.5	0.9
93.9	3	8/19/2014	612431	5075690	run	180.4	19.2	0.3	0.6

Appendix B. Continued from previous page.

94.3	3	8/19/2014	612685	5075750	run	41.3	13.8	0.5	1.0
96.3	3	8/19/2014	614177	5075580	riffle	43.0	22.3	0.2	0.6
98.4	3	8/19/2014	616042	5075810	run	31.7	9.9	0.3	0.6
98.7	3	8/19/2014	615837	5075770	run	54.9	13.5	0.5	1.1
100.5	3	8/19/2014	617417	5074890	pool	146.8	17.8	0.5	1.0
103.2	3	8/19/2014	618455	5073850	run	113.5	19.3	0.3	1.0

Appendix C. The number of snorkelers and fish observed by species at each site that was snorkeled in the South Fork Clearwater River, Idaho in August 2014.

		Cutthroat Trout			Rainbow Trout			Chinook Salmon					
River kilometer	Number of snorkelers	<150 mm	150–300 mm	>300 mm	<150 mm	>150 mm	Bull Trout	<150 mm	>150 mm	Mountain Whitefish	Catostomas spp.	Northern Pikeminnow	Smallmouth Bass
0.4	9	0	0	0	0	0	0	0	0	0	55	3	54
2.6	7	0	0	0	0	0	0	0	0	0	0	0	1
3.8	8	0	0	0	6	2	0	2	0	8	0	0	1
4.3	7	0	0	0	0	0	0	0	0	7	0	0	0
4.9	5	0	0	0	0	1	0	10	0	40	7	17	0
6.0	9	0	0	0	1	0	0	0	0	0	26	26	15
8.0	8	0	0	0	0	2	0	1	0	1	0	5	0
8.5	8	0	0	0	0	0	0	0	0	0	0	0	0
10.9	7	0	0	0	0	0	0	0	0	0	1	0	1
12.0	8	0	0	0	0	0	0	19	0	3	3	8	0
13.4	8	0	0	0	1	0	0	0	0	2	3	1	0
16.2	9	0	0	0	2	1	0	1	0	0	0	0	0
18.2	9	0	0	0	2	0	0	0	0	62	4	6	1
20.6	9	0	0	0	10	2	0	0	0	2	0	0	0
22.3	9	0	0	0	2	0	0	0	0	4	1	0	0
23.0	9	0	0	0	3	3	0	4	0	22	6	5	0
26.3	9	0	0	0	0	2	0	0	0	23	3	12	0
28.5	6	0	0	0	29	1	0	0	0	7	2	0	0
28.7	7	0	0	0	2	2	0	2	0	3	0	1	0
30.4	5	0	0	0	4	3	0	0	0	1	13	0	0
32.0	8	0	1	0	105	8	0	0	0	28	4	26	0
33.7	5	0	0	0	97	2	0	2	0	1	0	0	0
34.3	4	0	0	0	4	2	0	0	0	0	0	0	0
36.9	5	0	0	0	83	3	0	0	0	15	2	0	0
38.4	5	0	0	0	22	3	0	0	0	41	3	3	0
40.8	4	0	0	0	13	9	0	21	0	16	0	0	0

Appendix C. Continued from previous page.

42.6	5	0	0	0	26	7	0	10	2	15	1	0	0
43.9	5	0	0	1	14	5	0	16	0	13	1	11	0
46.4	5	0	0	0	31	6	0	0	0	10	0	0	0
48.5	5	0	0	0	17	5	0	8	0	7	1	15	0
50.0	5	0	0	0	30	4	0	12	0	15	3	2	0
52.5	5	1	1	0	43	12	0	2	0	22	0	3	0
53.0	5	0	1	0	5	13	0	3	0	36	0	0	0
56.2	5	0	1	0	30	19	0	3	0	28	1	1	0
58.2	5	0	0	0	54	13	0	1	0	3	0	1	0
60.6	5	1	0	0	56	20	0	1	0	3	7	0	0
62.4	5	0	0	0	45	5	0	4	0	5	0	0	0
63.7	5	0	0	0	86	20	0	12	0	9	1	0	0
66.7	5	0	0	0	23	13	0	0	0	6	0	1	0
68.6	2	0	0	0	17	13	0	1	0	6	0	0	0
68.7	5	1	1	3	56	35	0	13	0	12	0	0	0
70.2	5	0	0	0	38	26	0	1	1	11	0	0	0
72.1	5	0	0	0	14	12	0	4	0	0	1	2	0
73.7	5	0	0	1	11	21	0	1	0	12	0	0	0
74.1	5	0	1	3	11	17	0	0	0	5	0	2	0
76.6	5	2	1	4	20	10	4	9	0	16	0	0	0
78.3	5	0	0	0	43	18	0	4	2	5	0	0	0
80.4	5	0	0	0	6	3	1	2	0	2	0	0	0
82.7	5	0	0	0	14	2	0	2	0	19	0	0	0
83.9	5	0	1	1	7	7	0	2	0	18	0	0	0
84.5	4	0	0	0	1	2	0	2	0	20	0	0	0
86.4	5	0	0	0	10	2	0	4	20	2	0	0	0
88.1	4	0	0	0	3	0	0	0	0	2	0	0	0
88.7	4	0	0	0	2	0	0	0	0	5	0	0	0
92.6	5	0	0	0	1	1	0	0	0	0	0	0	0
93.9	5	0	1	0	0	0	0	0	0	1	0	0	0

Appendix C. Continued from previous page.

94.3	5	0	0	0	0	0	0	0	0	7	0	0	0
96.3	5	0	0	0	0	0	0	0	0	0	0	0	0
98.4	4	0	0	0	0	0	0	0	0	0	0	0	0
98.7	4	0	0	0	0	0	0	5	0	0	0	0	0
100.5	4	0	0	0	0	0	0	0	0	0	0	0	0
103.2	4	0	1	0	0	0	0	30	0	2	0	0	0

Appendix D. The presence or absence of other fish observed by species at each site that was snorkeled in the South Fork Clearwater River, Idaho in August 2014.

River kilometer	Redside Shiner	Chislemouth	Longnose Dace	Speckeled Dace	Sculpin spp.
0.4	present	present	absent	absent	present
2.6	absent	absent	absent	absent	present
3.8	present	absent	absent	present	absent
4.3	absent	absent	absent	present	absent
6.0	present	absent	absent	absent	absent
8.0	present	absent	absent	present	absent
8.5	absent	absent	absent	absent	absent
10.9	absent	absent	absent	absent	absent
12.0	present	absent	absent	present	absent
13.4	absent	absent	absent	present	present
16.2	absent	absent	absent	present	present
18.2	present	absent	present	present	present
20.6	present	absent	present	present	absent
22.3	absent	absent	absent	present	absent
23.0	present	absent	absent	absent	absent
26.3	present	absent	absent	absent	absent
28.7	absent	absent	present	present	absent
28.5	present	absent	present	present	absent
30.4	present	absent	present	present	absent
32.0	present	absent	absent	present	absent
34.3	absent	absent	present	present	absent
33.7	present	absent	present	absent	absent
36.9	present	absent	present	present	absent
38.4	present	absent	absent	present	absent
40.8	present	absent	present	absent	absent
42.6	present	absent	present	absent	absent

Appendix D. Continued from previous page.

43.9	absent	absent	absent	absent	absent
46.4	absent	absent	absent	absent	absent
48.5	present	absent	absent	absent	absent
48.7	absent	absent	present	absent	absent
50.0	absent	absent	present	absent	absent
52.5	absent	absent	absent	absent	absent
53.0	absent	absent	absent	absent	absent
56.2	present	absent	absent	absent	absent
58.2	absent	absent	absent	absent	absent
60.6	absent	absent	absent	absent	absent
62.4	absent	absent	absent	absent	absent
63.7	present	absent	present	present	present
66.7	absent	absent	absent	absent	absent
68.7	absent	absent	absent	present	absent
68.6	absent	absent	absent	absent	absent
70.2	absent	absent	present	absent	absent
72.1	absent	absent	absent	absent	absent
74.1	present	absent	absent	absent	absent
73.7	absent	absent	present	absent	absent
76.6	absent	absent	absent	absent	absent
78.3	present	absent	absent	present	absent
80.4	present	absent	present	present	absent
82.7	absent	absent	present	present	absent
83.9	absent	absent	present	present	absent
84.5	present	absent	present	present	absent
86.4	present	absent	present	present	absent
88.7	absent	absent	present	absent	absent
88.1	absent	absent	present	present	absent
92.6	absent	absent	present	absent	absent

Appendix D. Continued from previous page.

93.9	absent	absent	present	absent	absent
94.3	absent	absent	absent	present	absent
96.3	absent	absent	present	present	absent
98.7	absent	absent	absent	present	absent
98.4	present	absent	present	absent	absent
100.5	absent	absent	present	present	absent
103.2	absent	absent	absent	present	absent