

# Brown Trout Redd locations in Spearfish Creek, in the City of Spearfish, South Dakota, USA, in the Fall of 2025

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**ABSTRACT:** A naturally-reproducing brown trout (*Salmo trutta*) population exists in the reach of Spearfish Creek in the city of Spearfish, South Dakota, USA. This study recorded redd spawning locations and environmental factors in three different sections within this reach in 2025. The first redd was observed on 3 October, and the last redds were observed on 7 November. A total of 46 redds were observed in all three sections over the seven-week study period. Peak spawning activity occurred on 24 and 31 October, with 14 and 16 redds observed, respectively. The northernmost (downstream) section had over twice the number of redds as the two upstream sections. In addition, redds in this section were primarily located in two hot spots.

**Keywords:** Brown trout, redds, spawning, salmonid.

## INTRODUCTION

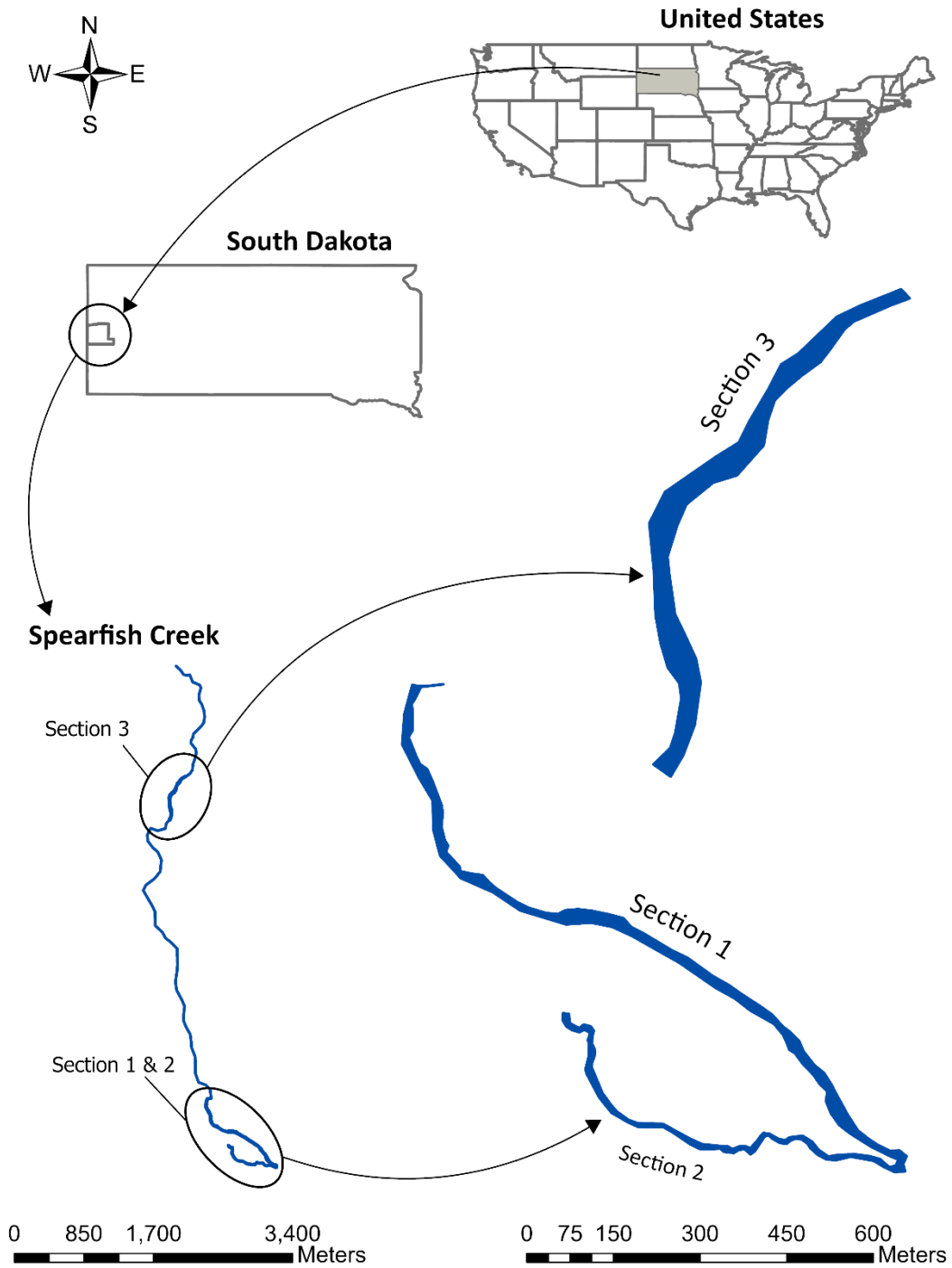
Throughout the Black Hills of South Dakota, USA, brown trout (*Salmo trutta*) are the primary fish targeted in streams by recreational anglers. They are not native to the Western Hemisphere, but after their introduction in South Dakota in 1886, they quickly became naturalized in the state (Barnes, 2004). If appropriate spawning habitat is present, brown trout will naturally reproduce in nearly all 1,287 km of Black Hills streams (Martling *et al.*, 2020; Erickson and Koth, 2000; Kientz, 2016). Spawning activity typically occurs from mid-October to mid-November and lasts around four weeks (Barnes, 2007; Martling *et al.*, 2020; Kientz, 2016).

Similar to other salmonids, brown trout create redds (gravel nests) for egg deposition during spawning (Helfman, 2009). Aspects of brown trout spawning can vary based on geography and environmental conditions (Muhlfeld *et al.*, 2006; Wydowski and Whitney, 2003). For example, spawning season length (Gortázar *et al.*, 2007), courtship behaviour (Binder *et al.*, 2015), and redd

locations can all be impacted by the time of year, temperature, and water flows (Vollset *et al.*, 2016). Stream characteristics like substrates, water morphology, and water velocity particularly influence redd location (Martling *et al.*, 2020; Witzel and MacCrimmon, 1983; Knapp and Preisler, 1999). Brown trout prefer fast-moving water and coarse substrates in shallower streams (Witzel and MacCrimmon, 1983; Grost *et al.*, 1990).

Counting the number of redds in a stream is a simple technique that can be used to evaluate trout population dynamics (Meffe, 1986; Konkel and McIntyre, 1987; Pratt, 1992; Weaver, 1992; Reiman and McIntyre, 1996). Environmental impacts, such as changes in water temperature or stream flows, can also be evaluated by counting the number of redds and their locations within a stream (Warren *et al.*, 2012).

Spearfish Creek is located in Lawrence County, South Dakota, USA (Figure 1). The creek originates at an elevation of approximately 2,100 m in the western



**Figure 1.** Study site map showing the location of Spearfish Creek within the United States and the locations of all sections of the study of Spearfish Creek within the Spearfish city limits.

limestone plateau area of the northern Black Hills. It flows generally northward through Spearfish Canyon and then through the city of Spearfish before emptying into the Redwater River at an elevation of 914 m (Clausen, 2018). The reach of Spearfish Creek within the city limits of Spearfish (hereafter referred to as the study reach)

contains an abundant and recreationally important naturally reproducing brown trout population (Stetler and Sieverding, 2001). While the entire reach of Spearfish Creek contains naturalized populations of rainbow trout (*Oncorhynchus mykiss*) and brook trout (*Salvelinus fontinalis*), the study reach contains brown trout almost

exclusively (Bucholz and Wilhite, 2010). This stretch of Spearfish Creek, and the associated brown trout fishery, may be vulnerable to urban impacts. For example, the city of Spearfish is growing rapidly (World Population Review, 2025), with unknown future water demands that could affect Spearfish Creek (South Dakota Department of Agriculture and Natural Resources, 2026). Water discharges from the D.C. Booth Historic National Fish Hatchery in the city of Spearfish may also be impacting the creek (South Dakota Department of Agriculture and Natural Resources, 2026), as may commercial development and agricultural operations relying on water from the creek for seasonal irrigation (Robidoux *et al.*, 2022). Redd information may be useful to assess the potential anthropogenic and other effects on the environmental conditions and brown trout populations within the study reach (Knapp and Preisler, 1999; Warren *et al.*, 2012).

The first redd monitoring in the study reach occurred in the southernmost section in 2019 (Martling *et al.*, 2020). Brown trout redds were subsequently surveyed in the northernmost section still within city limits in 2020 (Robidoux *et al.*, 2022). Gallagher *et al.* (2007) recommended conducting redd counts each year to estimate the size of fish populations. With several years since redds have been surveyed in the study reach, further sampling is warranted. Thus, the objective of this study was to survey brown trout redds in the previously-surveyed sections of Spearfish Creek within the city limits of Spearfish.

## METHODS AND MATERIALS

### Study area

This study occurred in three different sections along the study reach. Sections 1 and 2 include the area surveyed by Martling *et al.* (2020) in 2019. Section 1 was the mainstem creek, and Section 2 was the diversion channel within Spearfish City Park and Campground. The mainstem section (Section 1) was approximately 850 m long, began at the Spearfish City Hydropower Plant (latitude, longitude = 44.47837 °N, 103.85463 °W), and ended at a low-head dam located across from the pickleball courts in city park (latitude, longitude = 44.48403°N, 103.86214°W) (Figure 1). The diversion channel (Section 2) was approximately 400 m long in its entirety. It began on the downstream side of the Spearfish City Hydropower Plant, flowed through the south side of the Spearfish City Campground, and ended at the D.C. Booth Historic National Fish Hatchery (latitude, longitude = 44.48103 °N, 103.86064 °W). This diversion channel is the primary water source for the hatchery. Section 3, the northern-most section, was 400 m long. It started at the bridge beside Jorgensen Park (latitude, longitude =

44.50594 °N, 103.86637 °W) and ended south of Evans Park (44.50926 °N, 103.86487 °W). The starting point of this section was approximately 3.86 km (Robidoux *et al.*, 2022) from the hydropower plant. This reach was part of the site where Robidoux *et al.* (2022) surveyed brown trout redds in 2020. Time and labour constraints prevented sampling the entire reach surveyed by Robidoux *et al.* (2022). The locations of the sections used in this study in relation to those previously surveyed by Martling *et al.* (2020) and Robidoux *et al.* (2022) are shown in Figure 2.

### Redd Identification and location

Sampling of redds began on 3 October 2025, with weekly observations occurring until no new redds or spawning fish were seen as described by Gallagher *et al.* (2007). The final redd was observed on 7 November, with the final survey occurring on 14 November. Only new redds were marked each week.

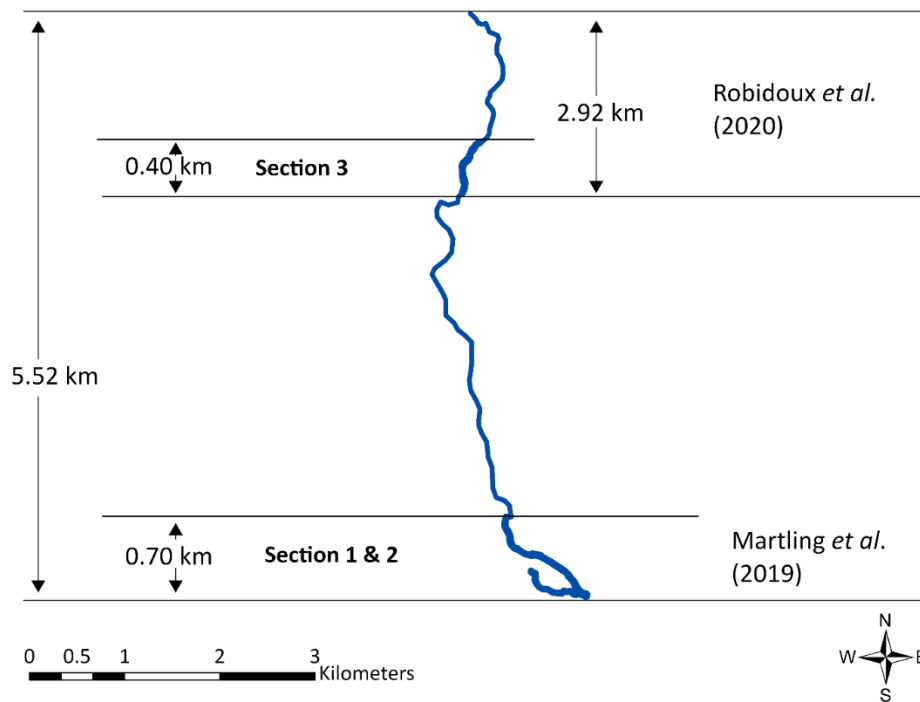
The identification of redds was based on previously described techniques (Gallagher *et al.*, 2007; Al-Chokhachy *et al.*, 2005; Gortázar *et al.*, 2007). Redd identification was based on the presence of a shallow, circular pit with lighter-appearing cobble because of overturned substrate using the criteria described by Gortázar *et al.* (2007) and Riedl and Peter (2013) (Figure 3). Redd locations were recorded using Terrasync on the Trimble Geo7X Global Positioning System unit (Trimble, Sunnyvale, California, USA).

Water temperature to the nearest 0.1°C was recorded for each of the stretches on each day of sampling at approximately the same time. Air temperatures were obtained for each of the sampling dates from a commercial website (<https://www.wunderground.com/history/monthly/us/sd/spearfish/KSPF/date/2025-11>). Stream flow data was obtained from the United States Geological Survey gauging station on Spearfish Creek by Spearfish City Park (USGS, 2025).

## RESULTS

A total of 46 redds were observed in all three sections of the creek over the seven-week study period (Table 1). The highest number of redds was observed on 31 October, with 16 redds, 10 of which were in the northernmost section (Section 3). This section only had redds observed on 24 and 31 October, but still had over twice the number of redds as Section 1, and five times the number of Section 2 (Figures 4 and 5). Two significant hot spots were located within Section 3 (Figure 6). No new redds or spawning activities were observed on 7 November.

Both water and air temperature remained relatively constant until the 24 October sampling date, when there was a dramatic decline (Table 2). Both temperatures



**Figure 2.** Study locations in Spearfish Creek within the city limits of Spearfish, South Dakota, USA, and in relation to two prior studies. Sections 1 and 2 included all of the stream reach sampled by Martling *et al.* (2019), while Section 3 was only 0.40 km of the entire 2.92 km reach surveyed by Robidoux *et al.* (2020).

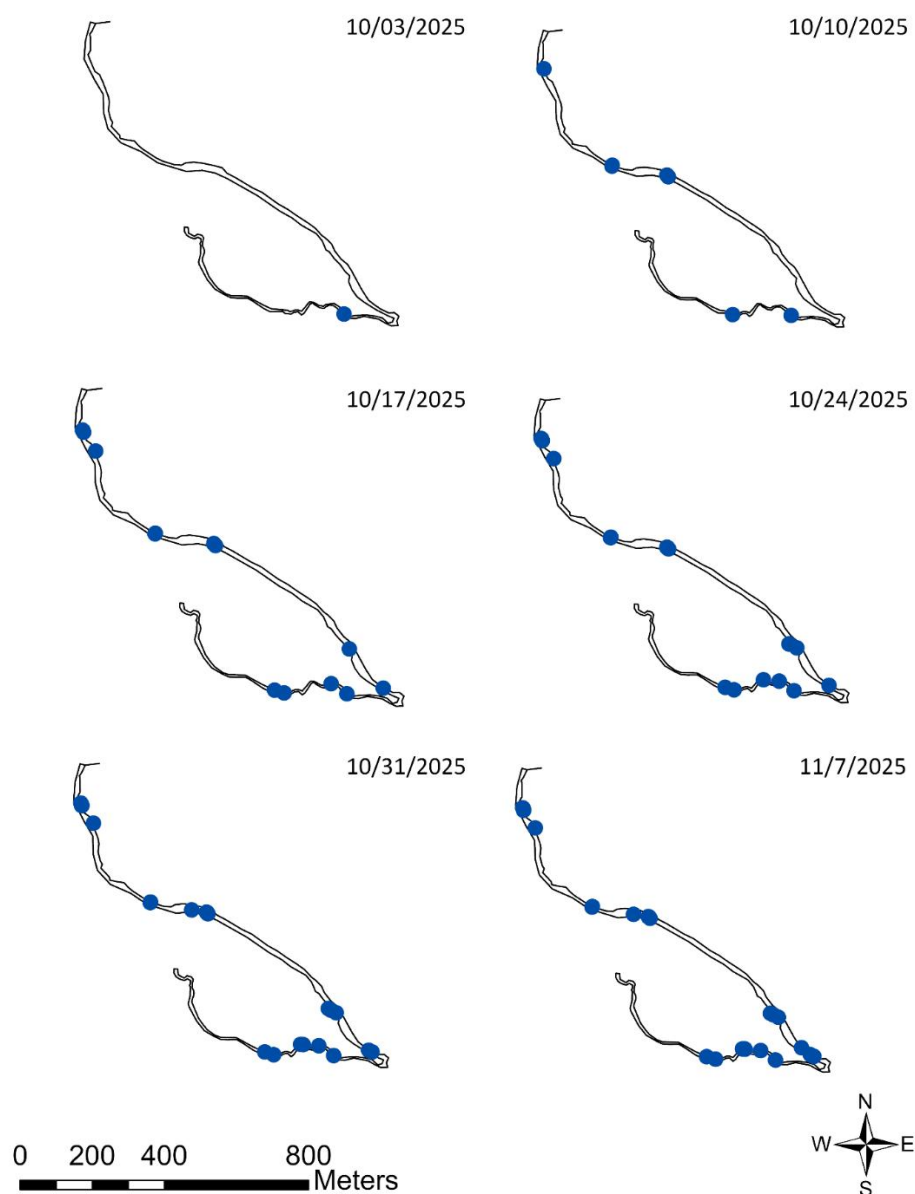


**Figure 3.** Photo of a redd in Spearfish Creek within the city limits of Spearfish. Note the contrast between the shallow pit and the surrounding area.

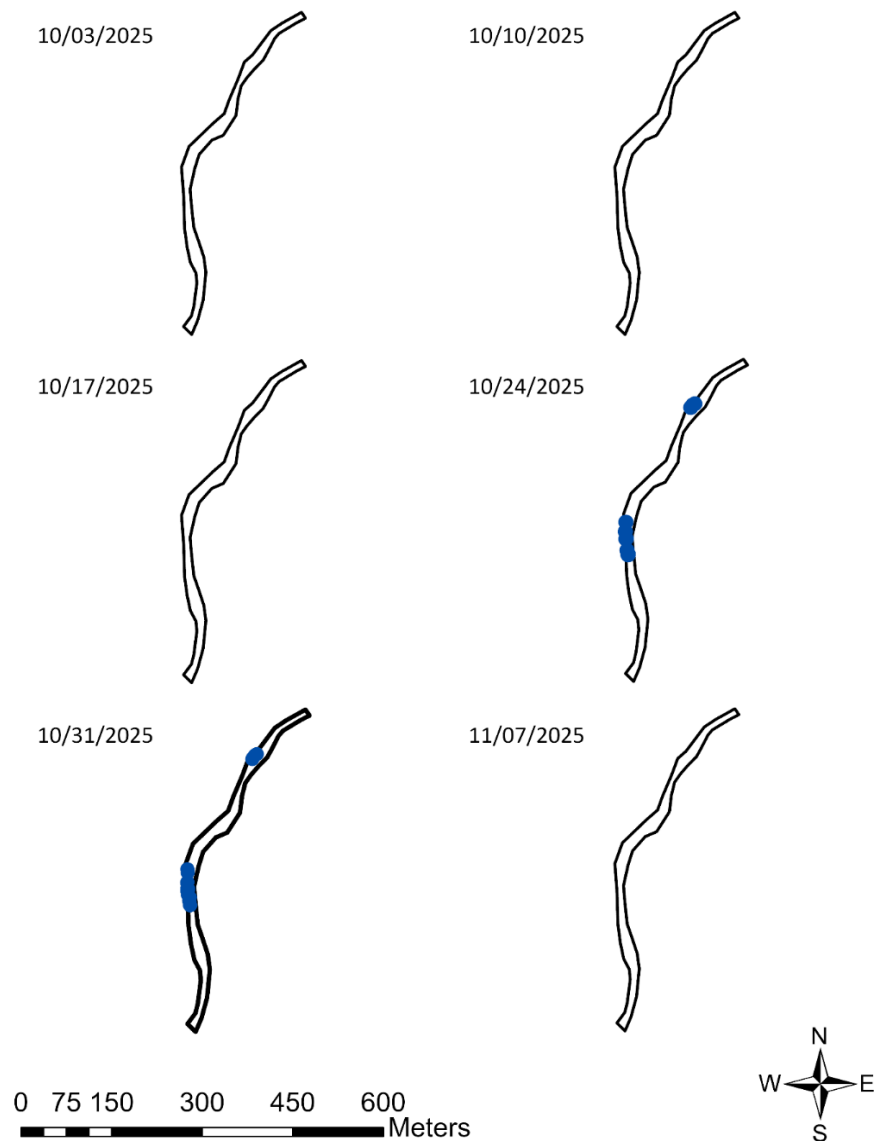
**Table 1.** The number of redds per section in Spearfish Creek within the city of Spearfish, South Dakota in the fall of 2025.

Dates	Section 1	Section 2	Section 3	Cumulative
October 3	0	1	0	1
October 10	5	1	0	7
October 17	5	2	0	14
October 24	3	1	11	29
October 31	4	2	10	45
November 7	1	0	0	46
November 14	0	0	0	46

Section 1 and 2 are the southern-most sections within city limits, while Section 3 is the northernmost section.



**Figure 4.** Weekly redd location and numbers for Sections 1 and 2, the southernmost stretches of Spearfish Creek in the city of Spearfish, South Dakota, during the fall of 2025.

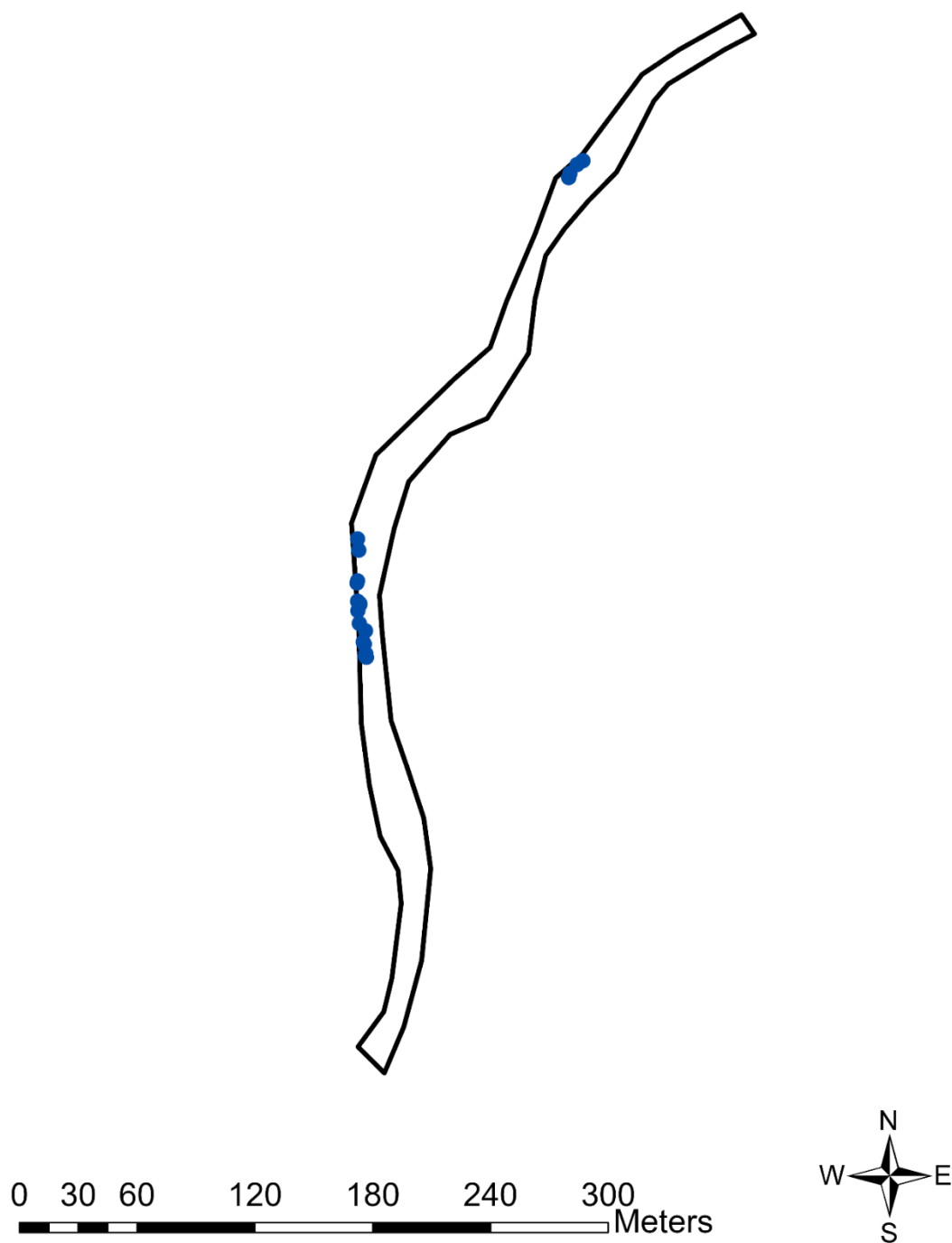


**Figure 5.** Weekly redd location and numbers for Section 3, the northernmost section of Spearfish Creek within the city limit of Spearfish, South Dakota, during the fall of 2025.

**Table 2.** Water temperatures (°C) from three sections of Spearfish Creek within the city limits of Spearfish, South Dakota and air temperature recorded on brown trout redd-counting days in the fall of 2025.

Dates	Water			Air
	Section 1	Section 2	Section 3	
October 3	8.8	9.4	11.0	23.3
October 10	9.0	9.0	11.0	16.3
October 17	9.0	9.0	10.0	10.4
October 24	5.0	6.0	8.0	9.6
October 31	4.0	4.0	4.0	0.9
November 7	6.0	6.0	6.0	8.2
November 14	6.0	6.0	6.0	16.4

Section 1 and 2 are the southernmost sections within city limits, while Section 3 is the northern-most section.



**Figure 6.** Redd hot spot locations in Section 3, the northernmost section of Spearfish Creek within the city limits of Spearfish, South Dakota, during the fall of 2025.

declined further on 31 October before increasing slightly on the last two sampling dates. Water temperatures and redd numbers were not significantly related ( $R^2 = 0.200$ ;  $p = 0.314$ ). Flows in Spearfish Creek during this study ranged from 0.49 to 1.40  $m^3/s$ , presumably because of powerplant generation needs.

## DISCUSSION

### Redd timing

The timing of redd construction observed in this study in this reach of Spearfish Creek is very similar to that

observed in the two prior studies. Martling *et al.* (2020) first observed redds on 15 October and final redds on 12 November in the southernmost section of the study reach. Robidoux *et al.* (2022) first observed redds on 13 October and final redds on 17 November in the northern-most section of the study reach. The timing in this study is also similar to that reported for redd construction in other areas in the South Dakota Black Hills and Canada (Zimmer and Power, 2006; Ketelsen *et al.*, 2017; Roduner *et al.*, 2025; Robinson *et al.*, 2025; Weavill *et al.*, 2024). However, spawning activity of brown trout in their native range typically runs from late November through December (Rubin *et al.*, 2005). Brown trout spawning in Turkey extends into January (Alp *et al.*, 2003).

### Redd density

The redd densities observed in this study are much less than those reported for the same sections of Spearfish Creek just five and six years earlier. Sections 1 and 2 had a redd density of approximately 18 redds/km, while Section 3 had 50 redds/km. In 2019, Martling *et al.* (2020) observed 84 redds/km in sections 1 and 2 of this study. Similarly, Robidoux *et al.* (2022) reported 91 redds/km in Section 3 of this study. Redd densities in other Black Hills streams include 106 redds/km in Rapid Creek (Ketelsen *et al.*, 2017), 43 redds/km in Box Elder Creek (Ketelsen *et al.*, 2017), and 6 redds/km in a section of Crow Creek (Blaine *et al.*, 2018). These redd numbers are similar to those reported for brown trout in their native range (Gortázar *et al.*, 2007; Youngson *et al.*, 2011; Vollset *et al.*, 2016). Caution should be used in comparing redd densities among streams and stream reaches however, because redd densities can be influenced by a number of factors including water surface gradient, stream sinuosity, in-stream habitat, and other stream morphology features (Fukushima 2001; Zimmermann and Lapointe, 2005; Zimmer and Power, 2006; Wollebæk *et al.*, 2008; Wildhaber *et al.*, 2014).

### Superimposition

Spawning trout of the same or different species will use an existing redd used by a different female (Gallagher and Gallagher 2005; Reiser and Wesche 1997; Essington *et al.* 1998; Togaki *et al.* 2023). While this redd superimposition was not observed in this current study, it was observed previously in Spearfish Creek by both Martling *et al.* (2020) and Robidoux *et al.* (2022). Because this study only sampled redds one day per week, it is possible that superimposition could have occurred and not been observed. While McNeil (1964) and Dudley (2019) suggest a possible positive relationship between redd density and superimposition, Gortázar *et al.* (2012) reported superimposition even at low redd densities.

### Stream flow impacts

Changing water flows may be partially responsible for the decreased number of redds observed in this study compared to prior years (Vollset *et al.*, 2016; Stetler and Sieverding, 2001; Pender and Kwak, 2002). On a stream section 600 m below a dam, Vollset *et al.* (2016) observed a positive relationship between dam discharge and the number of large brown trout on spawning grounds. Sections 1 and 2 in this study are similarly located downstream from the varied discharge of the Spearfish City hydroelectric plant. During the Martling *et al.* (2020) and Robidoux *et al.* (2022) studies in 2019 and 2020, mean flow in the study reach was 2.15 m<sup>3</sup>/s and 2.36 m<sup>3</sup>/s, respectively. However, during this study, maximum flows were only 1.40 m<sup>3</sup>/s. Additionally, James *et al.* (2010) suggested that lower discharge in Spearfish Creek decreased brown trout biomass by reducing pool habitat. Repeated discharge fluctuations may also lead to stress-induced behaviours (Youngson *et al.*, 2011), which may affect reproduction. Thus, the relatively lower discharge rate that occurred during this study compared to prior studies may explain the relatively lower redd counts.

### Temperature impacts

The large and sudden increase in redd construction observed in this study in conjunction with decreased air and water temperatures, is likely not just coincidental. Water temperatures are known to influence the timing of salmonid spawning (Warren *et al.*, 2012). The air and water temperatures observed in this study were higher than those occurring during prior redd studies on the study reach (Martling *et al.*, 2020; Robidoux *et al.*, 2022).

Because of its origin in the limestone plateau and limestone aquifer inputs, Spearfish Creek is supersaturated with calcium carbonate (Ray and Rahn, 1997; Stetler and Sieverding, 2001). Calcium carbonate precipitation is the primary stream substrate cementation source in Spearfish Creek (Otsuki and Wetzel, 1972; Noe *et al.*, 2001; Corman *et al.*, 2016; Moody *et al.*, 2016). Stetler and Sieverding (2001) documented cementation in Spearfish Creek, which fluctuated between precipitation and dissolution, and was likely at least partially controlled by water temperature. Typically, substrate cementation occurs during the summer in Spearfish Creek (Stetler and Sieverding, 2001). Once temperatures decrease in the fall, the calcium dissolves, leaving a non-cemented substrate for redd construction. Cementation likely influences trout spawning and physiology (Stetler and Sieverding, 2001; Bolliet *et al.*, 2003; Kondolf *et al.*, 2008). However, because temperatures did not decrease until relatively late in this study, it is possible that calcium dissolution did not occur. This could possibly make redd construction more difficult until cementation decreased with colder water

temperatures, as occurred in late October. Thus, it is possible that temperature could have greatly influenced the number of redds and the timing of redd construction observed in this study.

### Limitations

This study consisted of just three sections comprising only approximately 1.85 km of the entire 62 km length of Spearfish Creek. It was also only conducted for one spawning season. Therefore, the results of this study may not be representative of the entire creek nor accurately represent what may be occurring over several years (Shukla *et al.*, 2005). In addition, although the redd observers in this study were well-trained, they lacked experience. Observer inexperience can lead to redd counting errors (Dunham *et al.*, 2001; Muhlfeld *et al.*, 2006; Gallagher *et al.*, 2007). It is possible that additional redds could have been created after this study ended. This is unlikely, however, because only one redd was observed in the second-to-last week of sampling, and no redds were observed in the final week. Redd counts typically cease when no new redds are observed (Gallagher *et al.*, 2007). Lastly, just because redds can be observed does not necessarily indicate reproductive success, nor can redd counts be used to determine actual fish population sizes (Al-Chokhachy *et al.*, 2005; Howell and Sankovich, 2012; Pender and Kwak, 2002).

### Conclusion

This study indicated a decline in brown trout redd numbers in the reach of Spearfish Creek within the city limits of Spearfish from similar sampling that occurred in 2019 and 2020. While the cause for this decrease is unknown, it may be because of either decreased flows or increased fall water temperatures, or possibly both factors in combination. It is also unknown if the observed decrease in redd numbers is representative of the numbers of spawning-sized brown trout in this reach of Spearfish Creek. Additional research examining a possible relationship between redd observations and brown trout population estimates obtained by electrofishing is needed. Redd surveys are much less expensive than electrofishing but can also be much more inaccurate.

### CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this paper.

### ACKNOWLEDGEMENTS

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