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Brown Trout and Brook Trout Redd Locations in Cleopatra Creek, Lawrence County, South Dakota, USA

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Abstract: This study documented redds of brown trout (*Salmo trutta*) and brook trout (*Salvelinus fontinalis*) in the fall of 2023 in Cleopatra Creek, a tributary of Spearfish Creek, Lawrence County, South Dakota, USA. Observations began on 21 September, 2023 in an 0.8 km stream reach extending upstream from the confluence of Cleopatra Creek with Spearfish Creek. Four additional observations occurred at one-to-two-week intervals until 30 October, 2023 at which time no new redds were observed. The number of redds peaked on 20 October, 2023 with ten new redds. Over the course of the study, a total of 25 redds were observed, resulting in a redd density of 6.25 redds/km. This is the first study to document fall-spawning brook and brown trout redd locations in Cleopatra Creek.

Keywords: Redd, Spawning, Brown Trout, Brook Trout, Reproduction, Superimposition

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Introduction

Trout are not native to the Black Hills of the state of South Dakota, USA. Brook trout (*Salvelinus fontinalis*) were introduced by the United States government in 1890, with other trout species introduced shortly thereafter (Barnes, 2007). Brook trout and brown trout quickly became self-sustaining and naturalized in most of the 1,287 km of coldwater creeks in the Black Hills (Erickson and Koth, 2000; James, 2011b).

Cleopatra Creek is a small coldwater stream located in Lawrence County, South Dakota, USA. It is a tributary of Spearfish Creek, with the confluence approximately 14 km upstream from the city of Spearfish, South Dakota. Brown trout, brook trout, and rainbow trout (*Oncorhynchus mykiss*) are all present in Cleopatra Creek (SDGFP, 2025). Brook trout predominate throughout Cleopatra Creek, with brown trout and rainbow

trout present only in the lower reaches (SDGFP 2025). The rainbow trout population consists primarily of smaller juveniles, providing additional evidence that Cleopatra Creek is a spawning and nursery area for the larger rainbow trout population in Spearfish Creek (James, 2011a; Roduner *et al*., 2025). In addition to the resident brown trout in Cleopatra Creek, Spearfish Creek has an over-abundant population of brown trout (Stetler and Sieverding, 2001; Rehm, 2018), which likely migrate in-and-out of Cleopatra Creek during certain times of the year (James *et al*., 2007).

During spawning, female salmonids use their tails to dig and clean a section of gravel substrate to build a redd, or nest, where they deposit their eggs (Knapp and Preisler, 1999). Redd location depends on stream velocity, morphology, and bottom substrates (Grost *et al*., 1990). Trout prefer to construct redds in shallower, faster moving stream sections (Meffe, 1986; Ketelsen *et al*., 2017). Brook and brown trout spawn in the fall, with brown trout spawning over a shorter period and later than brook trout (Witzel and Maccrimmon, 1983; Wydowksi and Whitney, 2003). Rainbow trout spawn in the spring in the Black Hills (Davis, 2012; Kientz, 2016).

Redd data can be used to monitor the status of trout populations (Meffe, 1986; Konkel and McIntyre, 1987; Pratt, 1992; Weaver, 1992; Rieman and McIntyre, 1996; Elliot and Hurley, 1998). Redd location data can also assess environmental changes (Warren et al. 2012). In addition, redd information has been used to assess the environmental impacts of changes in water flows or temperatures on trout spawning activities (Warren *et al*., 2012). Spawning activities have also been used as an indicator of stream health (Herman and Nejadhashemi, 2015). Cleopatra Creek has been impacted by upstream gold mining activities for over 100 years, with moderate levels of arsenic in the water and high concentrations of metals in the sediment (Rahn, 1996; May *et al*., 2001).

Roduner *et al*. (2025) documented rainbow trout redds in the spring in Cleopatra Creek. However, no studies have documented redd locations of fall spawning brook trout and brown trout in Cleopatra Creek. Redd locations of brown trout have been reported for other streams in the Black Hills, including the mainstream of Spearfish Creek (Ketelsen *et al*., 2017; Blaine *et al*., 2018; Martling *et al*., 2020; Robidoux *et al*., 2022; Weavill *et al*., 2024). Thus, the objective of this study was to document the locations of brown trout and brook trout redds in Cleopatra Creek, Lawrence County, South Dakota, USA.

Materials and Methods

Study Area

Cleopatra Creek is located in the Northern Black Hills of Lawrence County, South Dakota, USA. The study area began at the confluence of Cleopatra and Spearfish Creek (103.8898237°W 44.3967827°N) and ended 0.8 km upstream (103.8944930°W 44.4012903°N; Fig. 1). Water velocities in the creek ranged from 1.15 m^3/s to 1.00 m^3/s during the study period (USGS, 2023).

Redd Identification and Location

Redd observations began on 21 September 2023. Observations subsequently occurred on 28 September, 5 October, and 20 October, 2023 with a final observation on 30 October, 2023 when no new redds nor any spawning behaviors were observed. The duration of each observation period was up to three hours. It was dependent on the number of redds observed and weather conditions, with snow or rain lengthening the time required to walk the 0.8 km stream reach. Redd identification was determined by techniques described previously (Gallagher *et al*., 2007). Redd location was recorded with a Trimble Geo7X Global Position System (Sunnyvale, California, USA). The locations of all redds that could be observed, including existing redds identified previously, were marked at every observation period.

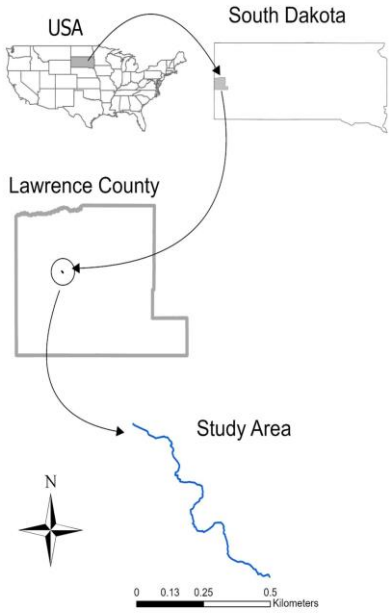

Fig. 1: Location of study area.

Table 1: New and cumulative redd numbers from an 0.8 km section of Cleopatra Creek, Lawrence County, South Dakota in the fall of 2023

Date	Redds	
	New	Cumulative
21 September	1	1
28 September	7	8
5 October	7	15
20 October	10	25
30 October	0	25

Results and Discussion

A total of 24 redds were observed throughout the seven-week study period, resulting in an overall redd density of 6.25 redds/km over the 0.8 km stream reach (Table 1). The first observed redd was on 21 September, 2023 with the largest number of redds observed on 20 October, 2023 (Fig. 2). Redd distribution was relatively uniform throughout the entire creek reach. While both brown and brook trout were observed, actual redd construction could not be assigned specifically to either species. Figure 3 is an image of a typical redd in Cleopatra Creek.

Redd Timing

The timing of redd construction observed in this study began and ended slightly earlier than that observed in other brook trout and brown trout redd studies in the Black Hills of South Dakota (Ketelsen *et al.*, 2017; Blaine *et al.*, 2018; Martling *et al.*, 2020; Robidoux *et al.*, 2022). For example, the first redd in the present study appeared on 21 September, 2023 with redd construction ending on 30 October, 2023. Similarly, redd construction in Rapid Creek and Box Elder Creek began on 14

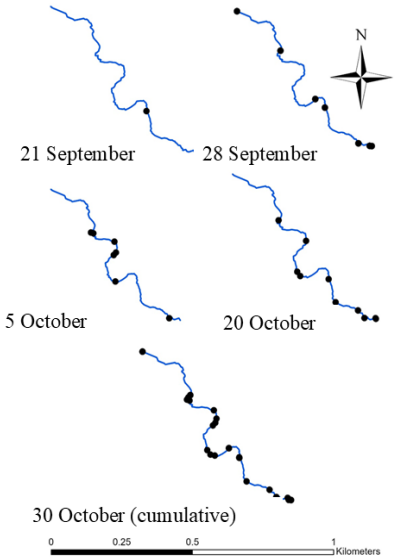

Fig. 2: Weekly and cumulative redd locations observed in the fall of 2023 in Cleopatra Creek, Lawrence County, USA.

Fig. 3: Image of a redd observed in the fall of 2023 in Cleopatra Creek, Lawrence County, South Dakota, USA.

October, 2024 and lasted until 5 November, 2023 (Ketelsen *et al*., 2017), redd construction in Crow Creek began on 17 October, 2023 and lasted until 21 November, 2023 (Blaine *et al*., 2018), and redd construction in Spearfish Creek began on October 13, 2023 and lasted until November 17, 2023 (Robidoux *et al*., 2022). This difference in timing is likely because of altitude, with Cleopatra Creek at a higher elevation than any of the other creeks studied in the Black Hills (Ried and Peter, 2013). The timing and duration of redd construction in this study was very similar to the 19 September through 27 October range reported for brown trout in Iron Creek (Weavill *et al*., 2024), which is at an elevation similar to Cleopatra Creek.

Redd Density

The redd density of 6.25 redds/km observed in this study was similar to the 5 redds/km observed in Crow Creek in the Black Hills (Blaine *et al*., 2018). However, it is substantially lower than that observed in other Black Hills streams, including the 30 redds/km in Iron Creek (Weavill *et al*., 2024), 43 redds/km in Box Elder Creek (Ketelsen *et al*., 2017), 84-to-91 redds/km in Spearfish Creek (Martling *et al*., 2020; Robidoux *et al*., 2022), and 106 redds/km in Rapid Creek (Ketelsen *et al*., 2017). Redd densities for brown trout in other locations include 10 redds/km in Canada (Zimmer and Power, 2006), 36 redds/km in Spain (Gortázar *et al*., 2012), and 73 redds/km in Scotlant (Youngson *et al*., 2011). Cleopatra Creek may have relatively lower redd densities because of relatively low flows and heavy sedimentation,

limiting habitat suitability for spawning (Vadas *et al*., 2016; Harrison *et al*., 2019).

Superimposition

Redd superimposition occurs when a female trout of the same or different species deposits eggs in an existing redd. Brook trout and brown trout spawn at the same time, leading to both intraspecific and interspecific redd superimposition (Sorenson *et al*., 1995). Other factors influencing superimposition include trout homing behavior and substrate alterations (Essington *et al*., 1998; Frank *et al*., 2012; Gortazar *et al*., 2012). Redd superimposition has been suggested in other Black Hills streams (Blaine *et al*., 2017; Martling *et al*., 2020). While superimposition was not directly observed in the current study, it could have occurred particularly because of the narrow and short morphology of Cleopatra Creek (Togaki *et al*., 2023).

The results of this one-year study may or may not be indicative of longer-term redd numbers. With a continental climate, precipitation and subsequent stream flows can vary greatly from year-to-year in South Dakota (Ryberg *et al*., 2014). In addition, the results may be only applicable to a very specific 0.8 km reach of Cleopatra Creek. The study was also conducted by a relatively inexperienced individual, which could potentially affect the results (Gallagher *et al*., 2007). Lastly, just because redds were observed does not mean that eggs were actually deposited or successful reproduction occurred.

Conclusion

This study documenting redd numbers and locations for brook trout and brown trout spawning in Cleopatra Creek provides a baseline for future redd counts. The results from this study, when used in conjunction with future redd count observations, could be used to quickly and inexpensively estimate trout populations. Redd counts could also be used as indicators of stream condition, particularly in relation to changes in environmental conditions from upstream gold mining activities. Lastly, the data provided in this study could provide the basis for evaluating future stream habitat improvement or restoration projects.

Ethical Statement

No animal sacrificed for this study, hence Ethical Approval not required.

Author Contributions

Robinson: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing-Original draft, Visualization; *Domagall*: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing-Review & editing, and Supervision; *Voorhees*: Conceptualization, Methodology, Writing-Review & editing, Visualizatoin, and Supervision; *Barnes*: Conceptualization, Methodology, Writing-Review & editing, Visualizatoin, Supervision, and Project administration. All authors have read and agreed to the published version of the manuscript.

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Conflict of Interest

The authors declare no conflicts of interest.

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