Chapter GQ

# COAL QUALITY AND GEOCHEMISTRY, GREATER GREEN RIVER BASIN, WYOMING

By G.D. Stricker and M.S. Ellis

*in* U.S. Geological Survey Professional Paper 1625-A

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Tables

# COAL QUALITY AND GEOCHEMISTRY, GREATER GREEN RIVER BASIN, WYOMING

Actively mined coal in the Greater Green River Basin, Wyoming (fig. GQ-1) is considered to be a "clean coal." The coal is a low-contaminant subbituminous coal resource. The Greater Green River Basin has one coalfield, the Point of Rocks-Black Butte, consisting of two study areas: (1) The Jim Bridger area, located in the north half of the coalfield, and (2) The Point of Rocks-Black Butte area, located in the south half of the coalfield. There is one assessment unit in the Greater Green River Basin, the Deadman coal zone, which is composed of coal beds 1 through 5 and A through C. For the location and description of coalfield and coal zone, see Chapter GF-Framework Geology of Fort Union Coal in the Eastern Rock Springs Uplift, Greater Green River Basin. This coal zone has the following arithmetic mean values (on an as-received basis) for coal that is not presently being mined or under lease to be mined in the future: **moisture**–19.95 percent, **ash yield**–11.18 percent, **total sulfur**–0.56 percent, **calorific value**–9,000 Btu/lb, **pounds of $SO_2$ per million Btu**–1.27, and **moist, mineral-matter-free Btu**–10,270. Arithmetic mean concentration (in parts per million and on whole-coal and remnant-moisture basis) of elements of environmental concern for the Deadman coal zone are: **antimony**–0.97, **arsenic**–21, **beryllium**–0.69, **cadmium**–0.28, **chromium**–13, **cobalt**–2.8, **lead**–5.5, **manganese**–23, **mercury**–0.20, **nickel**–9.7, **selenium**–2.8, and **uranium**–5.1. Coal from the Greater Green River Basin is developed from 2 mines and utilized for electric power generation. Table GQ-1 is a summary of coal quality in the Point of Rocks-



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1999 Resource assessment of selected Tertiary coal beds and zones in the Northern Rocky Mountains and Great Plains region, U.S. Geological Survey Professional Paper 1625-A

Black Butte coalfield, while tables GQ-2 and GQ-3 summarize the coal quality of the Jim Bridger and Black Butte areas separately.

Summary data for the 18 variables mentioned in the previous paragraph were calculated for the Deadman coal zone. However, much of the coal quality data in this basin are proprietary. This data, along with public data, is used in the summary tables but is not shown on location maps or on other illustrations. A common problem in statistical summaries of trace-element data arises when element values are below the limits of detection. This results in a censored distribution. To compute unbiased estimates of censored data for the elements in this table, we adopted the protocol of reducing all "less than" values by 50 percent to generate a real value for these data. Summary statistics of range (minimum, with an "L" indicating "less than", and maximum values) and arithmetic means were generated using the modified data. Moisture values are reported on an as-received basis (American Society for Testing and Materials, 1994b, designation D3180-89). Because no equilibrium moisture values are available for this report, apparent ranks can not reliably be determined.

Between 1974 and 1994, the U.S. Geological Survey analyzed samples of coal for major-, minor-, and trace-element contents. Prior to performing the analyses, most of the coal samples were dried at room temperature and humidity for as much as 80 hours. Some samples, however, may have only been dried enough to allow grinding (to less than 100 mesh). Moisture content in the samples is unknown, although moisture contents were probably similar to that which would remain after air-dry loss determination (American Society for Testing and Materials, 1994c, D3302-91). Since the actual moisture content of the samples analyzed between 1974 and 1994 is unknown and can not be determined, the major-, minor-, and



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trace-element contents is reported on a remnant moisture basis. Also, the elemental analysis of the samples cannot be converted to any other moisture basis. In addition, these analyses can only provide an approximation of load factors (such as, pounds of mercury per trillion Btu).

The following graphical displays, figures GQ-2 through GQ-35, show public data locations and values for the variables listed in tables GQ-2 and GQ-3, except for calorific value and moisture, for the Deadman assessment unit in the Jim Bridger and Point of Rocks-Black Butte areas. The locations of public data points used in this summary are shown on figures GQ-2 and GQ-3. When more than one analysis was available per location, the analytical values were weight averaged on coal sample thickness. For ash yield (figs. GQ-4 and GQ-5) and total sulfur content (figs. GQ-6 and GQ-7), the values are color coded to low, medium, and high, following guidelines established in U.S. Geological Survey Circular 891 (Wood and others, 1983). For moist, mineral-matter-free Btu, which is used in conjunction with other factors to determine apparent rank (figs. GQ-8 and GQ-9), we utilized the apparent rank designations established by American Society for Testing and Materials, (1994a), designation D388-92a. For pounds of sulfur dioxide per million Btu ($lbSO_2$) (figs. GQ-10 and GQ-11), values are color coded according to the U.S. Environmental Protection Agency's Phase I, Phase II, and non-compliant limits for sulfur emission from coal-fired power plants (U.S. Environmental Protection Agency, 1996).

No guidelines have been established for the elements of environmental concern (also referred to as "hazardous air pollutants" or "HAPs"). Analytical values for these elements (figs. GQ-12 through GQ-35) are color coded based on the following parameters: (1) each element of environmental concern was ranked from



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the lowest to highest value for all data in the Northern Rocky Mountains and Great Plains region and (2) quartiles were established for each element such that low represents those values that are less than the .25 quartile (also known as the lower quartile or the 25$^{th}$ percentile), medium represents those values that are within the .25 to .75 quartiles (two quartiles representing 50 percent of the values or between the 25$^{th}$ to 75$^{th}$ percentile), and high represents those values that are in the upper .25 quartile (or greater than the 75$^{th}$ percentile).



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## REFERENCES CITED

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_____1994b, Annual book of ASTM Standards, Section 5, Petroleum products, lubricants and fossil fuels, vol. 05.05 Gaseous fuels; coal and coke; section D3180-89; Standard Practice for Calculating Coal and Coke Analysis from As-Determined to Different Bases: American Society for Testing and Materials, Philadelphia, Pennsylvania, p. 318-320.

_____1994c, Annual book of ASTM Standards, Section 5, Petroleum products, lubricants and fossil fuels, vol. 05.05 Gaseous fuels; coal and coke; section D3302-91; Standard Test Method for Total Moisture in Coal: American Society for Testing and Materials, Philadelphia, Pennsylvania, p. 330-336.

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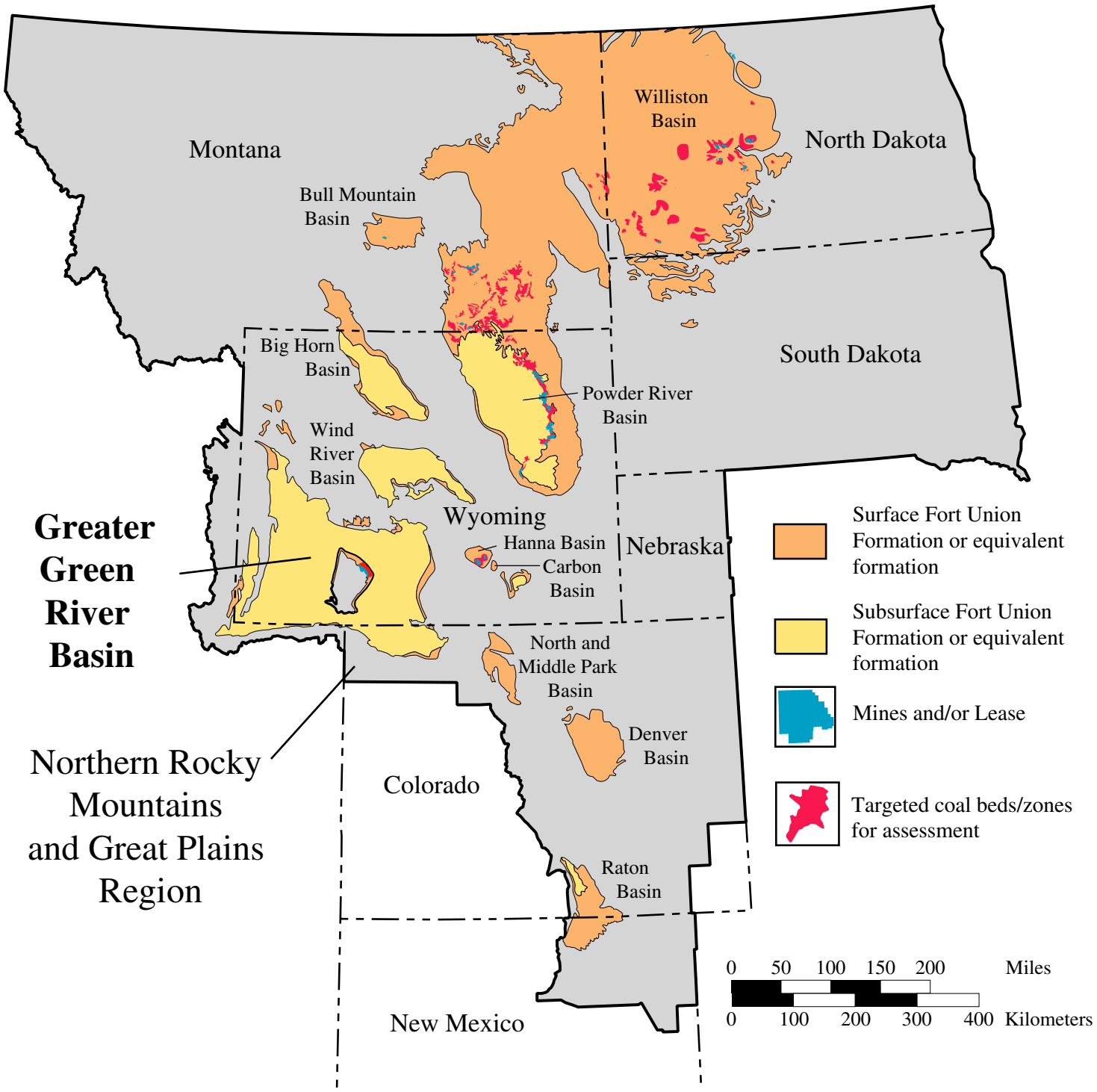


Figure GQ-1. Index map showing the Greater Green River Basin, Wyoming.

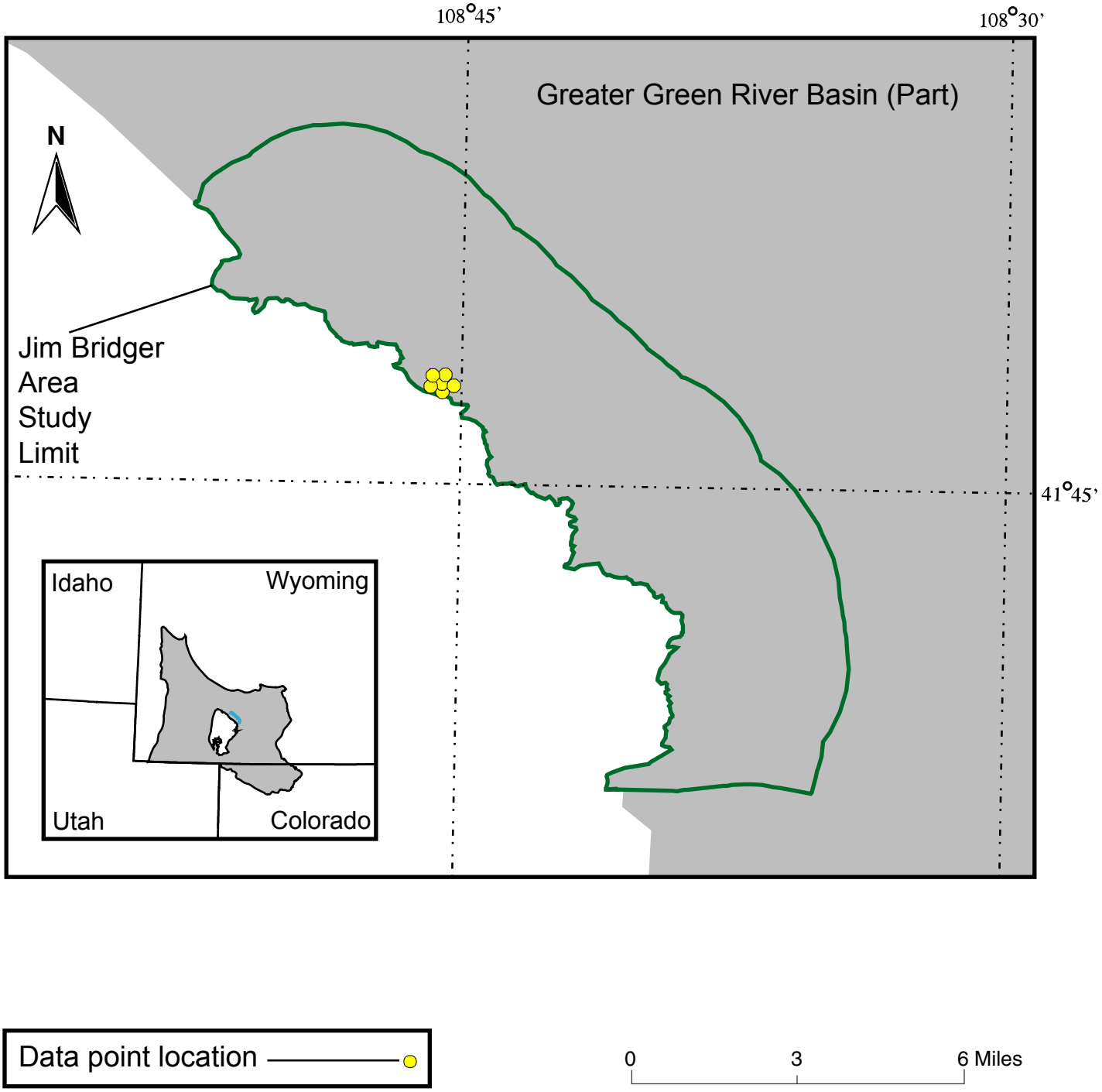


Figure GQ-2. Index map showing coal quality data distribution in the Deadman coal zone, Jim Bridger area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

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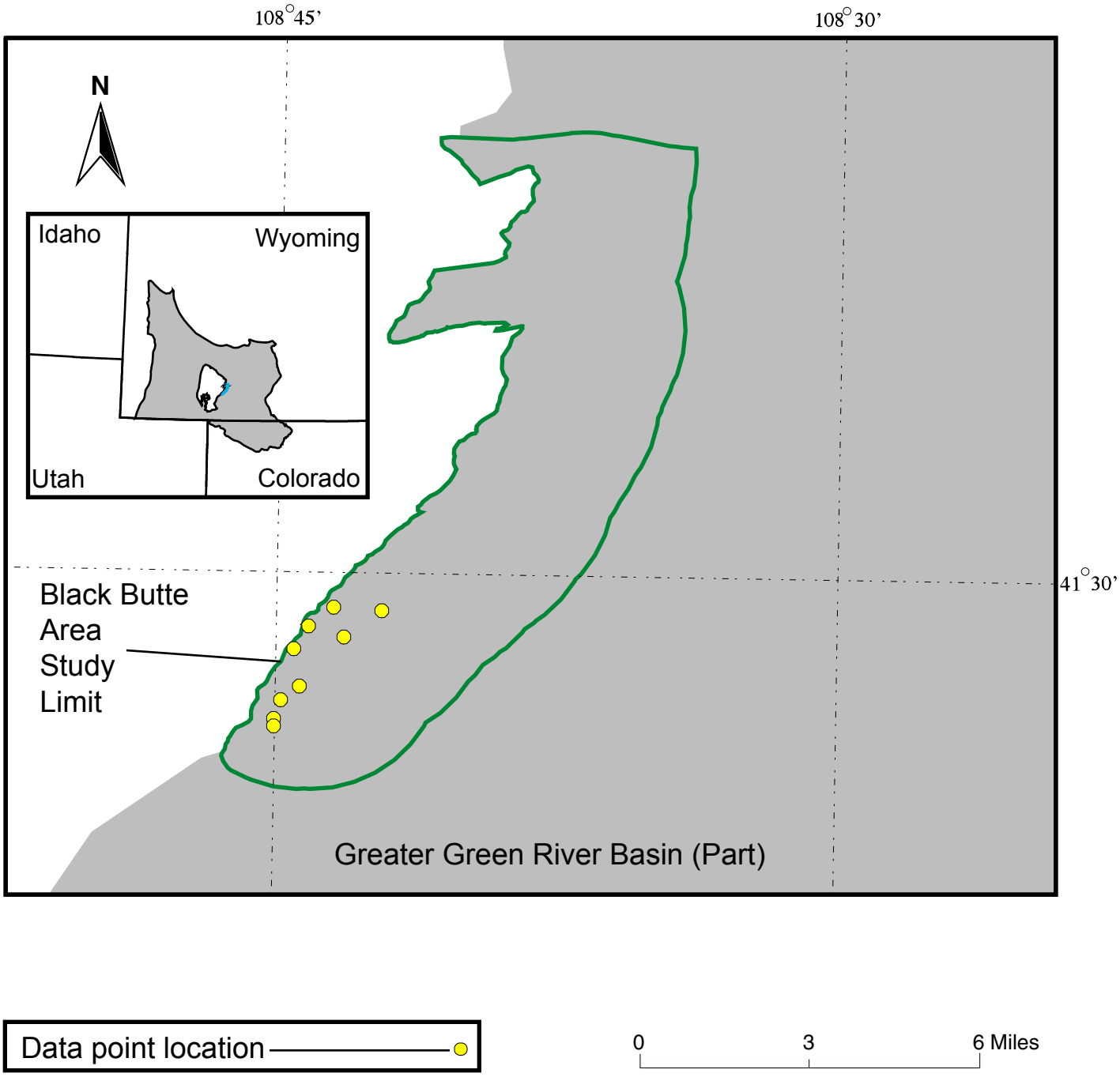


Figure GQ-3. Index map showing coal quality data distribution in the Deadman coal zone, Black Butte area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

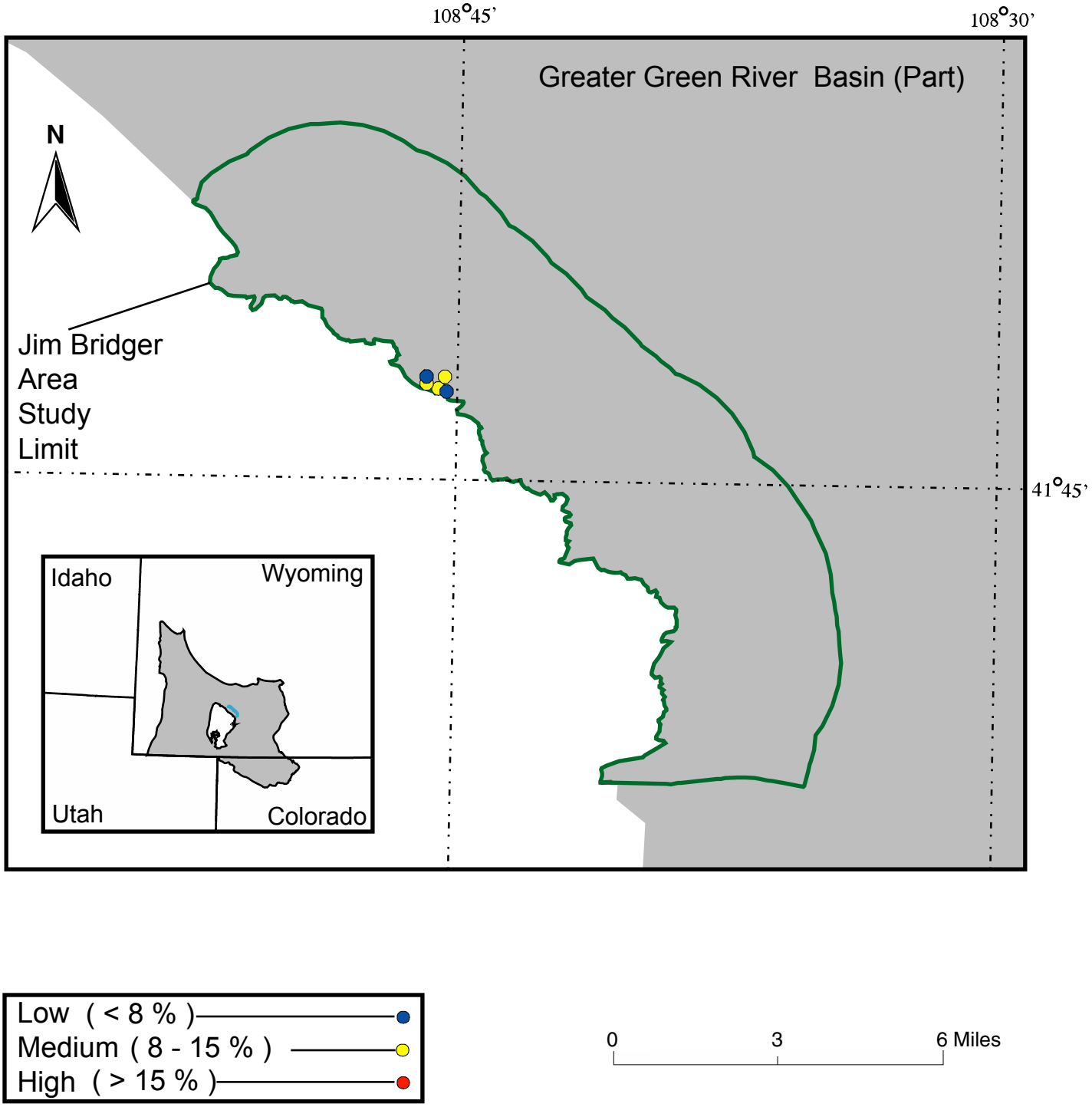


Figure GQ-4. Ash yield in the Jim Bridger area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

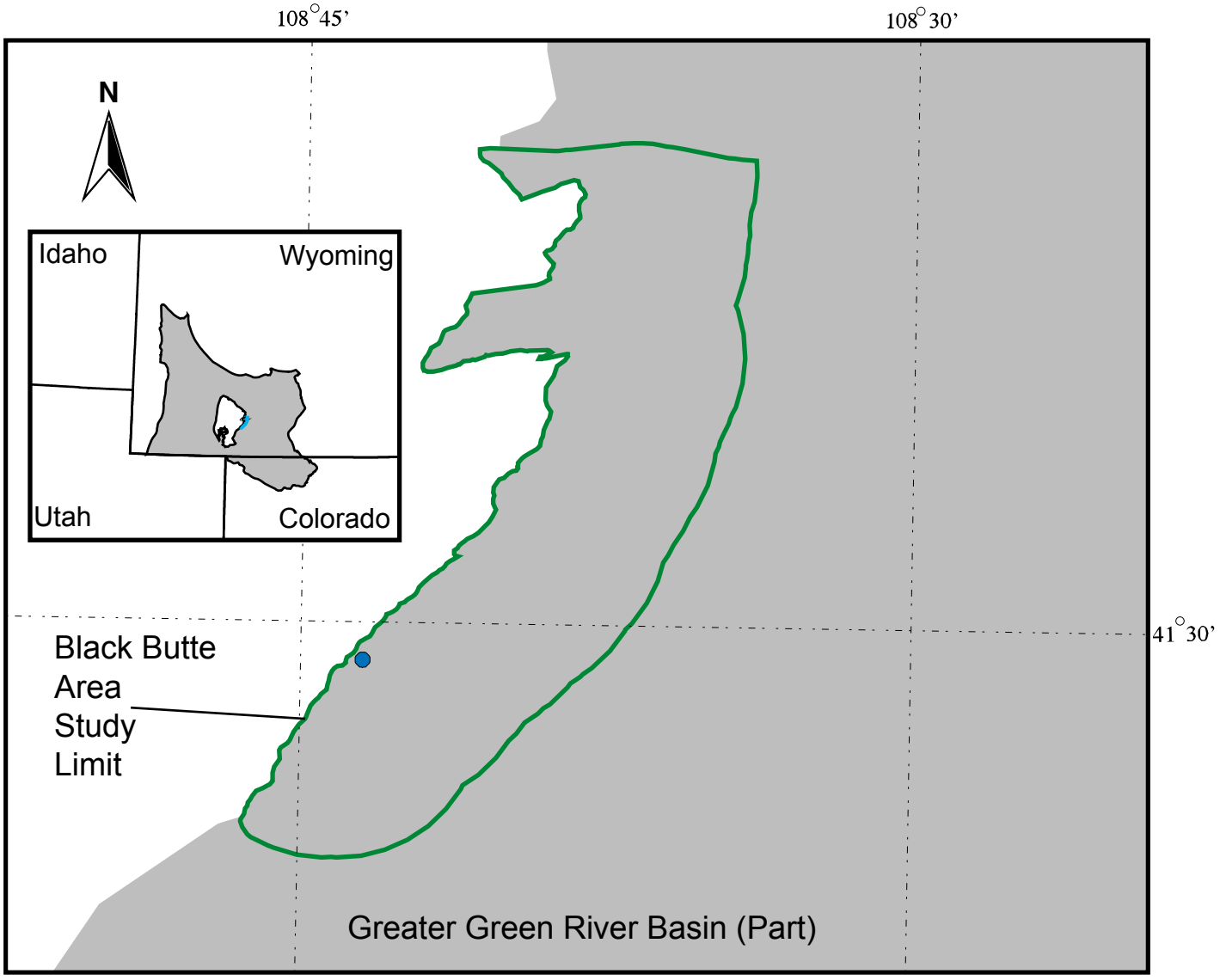


Figure GQ-5. Ash yield in the Black Butte area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

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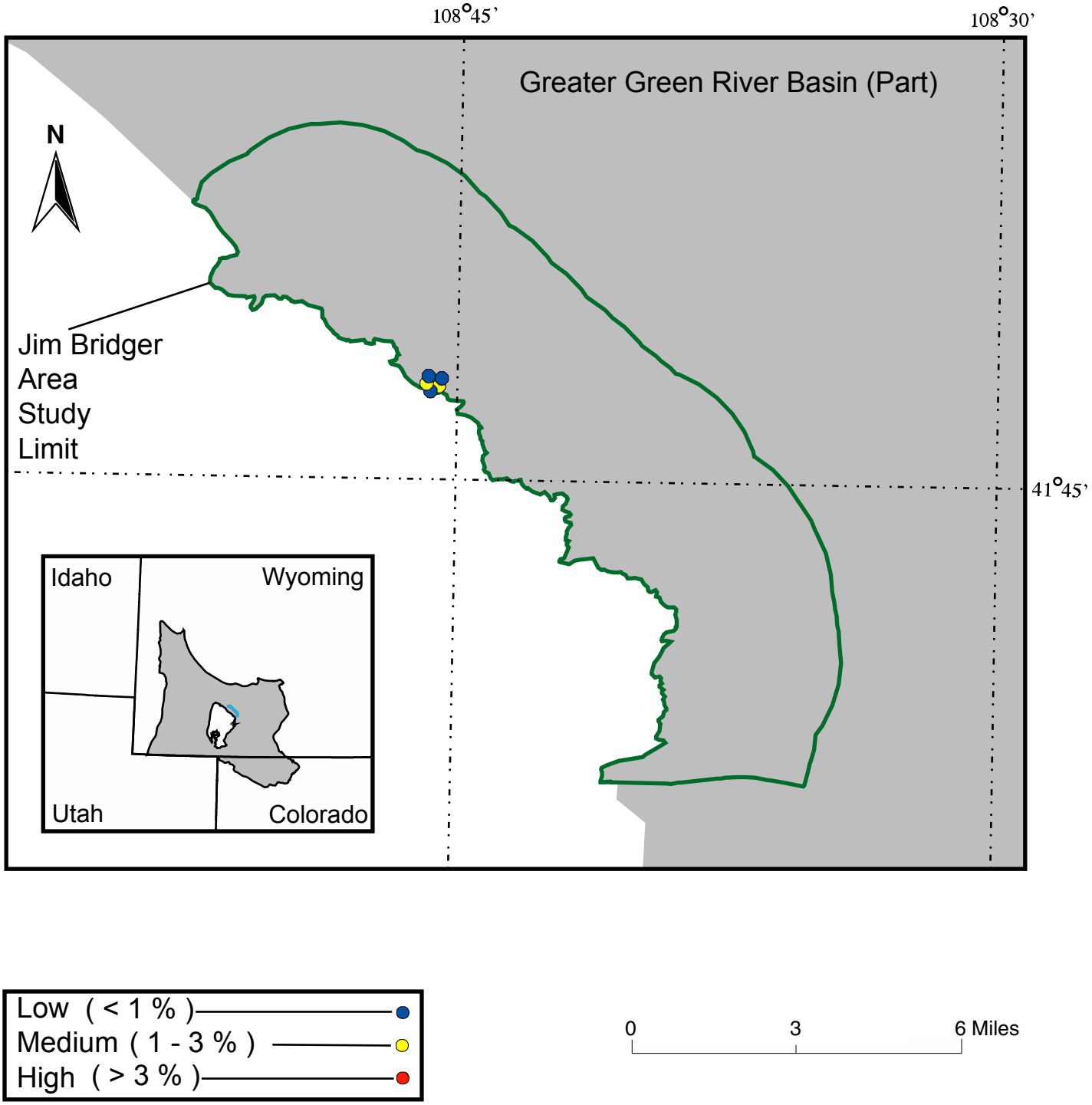


Figure GQ-6. Total sulfur content in the Jim Bridger area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

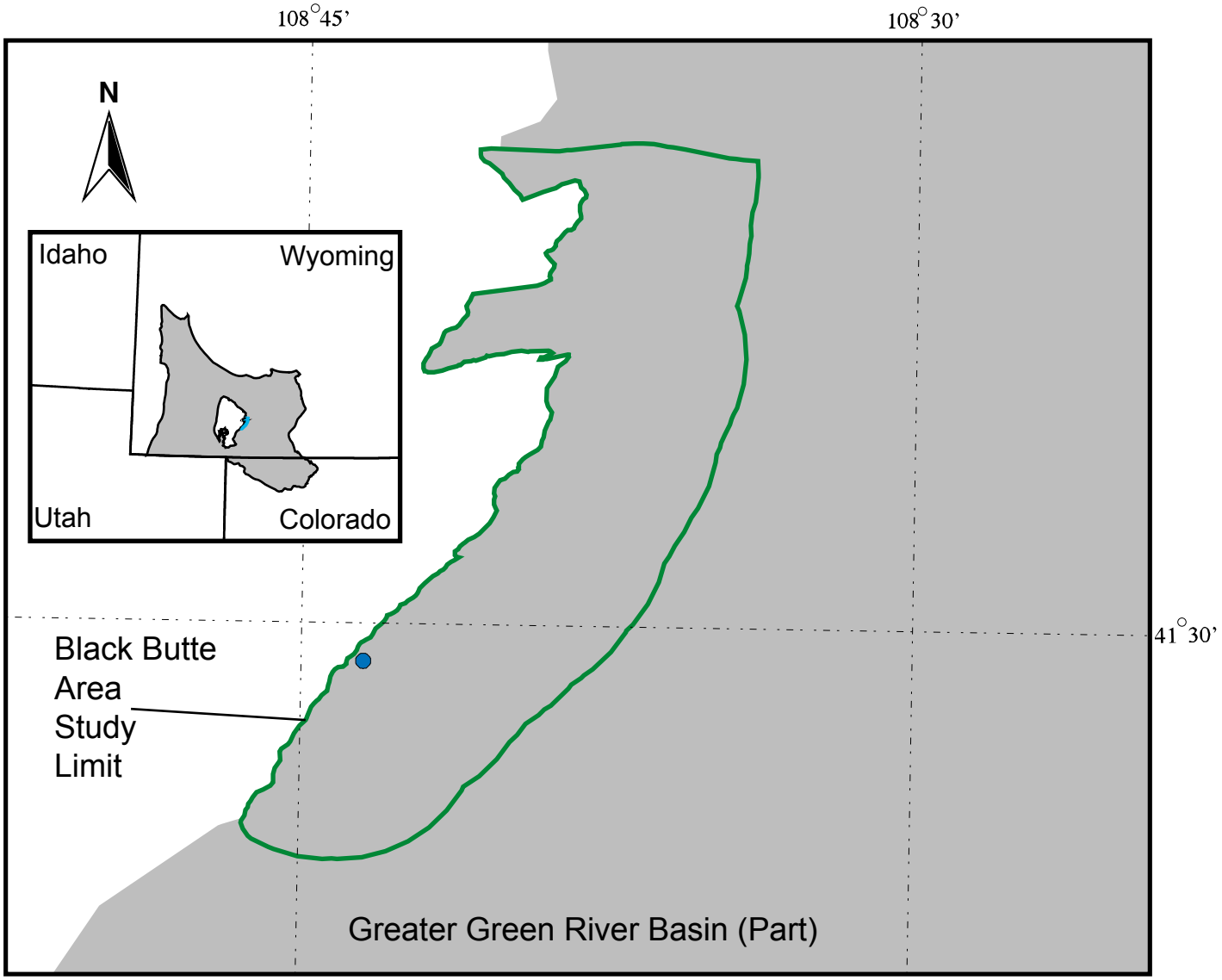


Figure GQ-7. Total sulfur content in the Black Butte area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

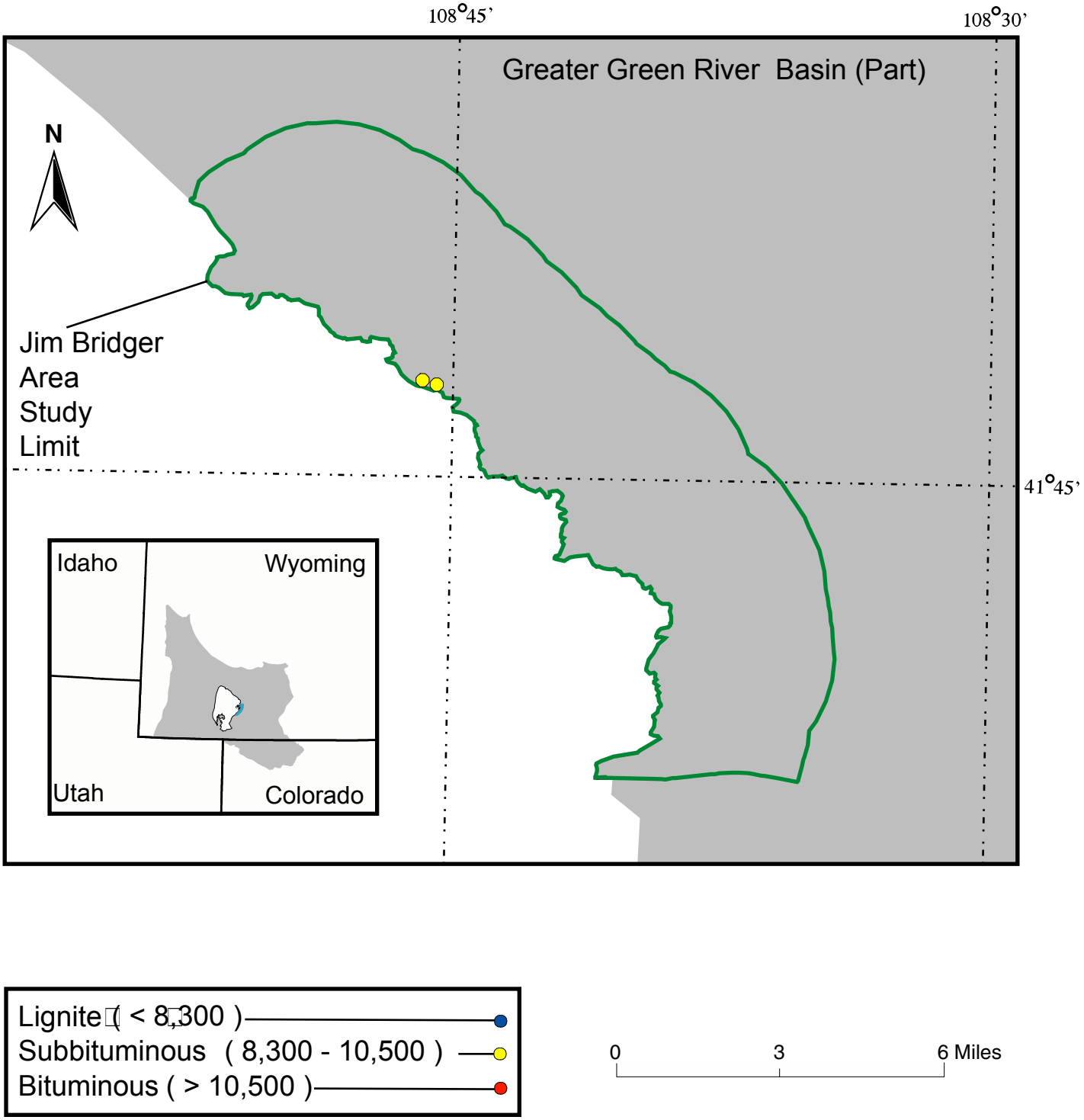


Figure GQ-8. Moist, mineral-matter-free Btu/lb in the Jim Bridger area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

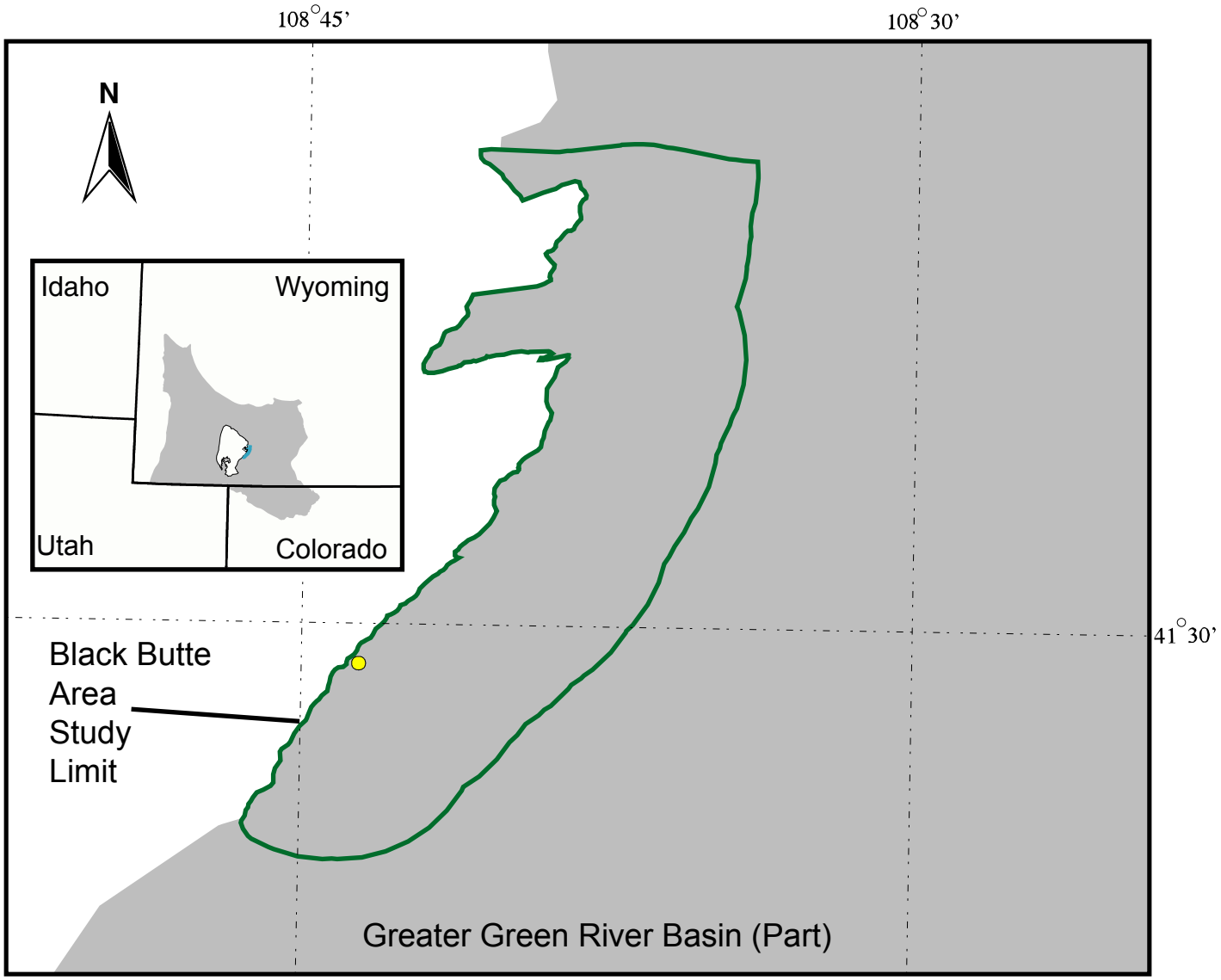


Figure GQ-9. Moist, mineral-matter-free Btu/lb in the Black Butte area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

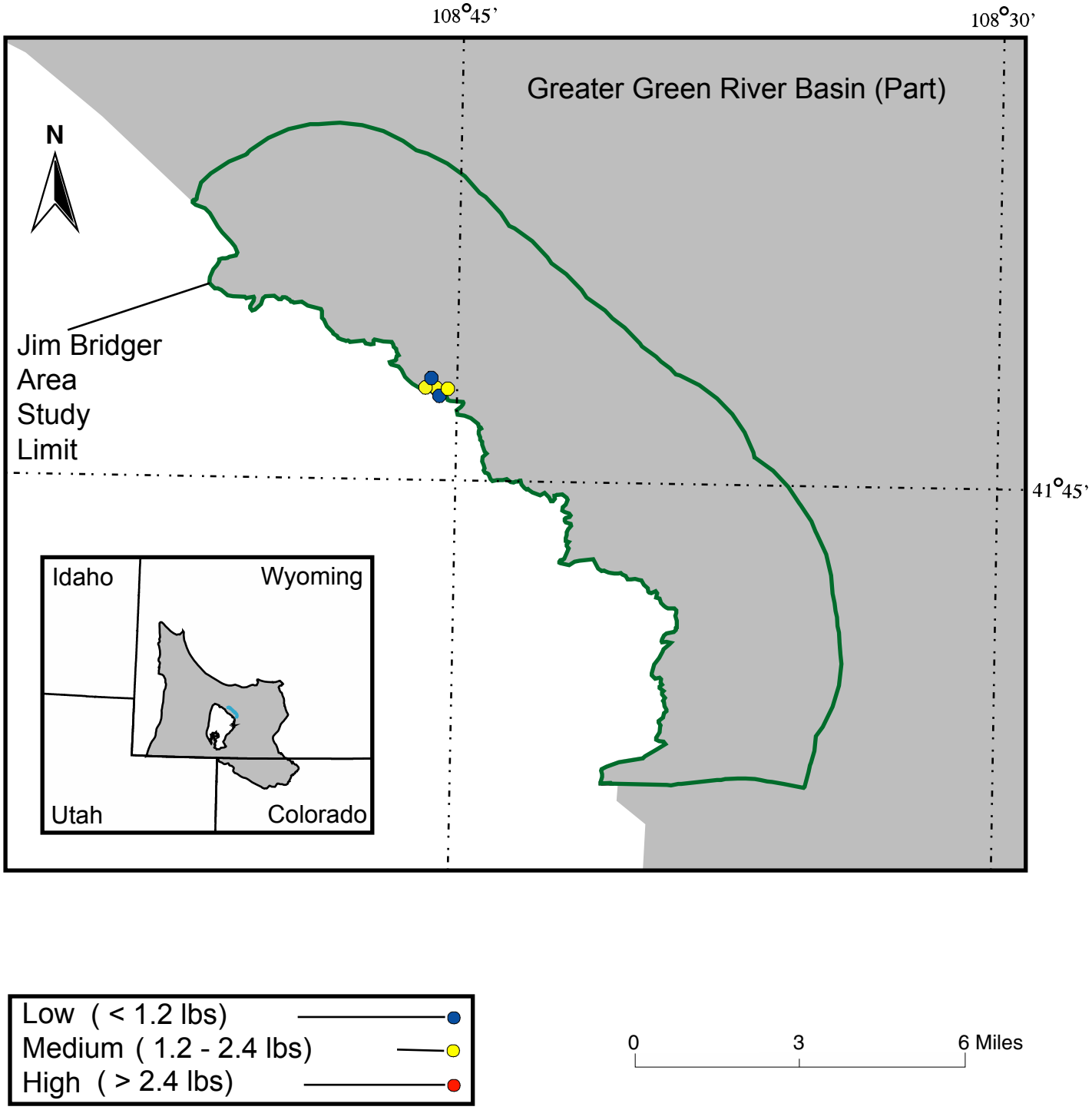


Figure GQ-10. Pounds of sulfur dioxide per million Btu in the Jim Bridger area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

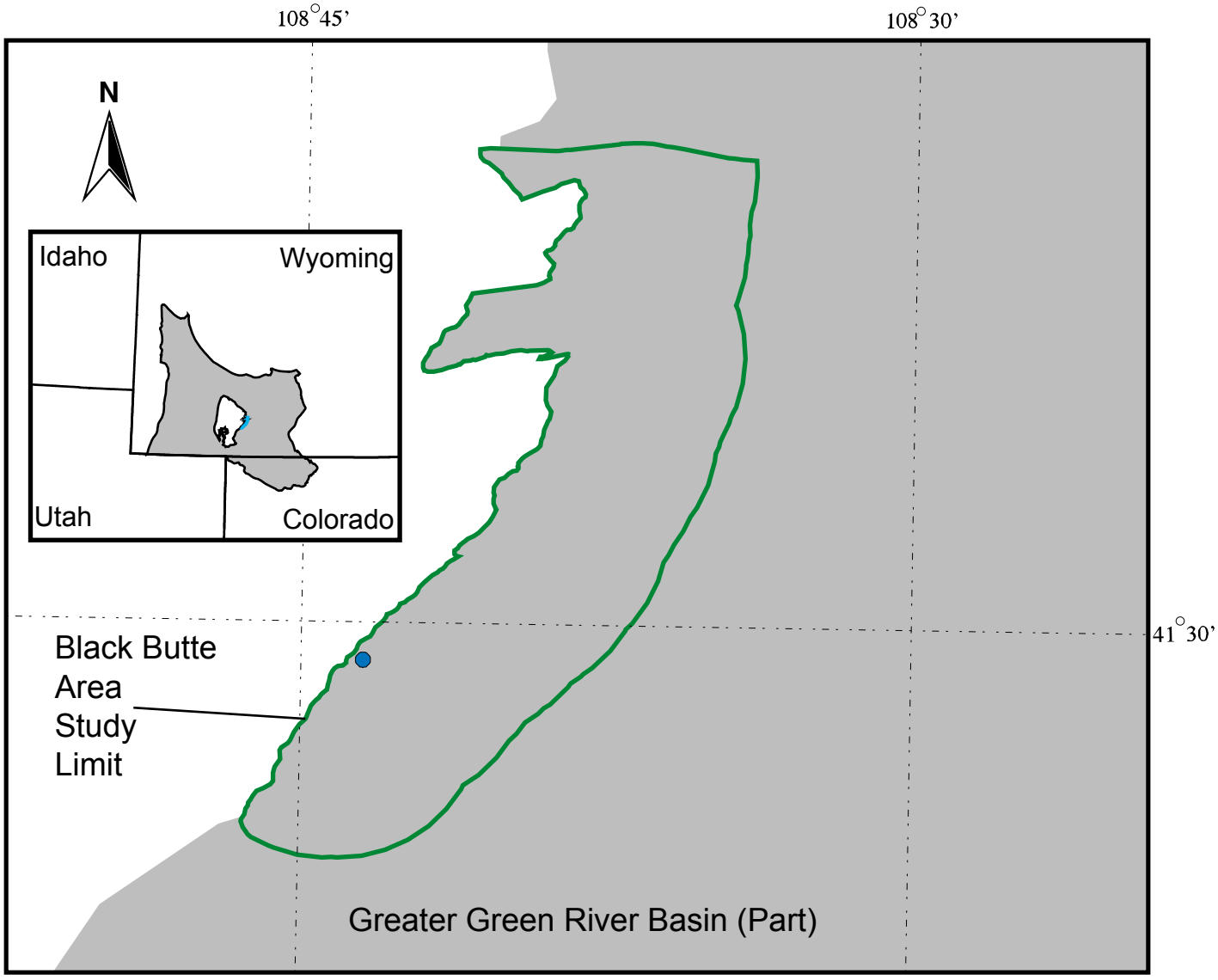


Figure GQ-11. Pounds of sulfur dioxide per million Btu in the Black Butte area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

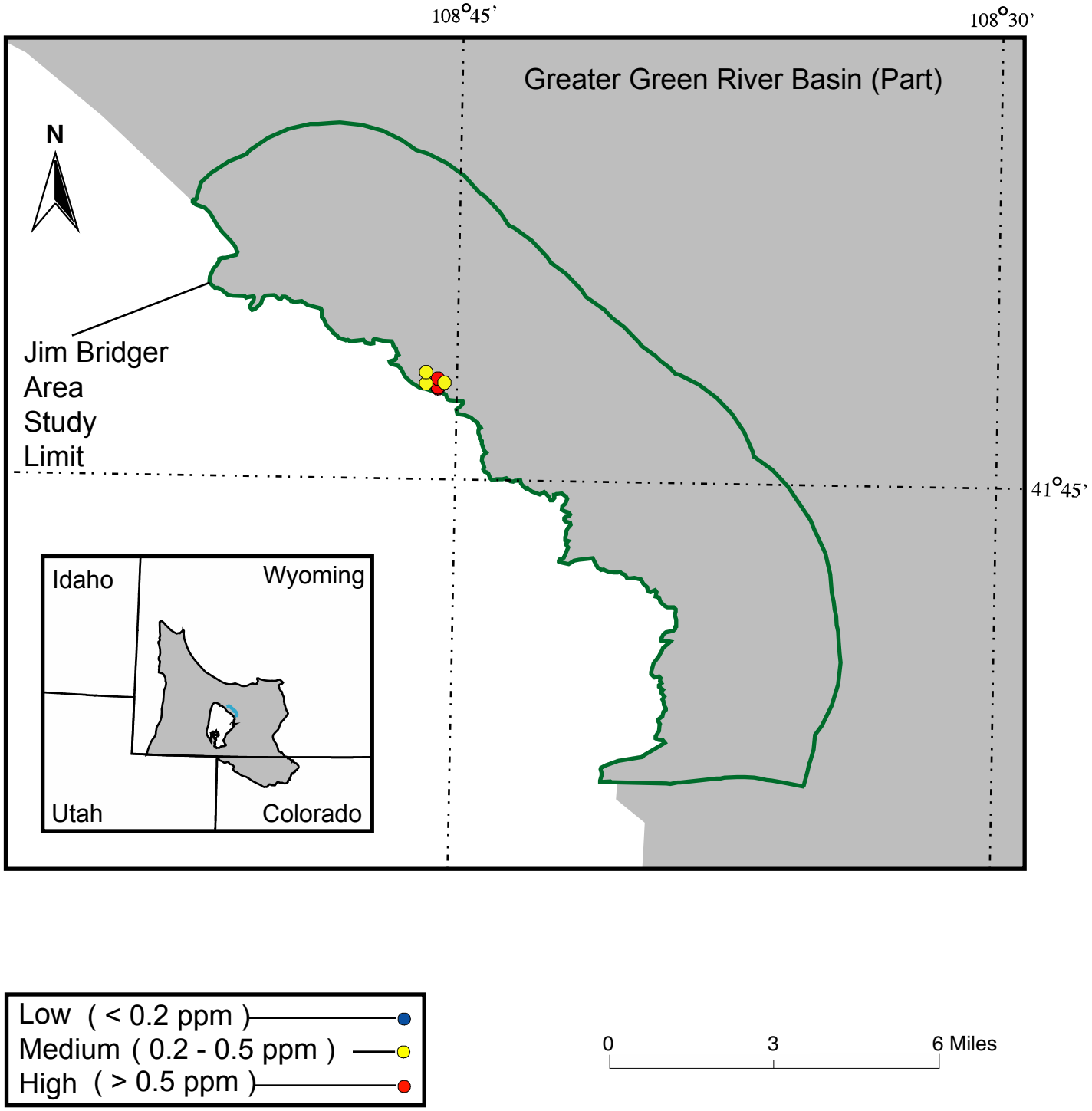


Figure GQ-12. Antimony concentration in the Jim Bridger area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

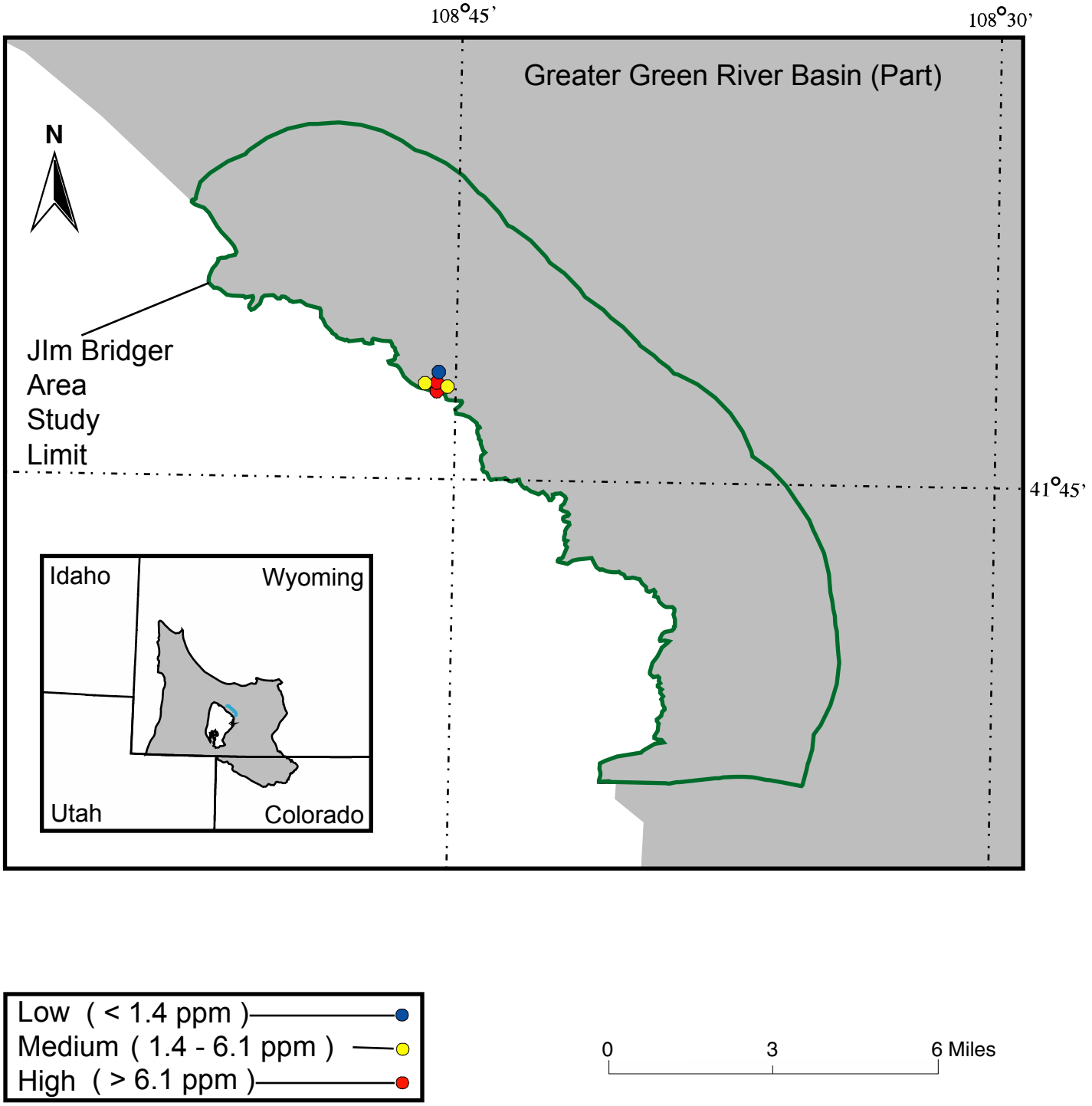


Figure GQ-13. Arsenic concentration in the Jim Bridger area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

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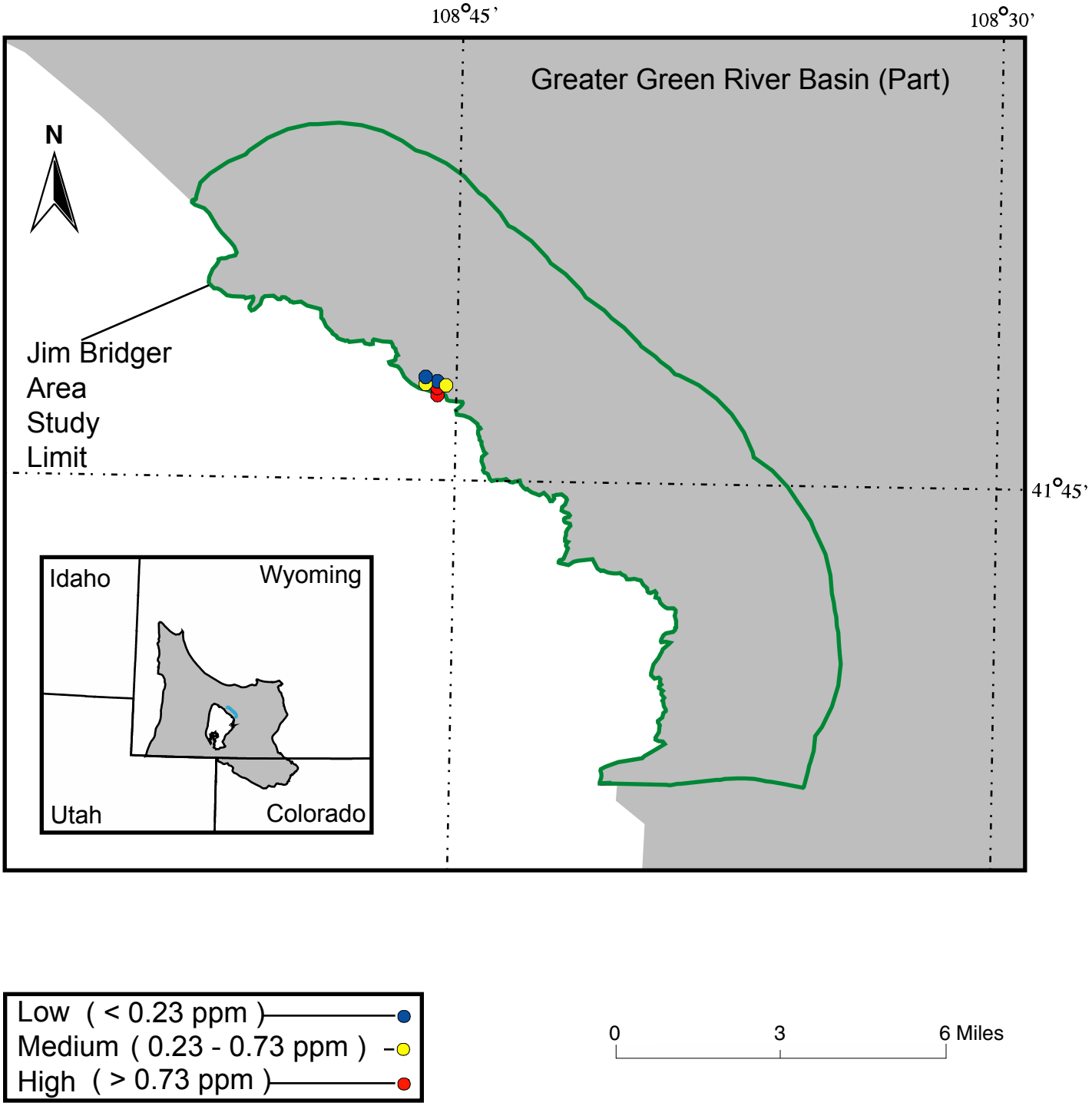


Figure GQ-14. Beryllium concentration in the Jim Bridger area of the Point of RocksóBlack Butte coalfield, Greater Green River Basin, Wyoming.

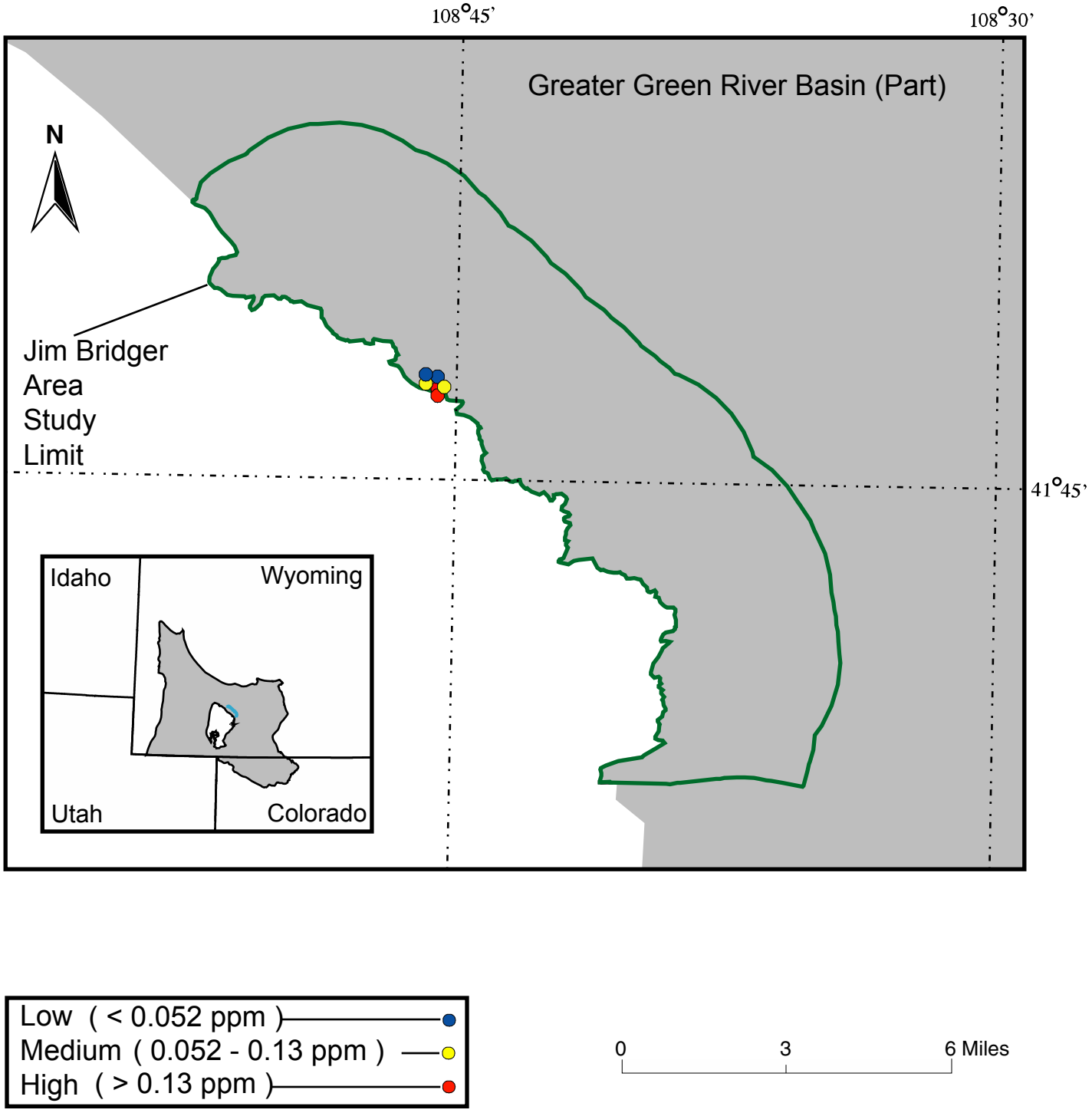


Figure GQ-15. Cadmium concentration in the Jim Bridger area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

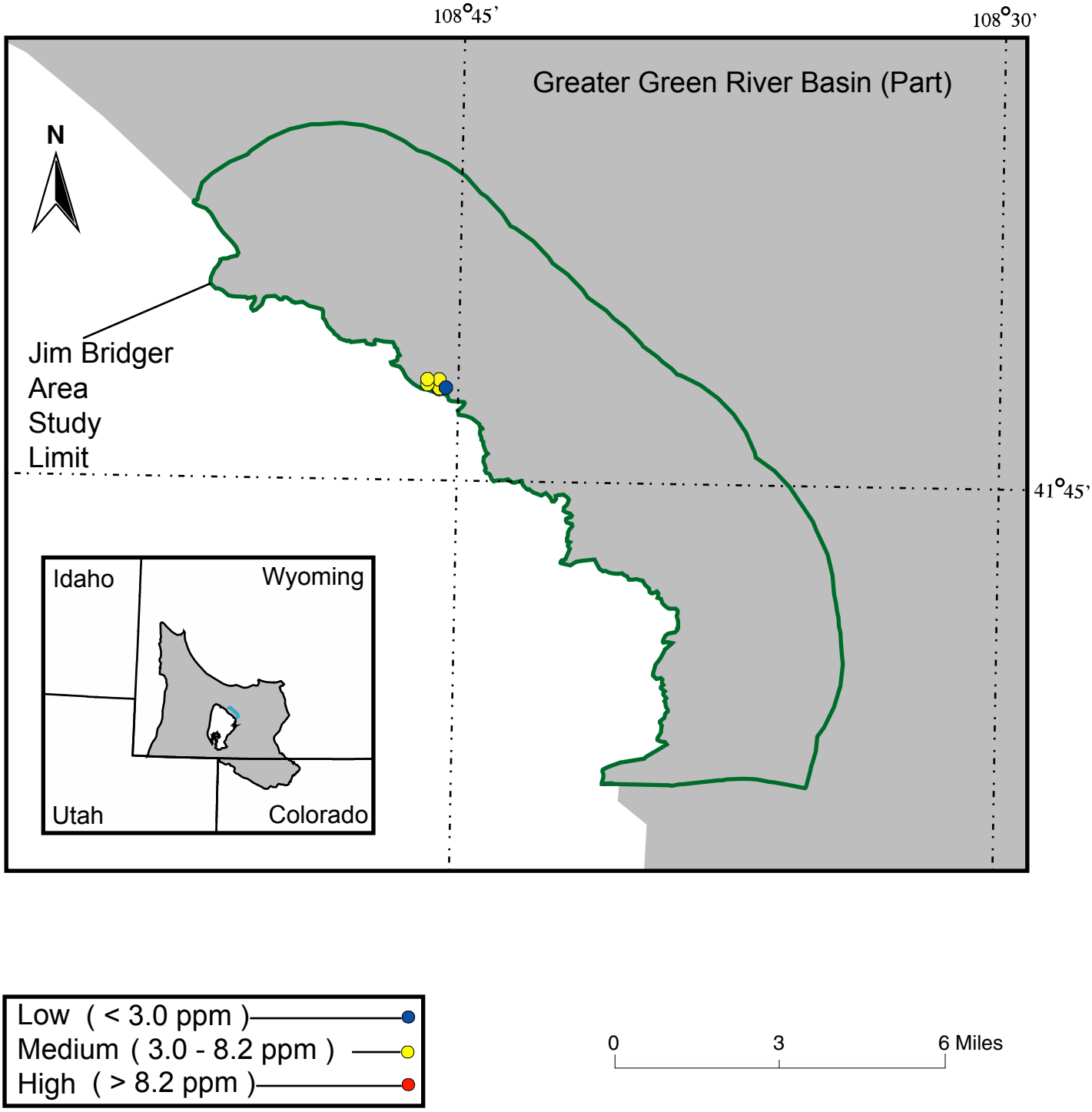


Figure GQ-16. Chromium concentration in the Jim Bridger area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

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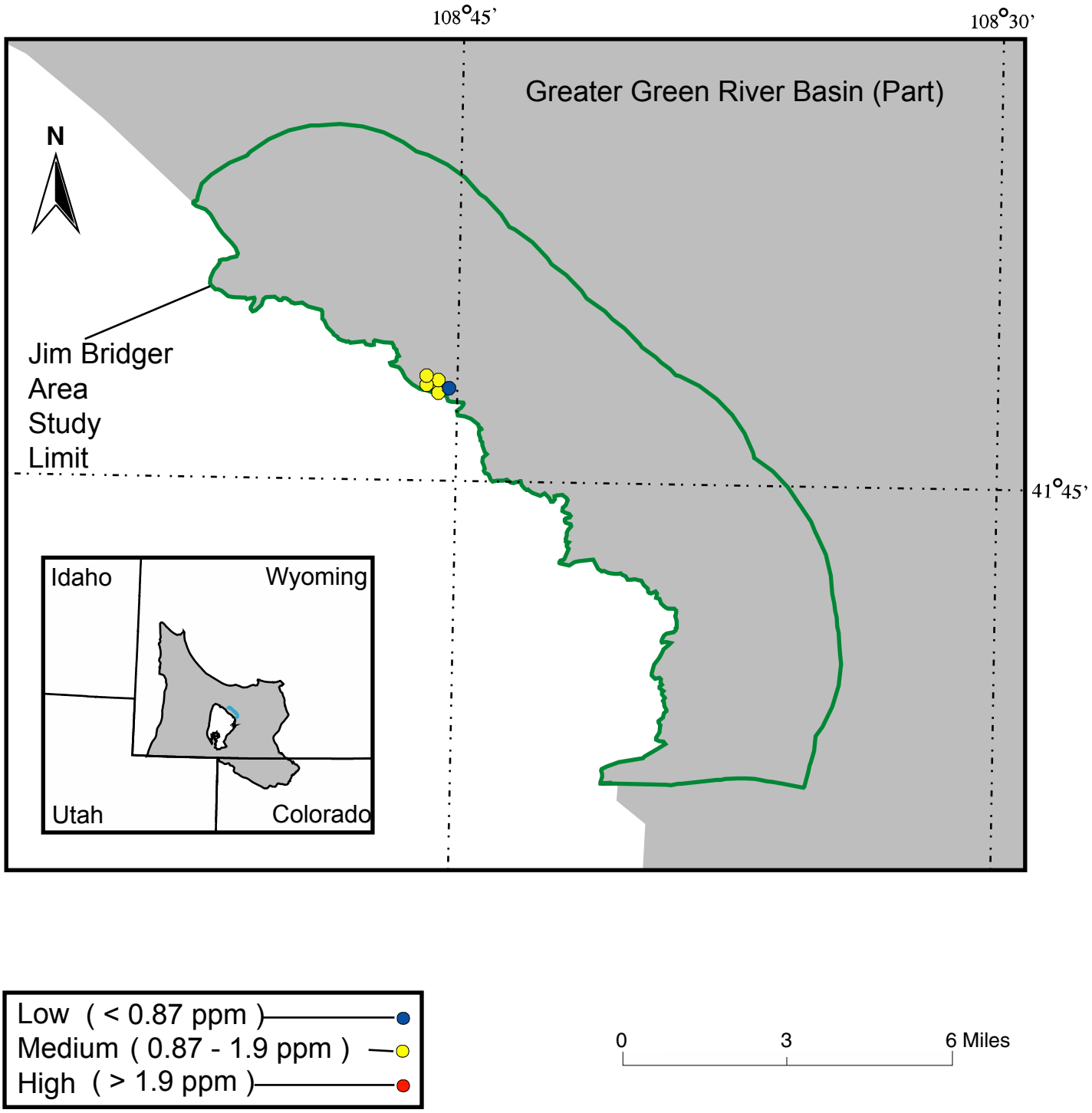


Figure GQ-17. Cobalt concentration in the Jim Bridger area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

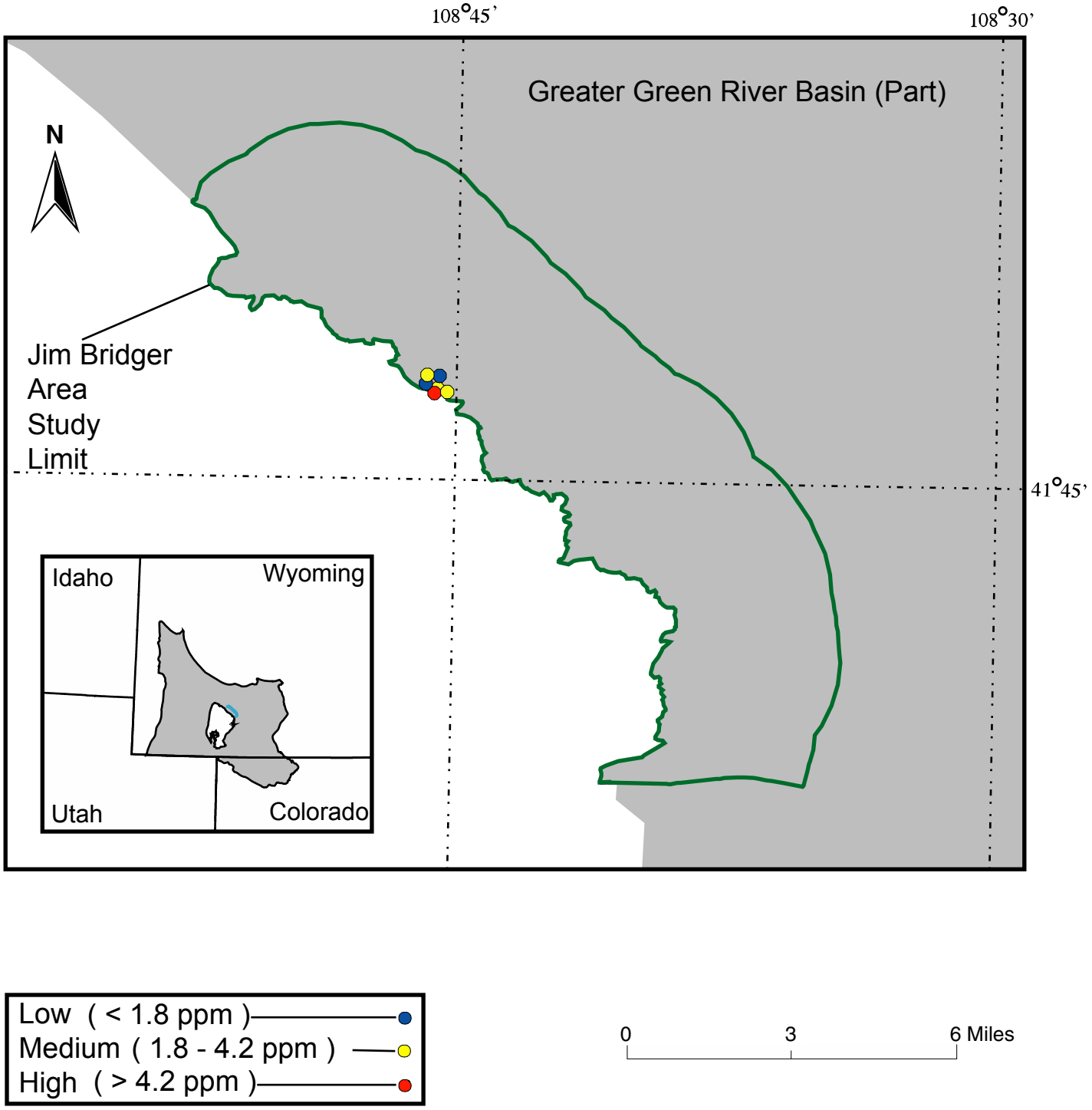


Figure GQ-18. Lead concentration in the Jim Bridger area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

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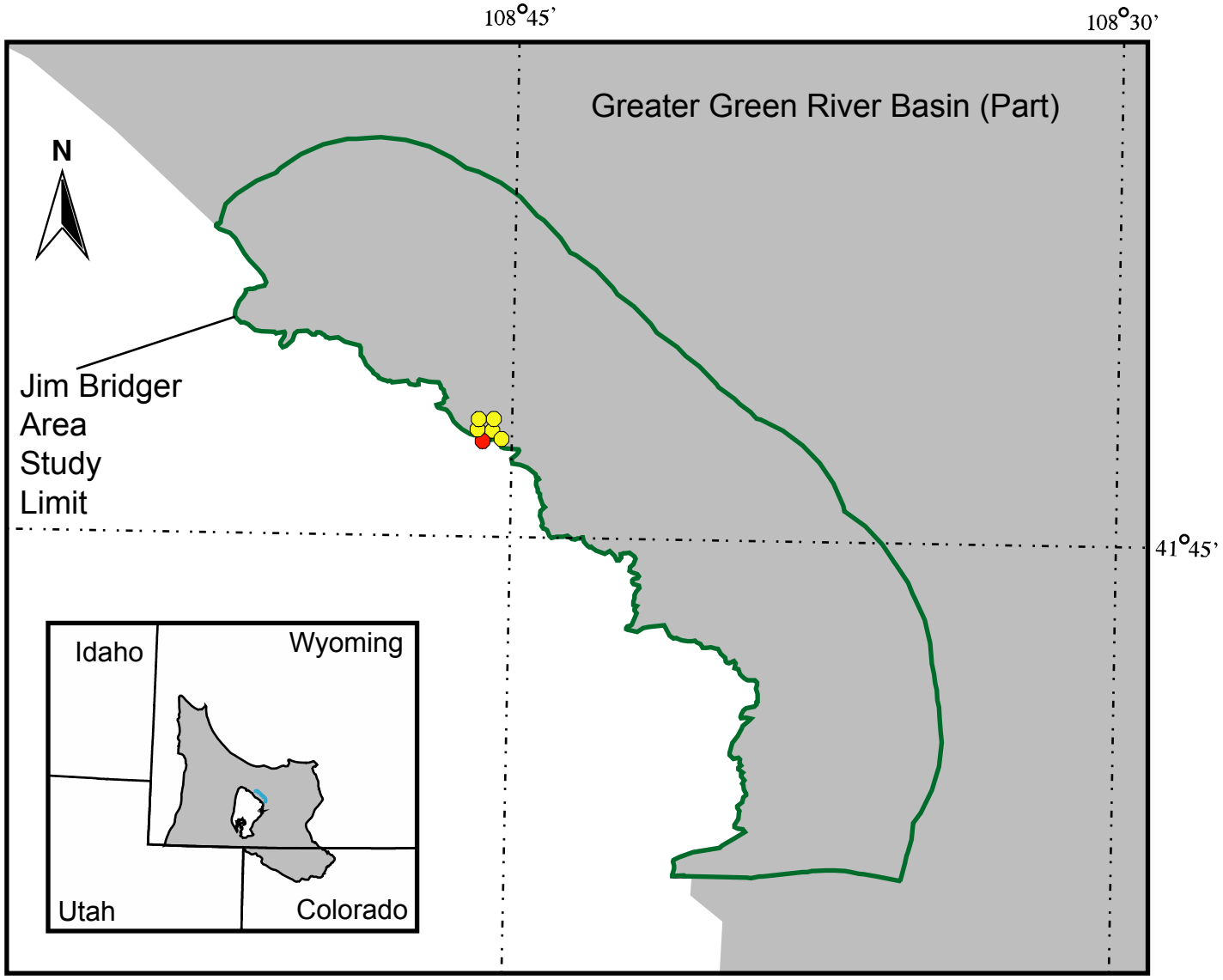


Figure GQ-19. Manganese concentration in the Jim Bridger area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

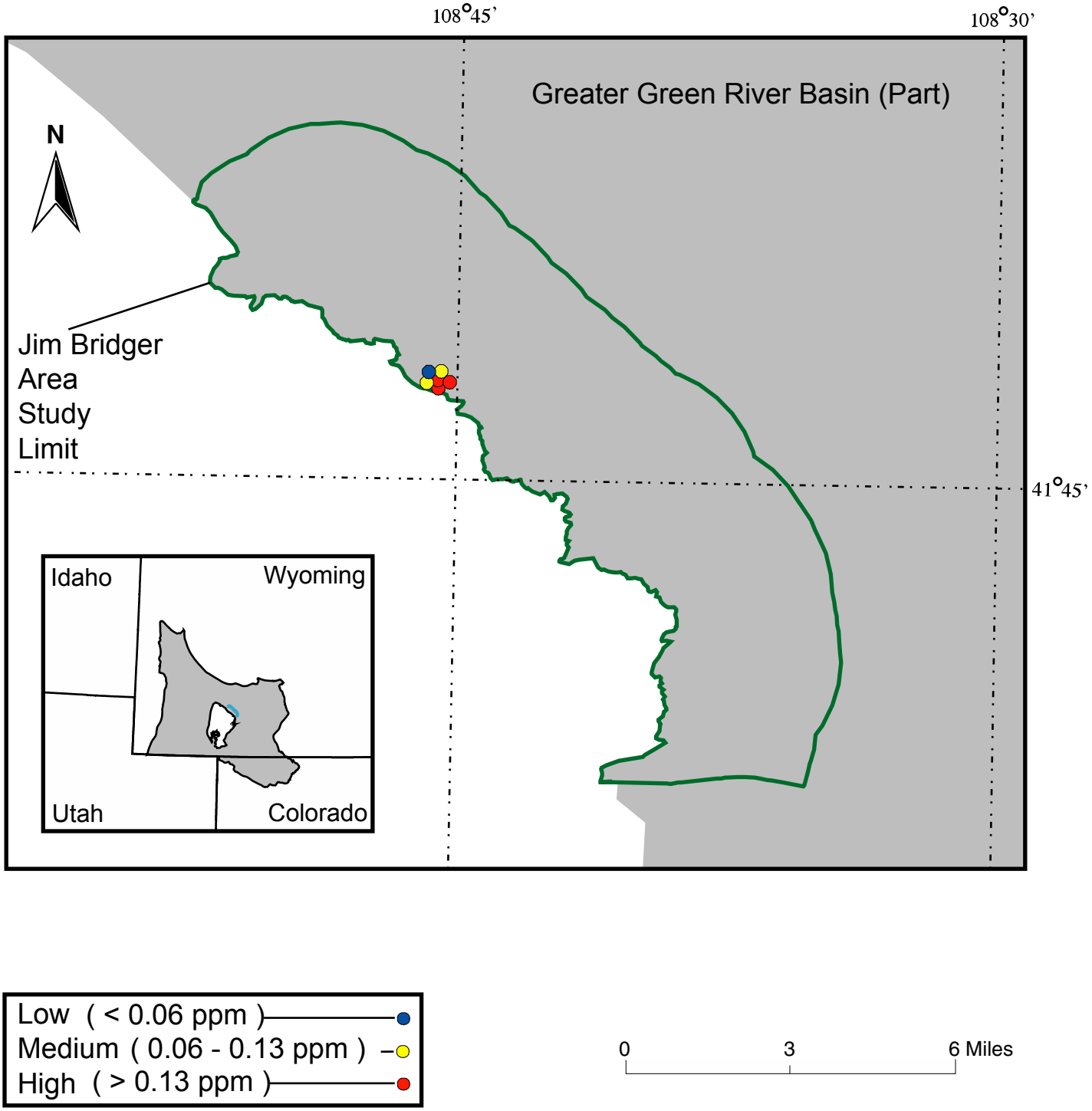


Figure GQ-20. Mercury concentration in the Jim Bridger area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

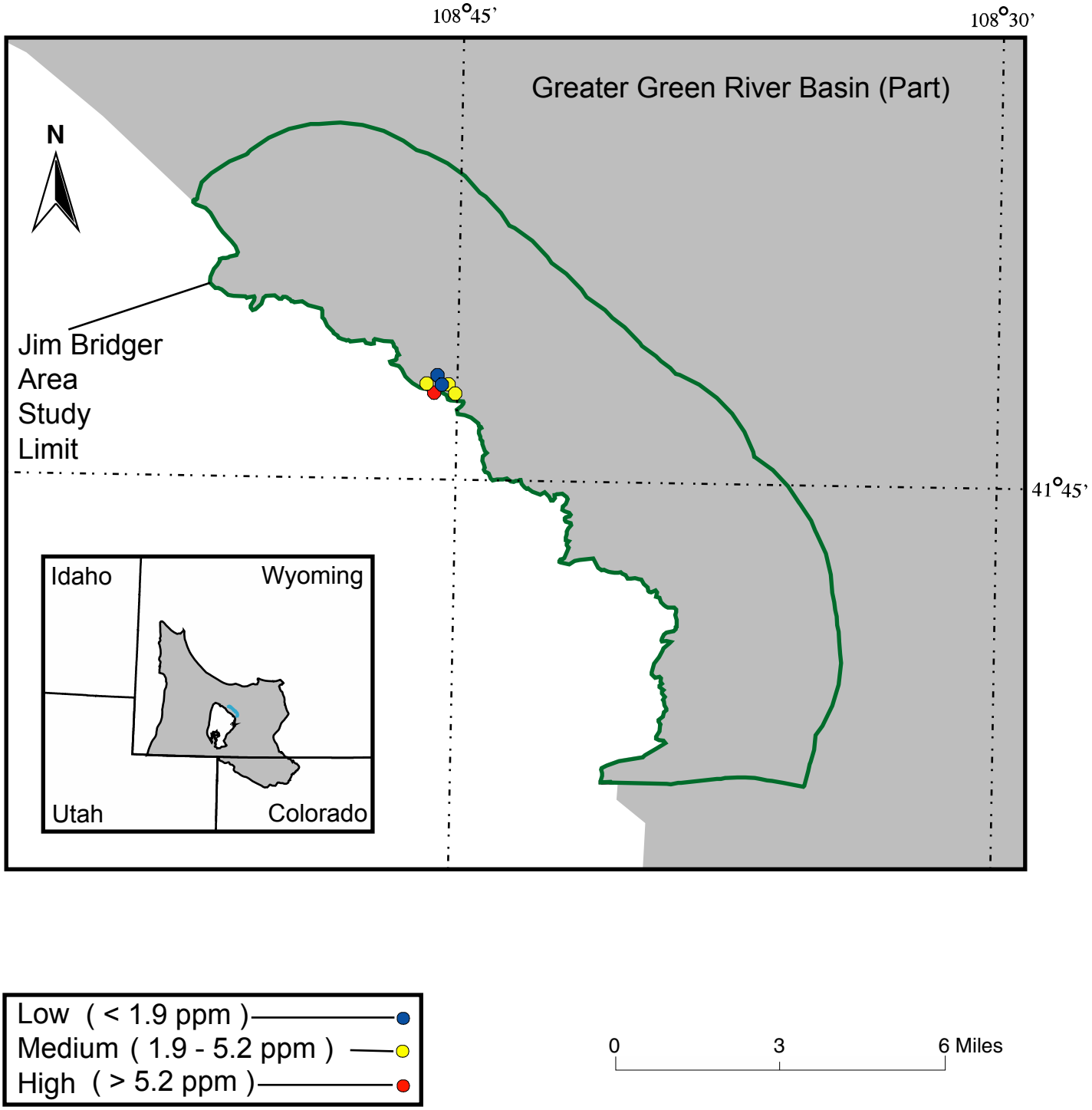


Figure GQ-21. Nickel concentration in the Jim Bridger area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

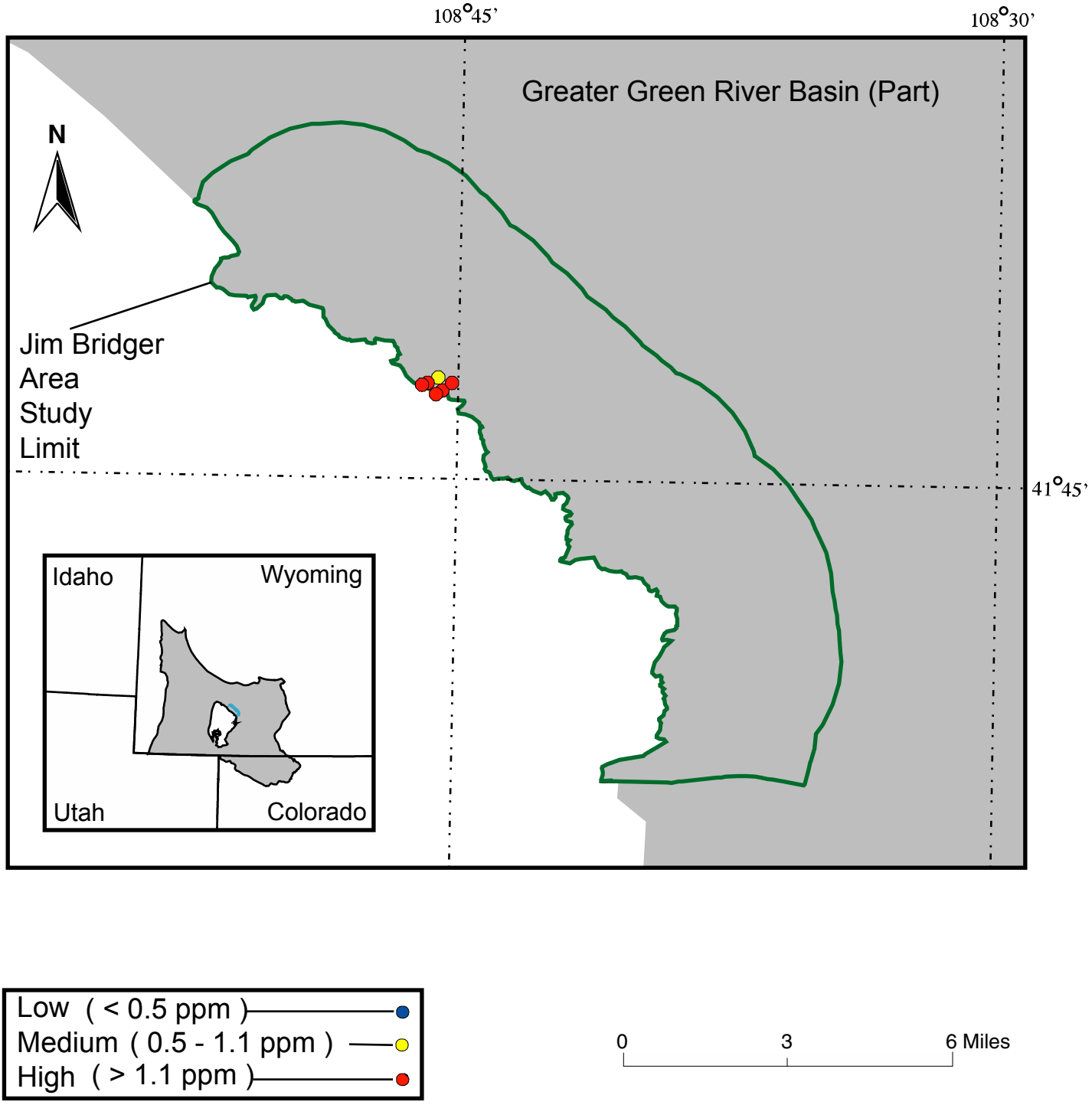


Figure GQ-22. Selenium concentration in the Jim Bridger area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

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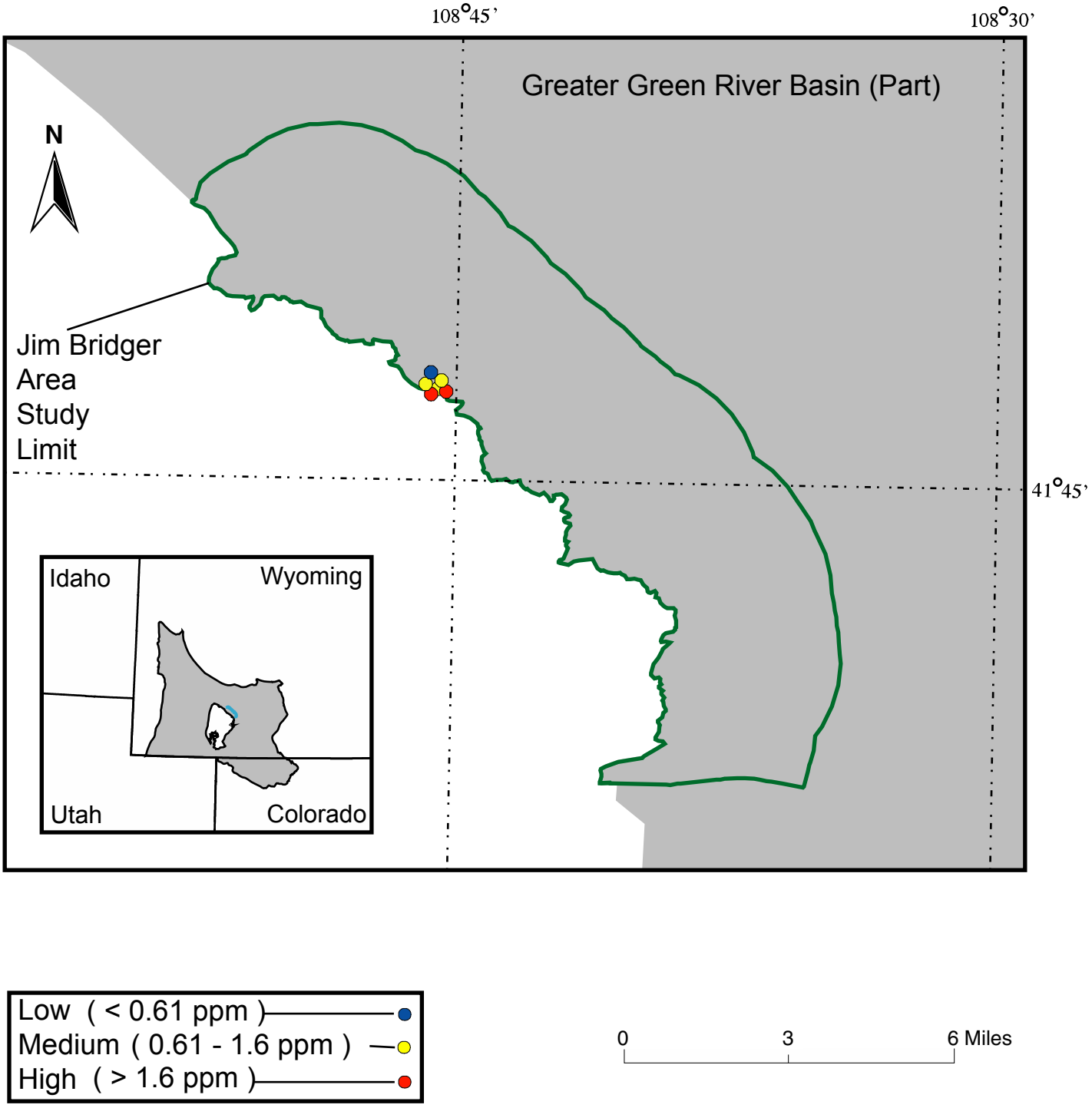


Figure GQ-23. Uranium concentration in the Jim Bridger area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

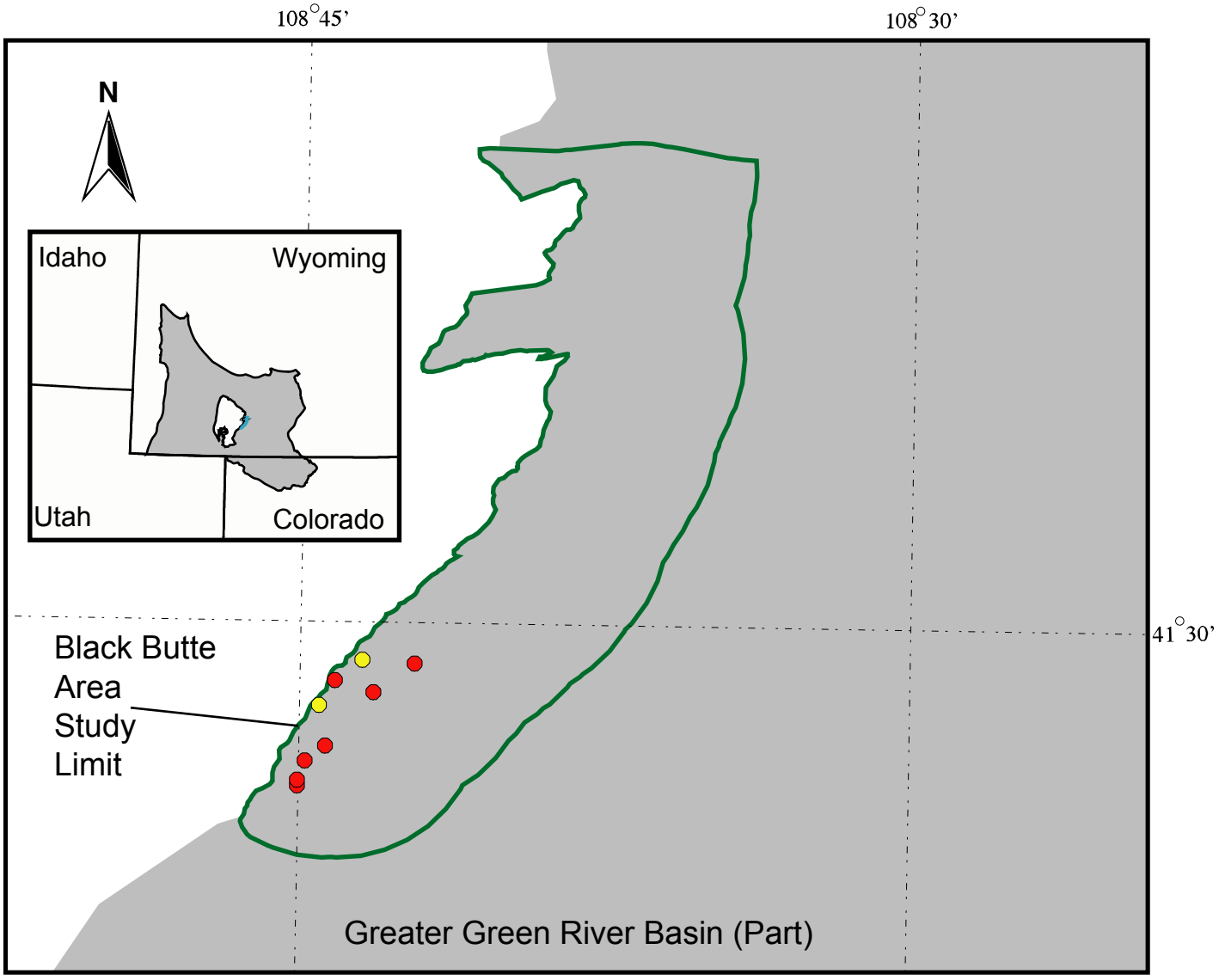


Figure GQ-24. Antimony concentration in the Black Butte area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

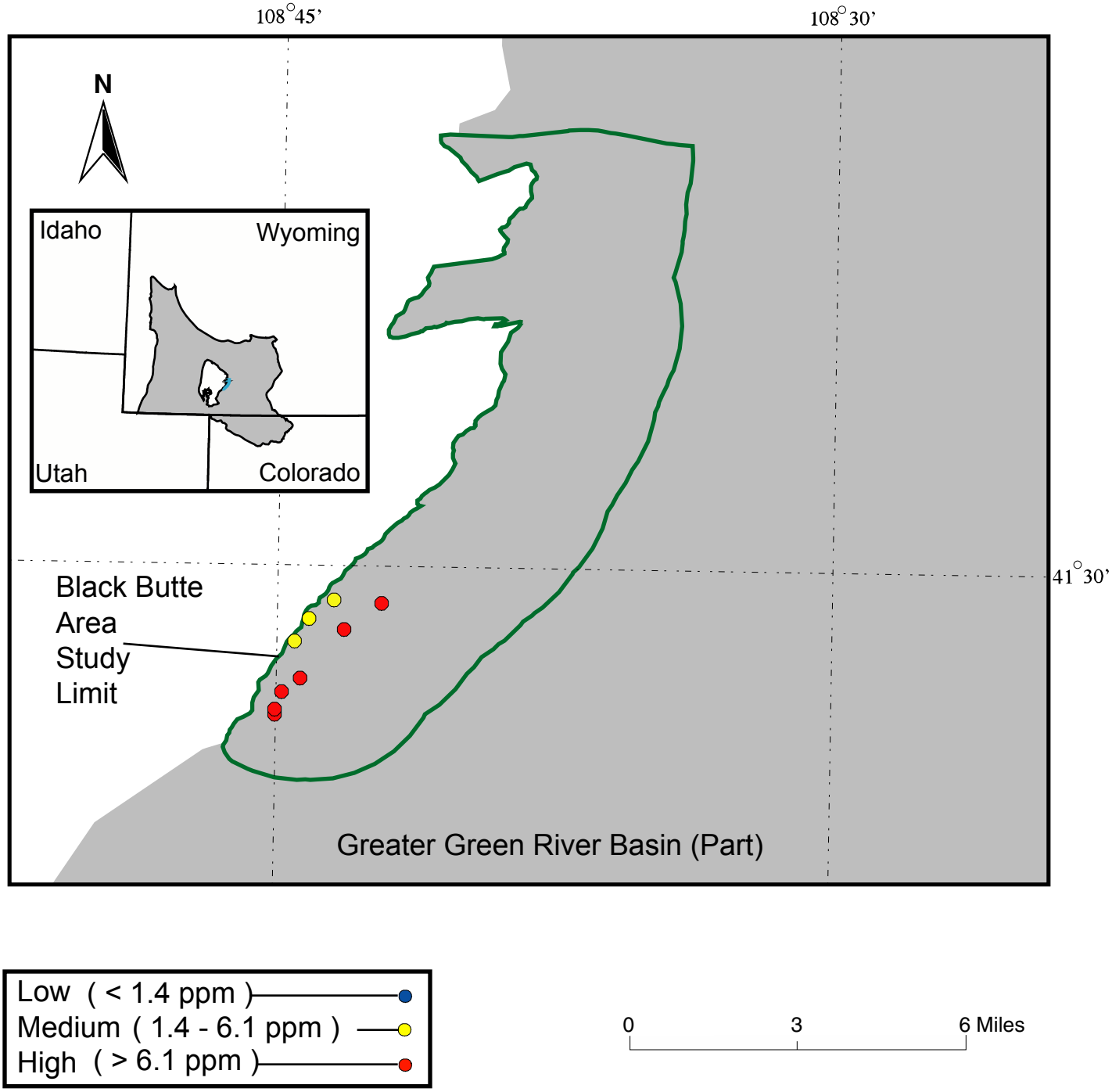


Figure GQ-25. Arsenic concentration in the Black Butte area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

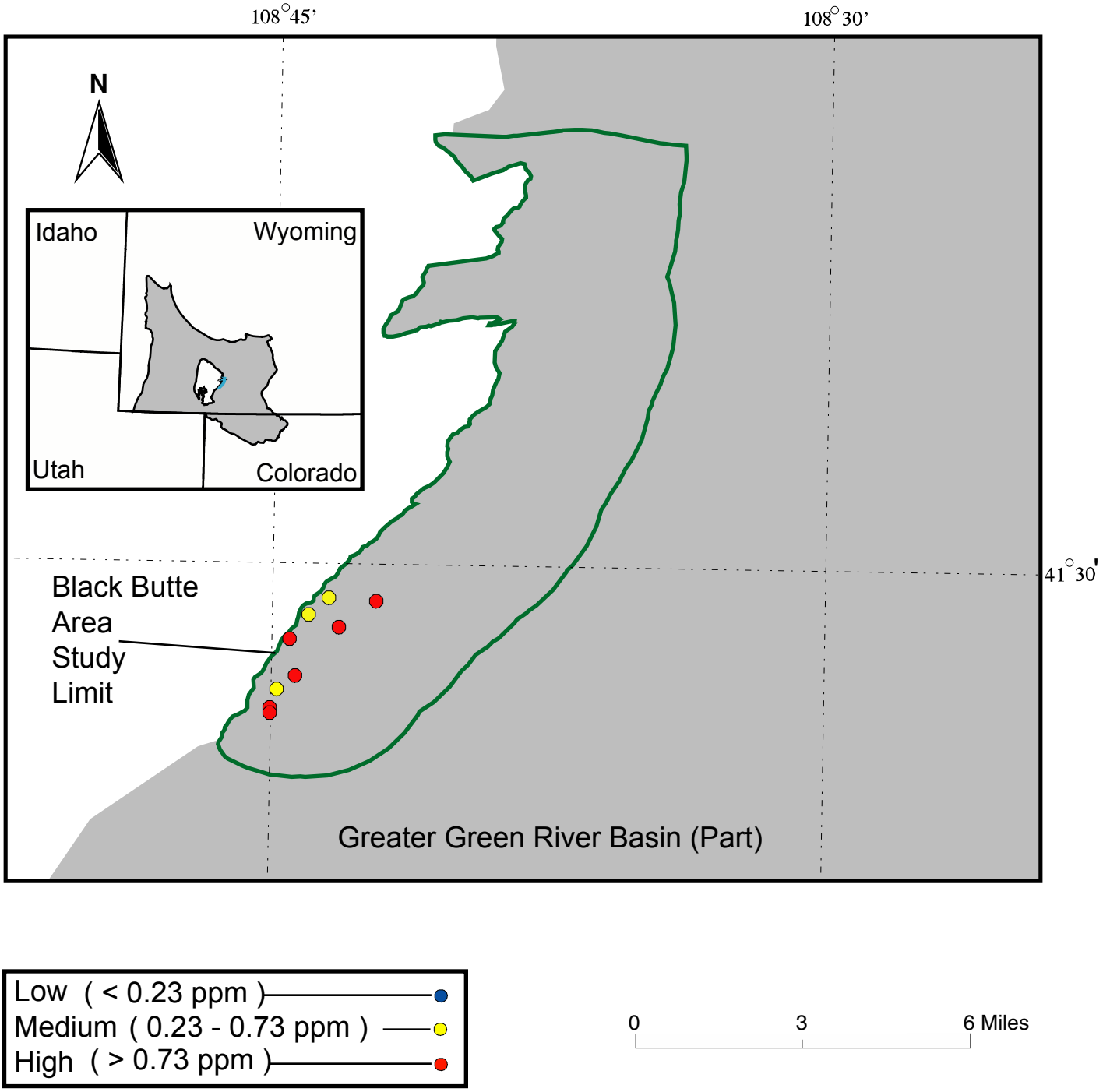


Figure GQ-26. Beryllium concentration in the Black Butte area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

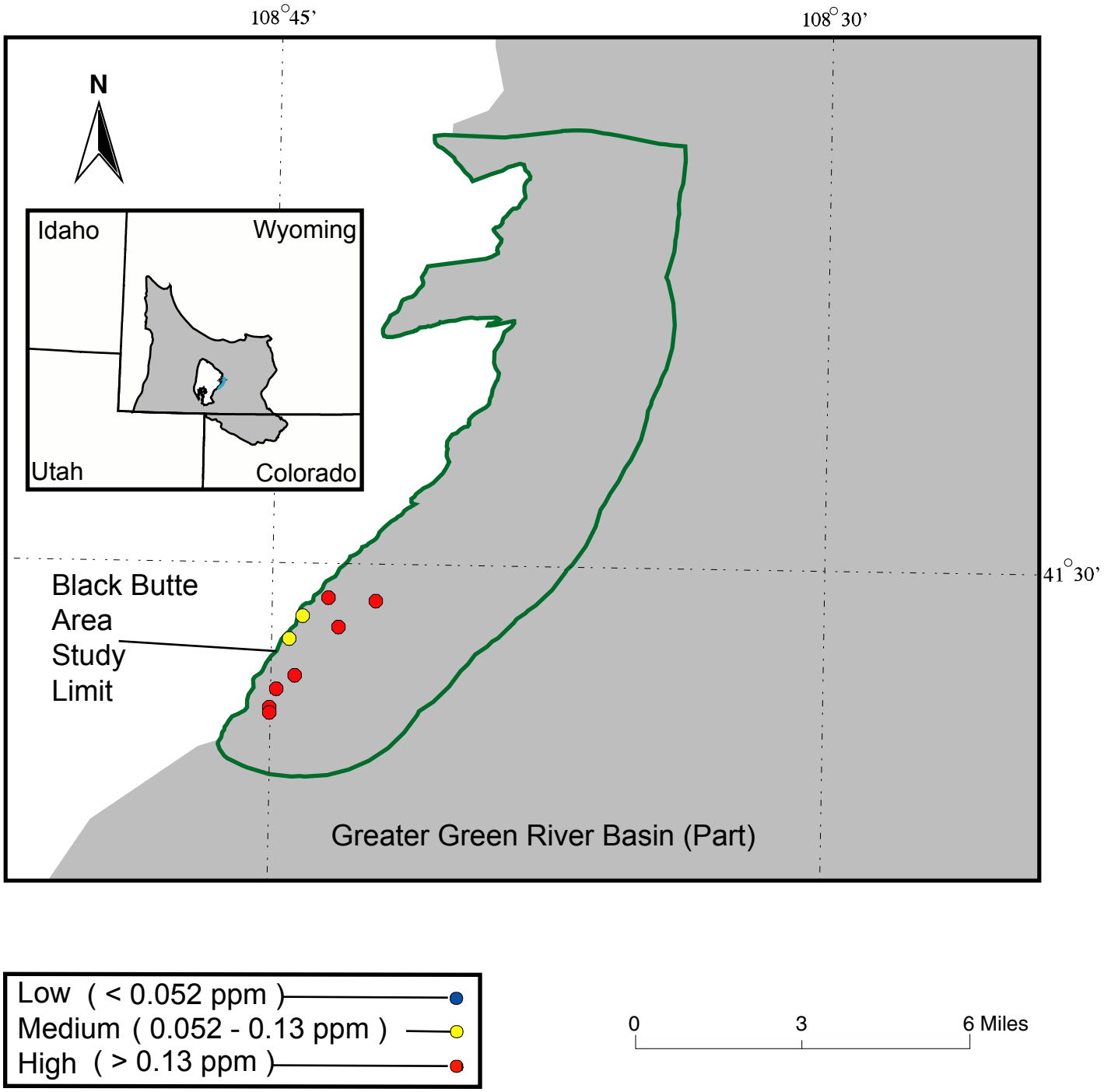


Figure GQ-27. Cadmium concentration in the Black Butte area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

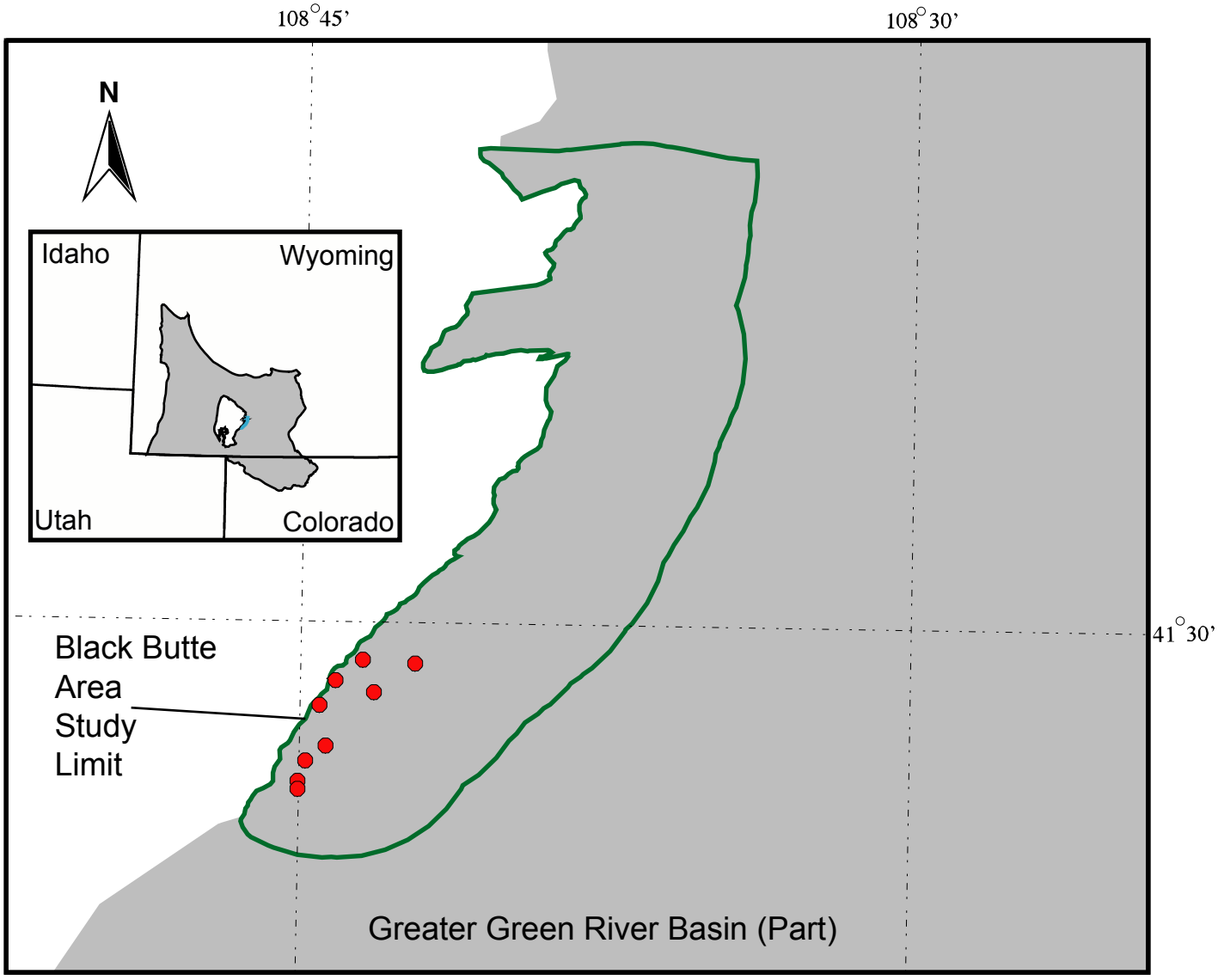


Figure GQ-28. Chromium concentration in the Black Butte area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

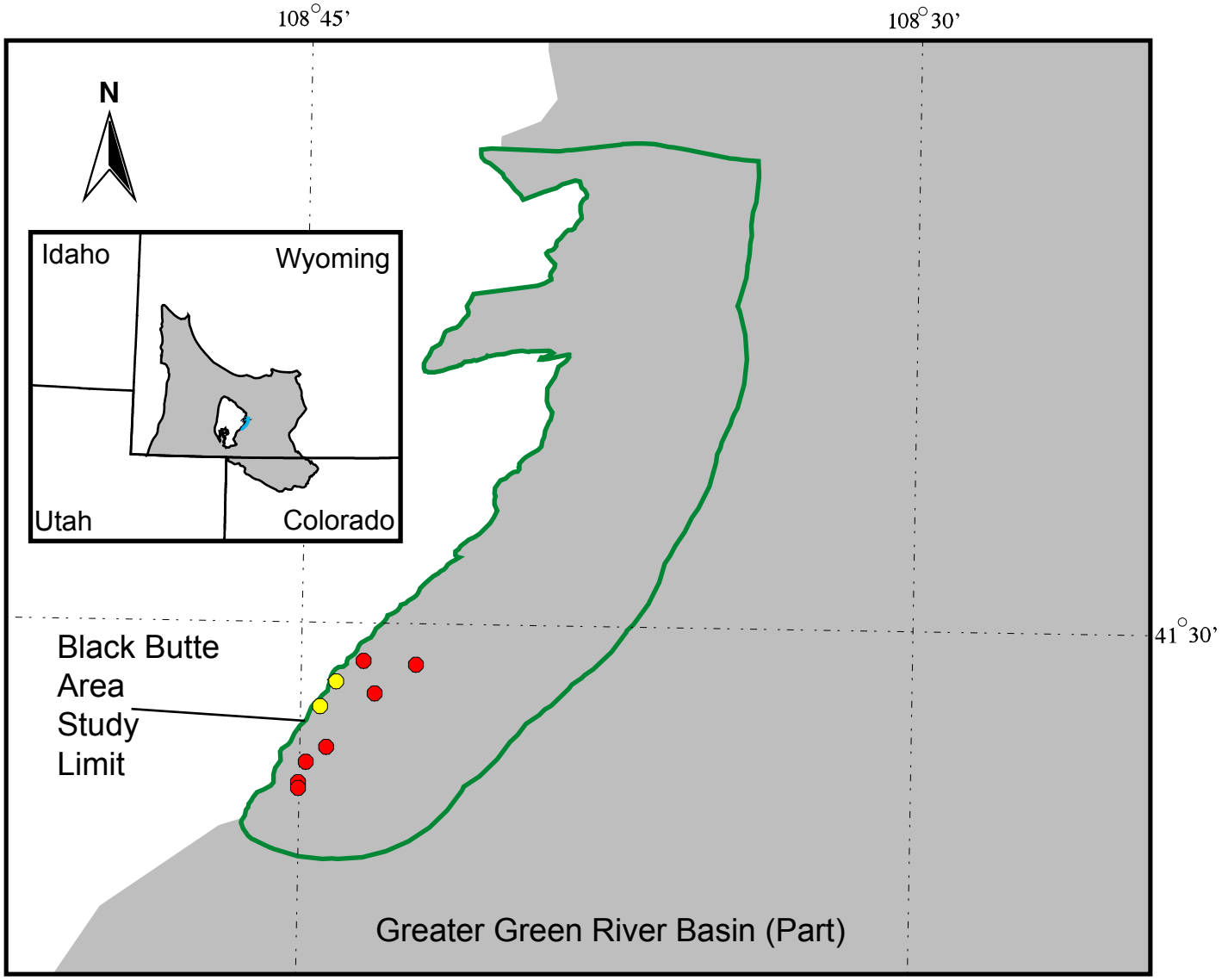


Figure GQ-29. Cobalt concentration in the Black Butte area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

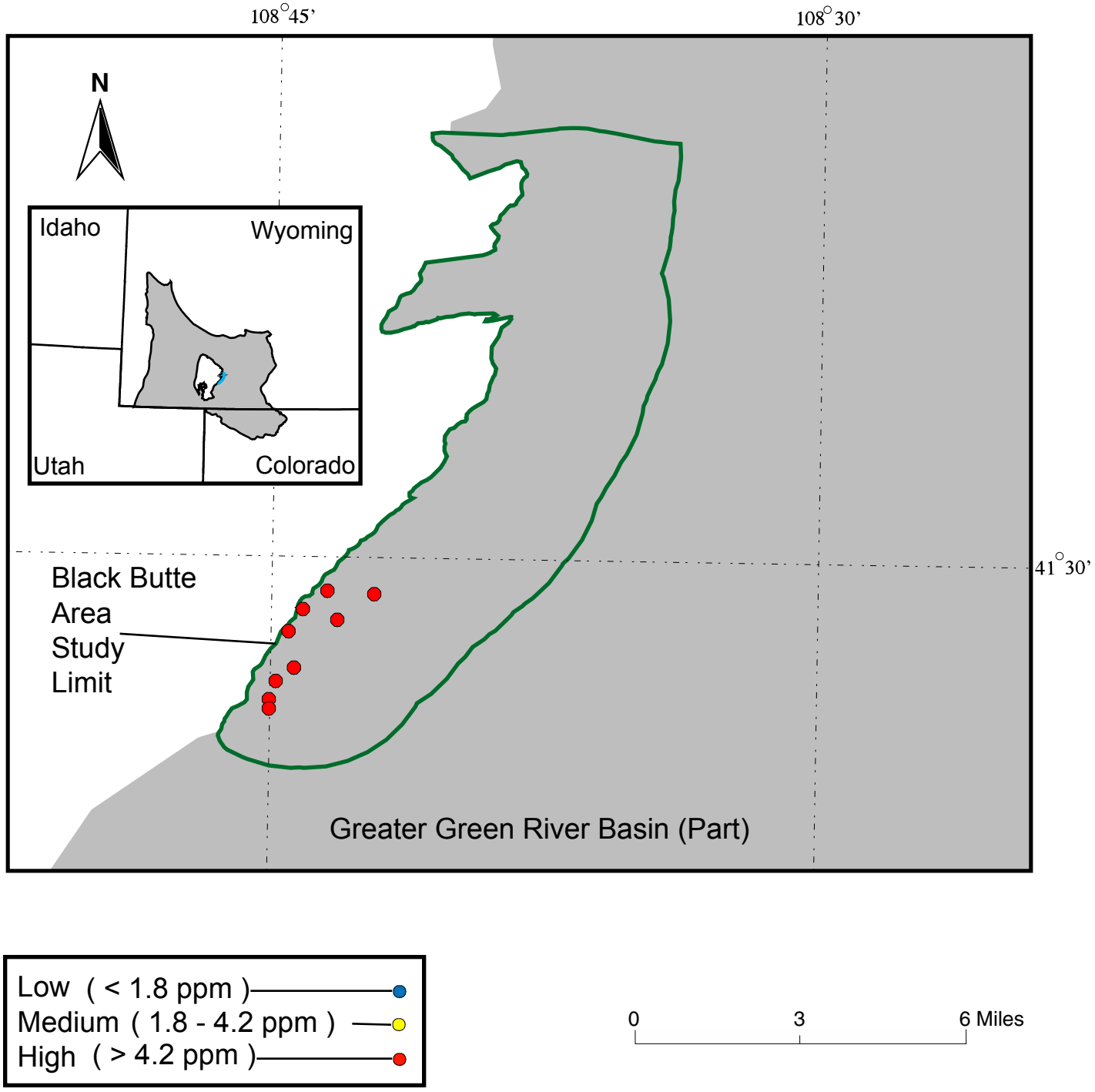


Figure GQ-30. Lead concentration in the Black Butte area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

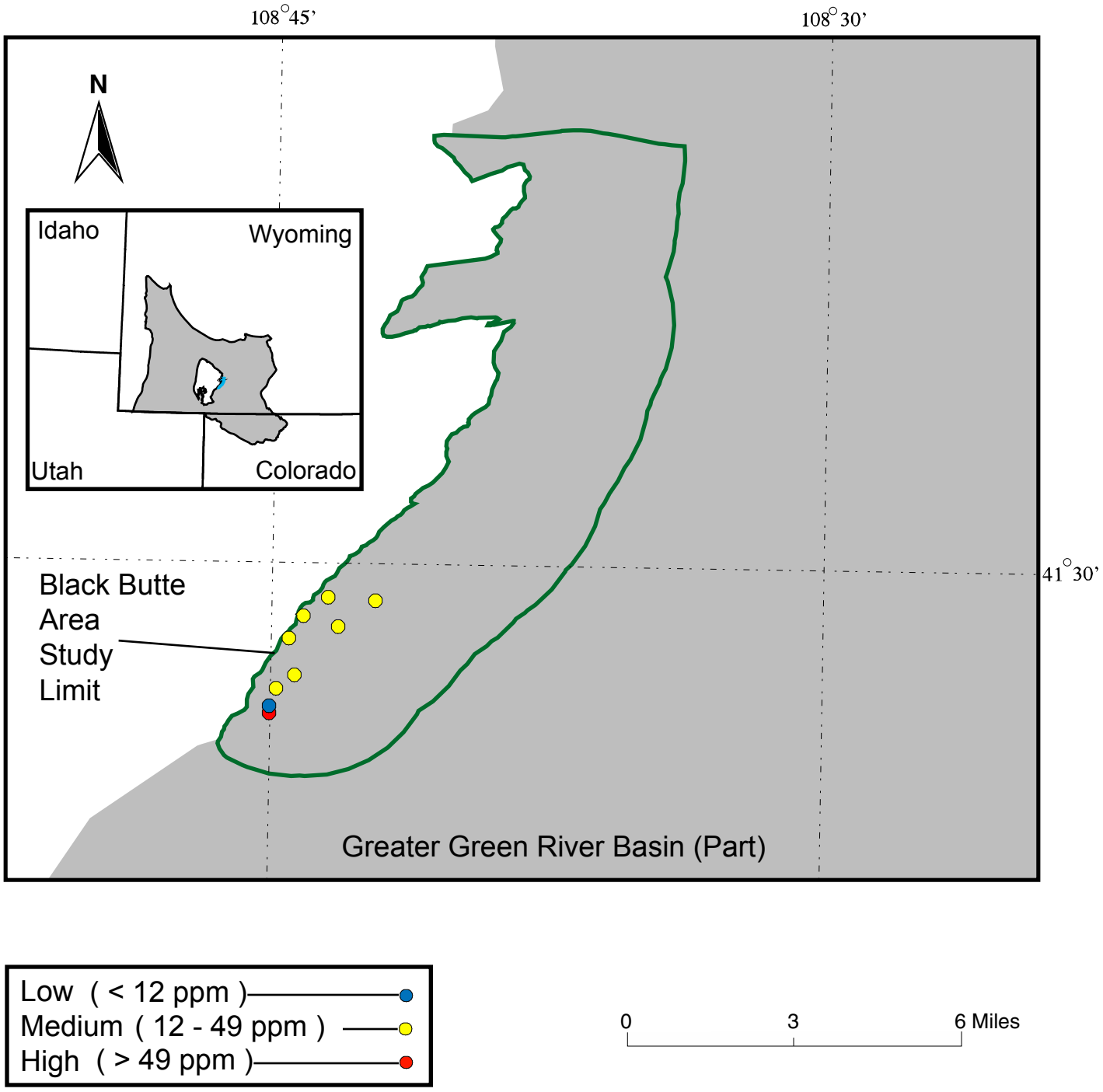


Figure GQ-31. Manganese concentration in the Black Butte area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

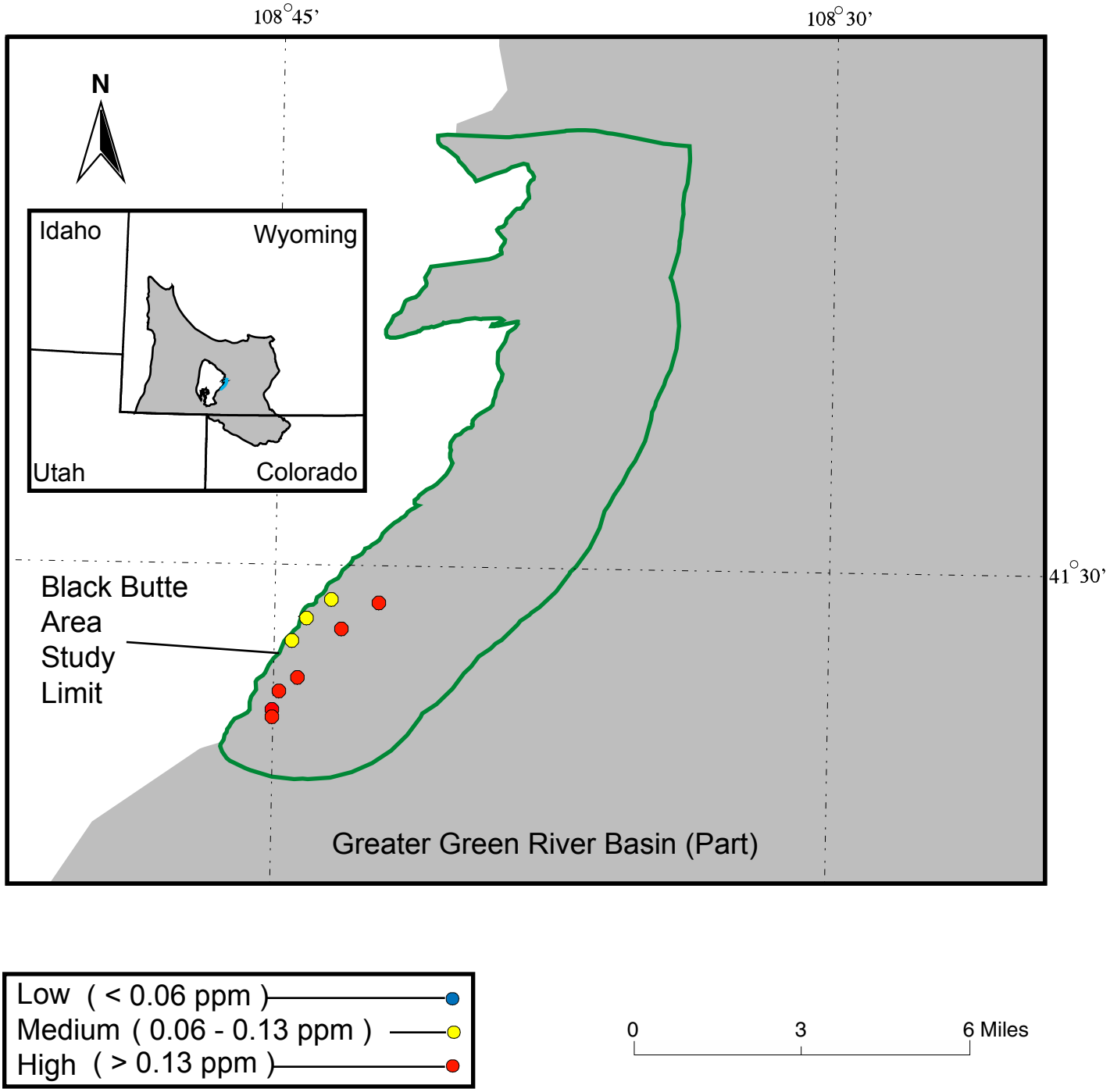


Figure GQ-32. Mercury concentration in the Black Butte area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

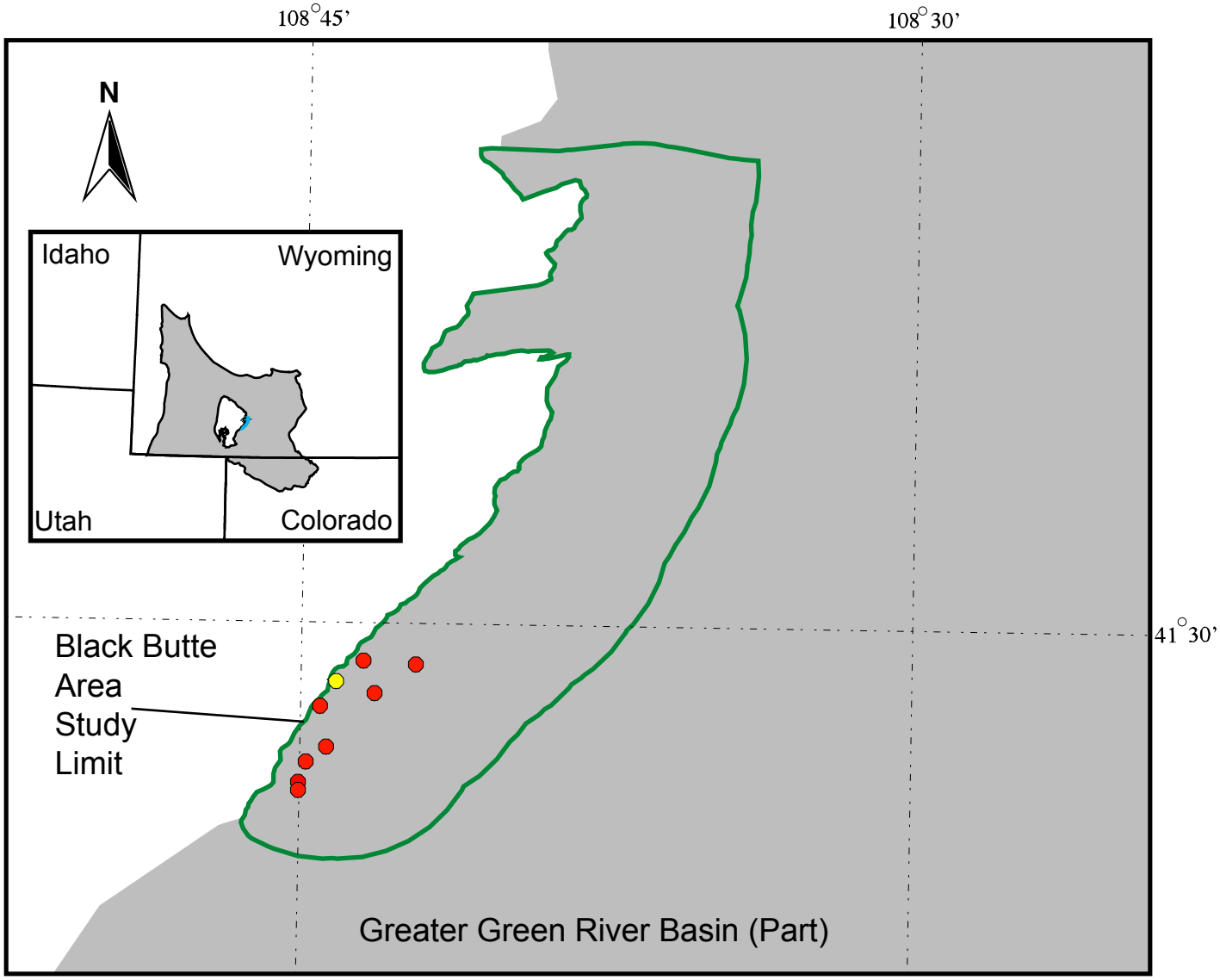


Figure GQ-33. Nickel concentration in the Black Butte area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

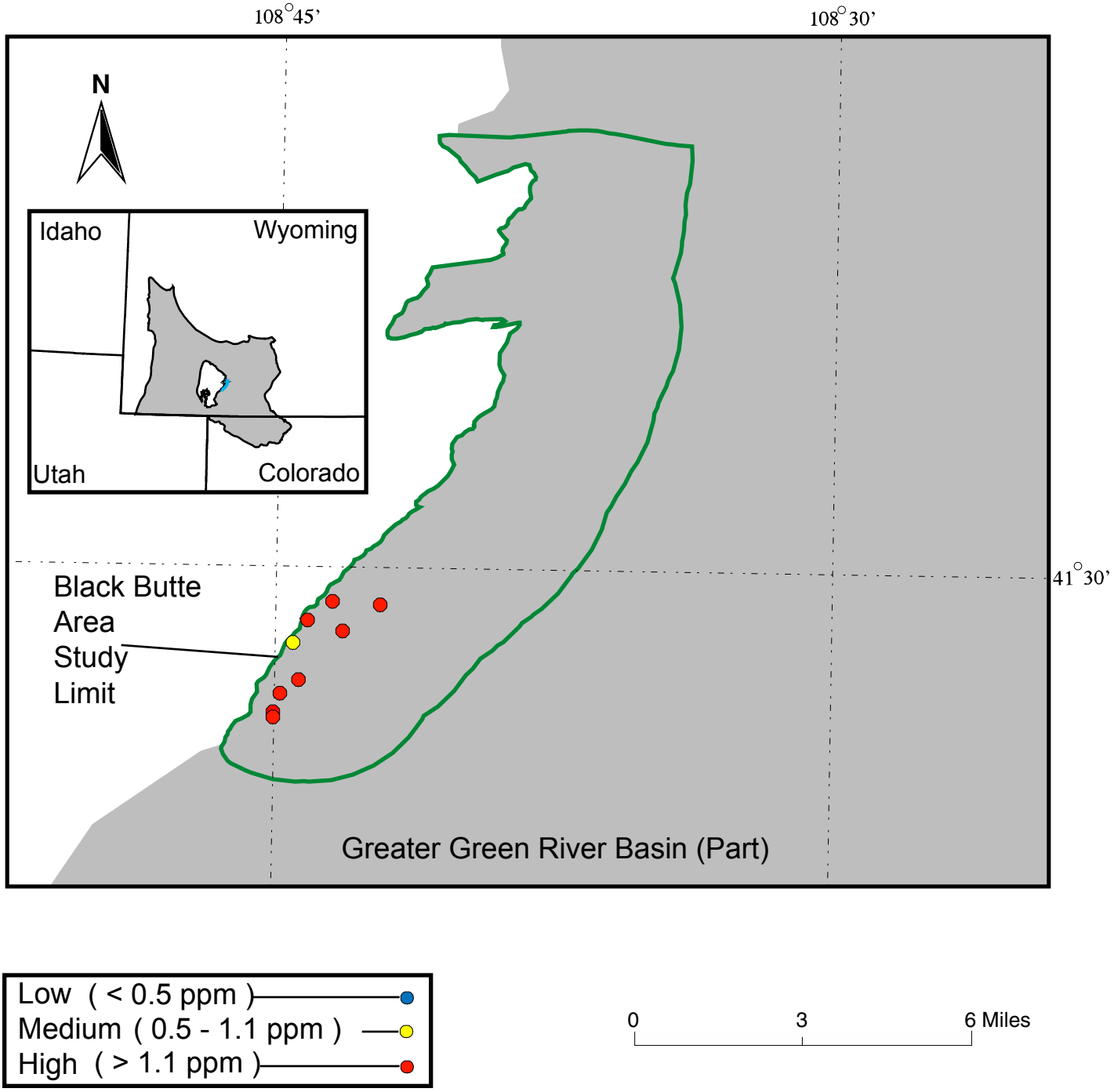


Figure GQ-34. Selenium concentration in the Black Butte area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

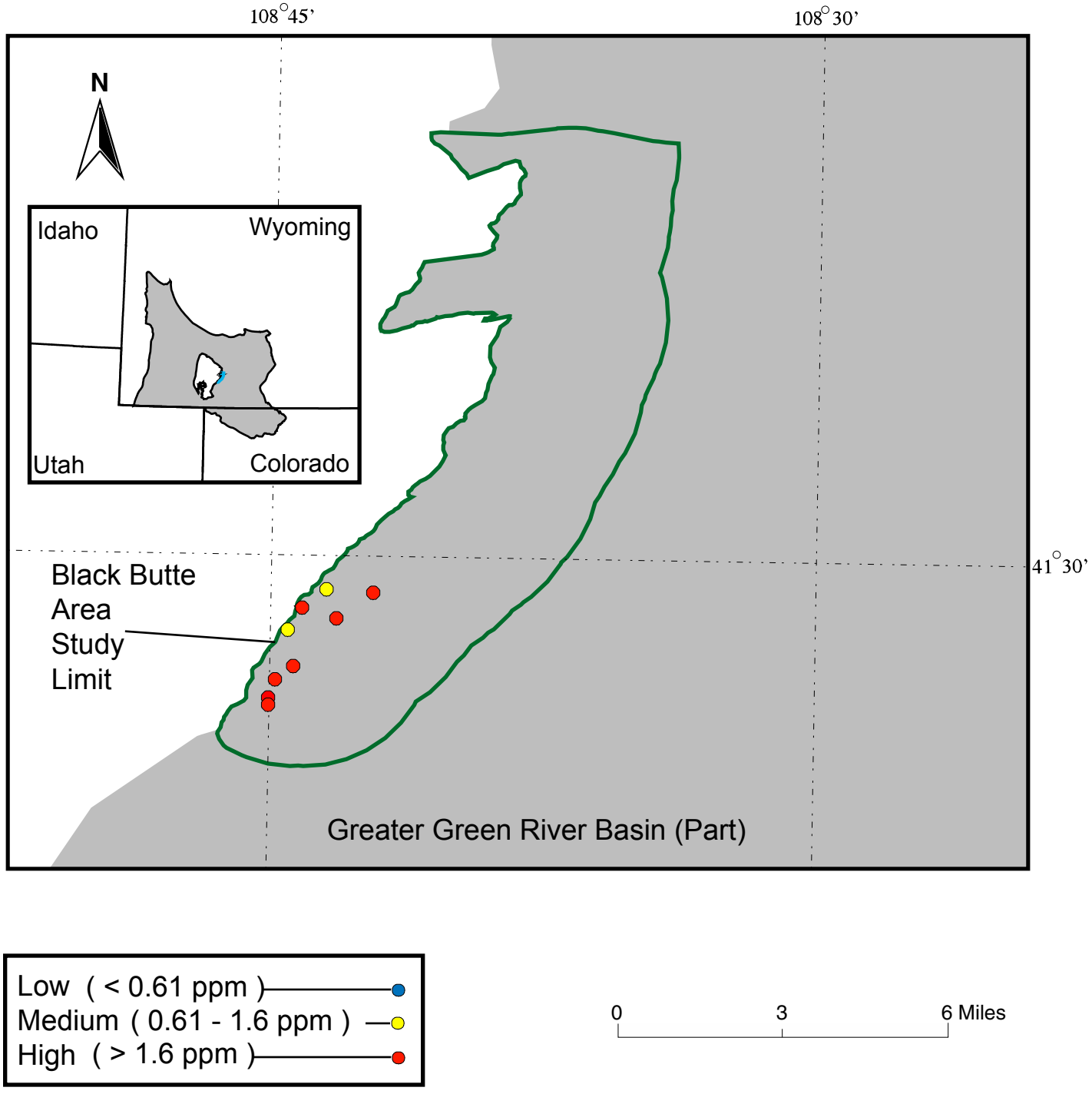


Figure GQ-35. Uranium concentration in the Black Butte area of the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming.

Table GQ-1. Summary data for Deadman coal zone in the Point of Rocks-Black Butte coalfield, Greater Green River Basin, Wyoming. Calculated from the unpublished U.S. Geological Survey coal quality database (USCHEM), February, 1992; Bragg and others (1994); and proprietary source(s)

| Variable | Number of samples | Range | | Mean |
|---|---|---|---|---|
| | | Minimum | Maximum | |
| Moisture [1] | 1,101 | 3.8 | 36.35 | 19.95 |
| Ash [1] | 1,090 | 4.11 | 49.91 | 11.18 |
| Total sulfur [1] | 1,082 | 0.13 | 2.43 | 0.56 |
| Calorific value [2] | 1,090 | 2,400 | 10,510 | 9,000 |
| lb $SO_2$ [3] | 1,082 | 0.31 | 5.71 | 1.27 |
| MMMFBtu [4] | 1,082 | 5,200 | 12,000 | 10,270 |
| Antimony [5] | 26 | 0.20 | 6.4 | 0.97 |
| Arsenic [5] | 26 | 0.25L | 130 | 21 |
| Beryllium [5] | 21 | 0.12 | 2.0 | 0.69 |
| Cadmium [5] | 26 | 0.02L | 1.2 | 0.28 |
| Chromium [5] | 26 | 2.9 | 55 | 13 |
| Cobalt [5] | 26 | 0.57 | 12 | 2.8 |
| Lead [5] | 26 | 0.5L | 20 | 5.5 |
| Manganese [5] | 26 | 7.0 | 68 | 23 |
| Mercury [5] | 26 | 0.03 | 0.69 | 0.20 |
| Nickel [5] | 26 | 1.1 | 39 | 9.7 |
| Selenium [5] | 26 | 0.30 | 9.0 | 2.8 |
| Uranium [5] | 26 | 0.34 | 75 | 5.1 |

[1] Values are in percent and on an as-received basis.
[2] Value is in British thermal units (Btu).
[3] Value is in pounds per million Btu and on an as-received basis.
[4] Value is in British thermal units on a moist, mineral-matter-free basis.
[5] Values are in parts per million (ppm) on a whole-coal and as-received basis; “L” denotes less than value shown.

Table GQ-2. Summary data for Deadman coal zone in the Jim Bridger area in the Black Butte/ Point-of-Rocks coalfield, Greater Green River Basin, Wyoming. Calculated from the unpublished U.S. Geological Survey coal quality database (USCHEM), February, 1992; Bragg and others (1994); and proprietary source(s)

| Variable | Number of samples | Range | | Mean |
|---|---|---|---|---|
| | | Minimum | Maximum | |
| Moisture [1] | 693 | 11.59 | 32.15 | 19.92 |
| Ash [1] | 682 | 4.90 | 49.91 | 12.96 |
| Total sulfur [1] | 682 | 0.13 | 2.43 | 0.65 |
| Calorific value [2] | 682 | 2,400 | 10,510 | 8,740 |
| lb $SO_2$ [3] | 682 | 0.58 | 5.71 | 1.51 |
| MMMFBtu [4] | 682 | 5,200 | 12,000 | 10,190 |
| Antimony [5] | 14 | 0.20 | 0.90 | 0.43 |
| Arsenic [5] | 14 | 0.25L | 15 | 2.6 |
| Beryllium [5] | 9 | 0.12 | 0.34 | 0.24 |
| Cadmium [5] | 14 | 0.02L | 0.27 | 0.06 |
| Chromium [5] | 14 | 2.9 | 9.4 | 5.5 |
| Cobalt [5] | 14 | 0.57 | 1.9 | 1.2 |
| Lead [5] | 14 | 0.50L | 5.6 | 3.3 |
| Manganese [5] | 14 | 11 | 68 | 25 |
| Mercury [5] | 14 | 0.03 | 0.69 | 0.15 |
| Nickel [5] | 14 | 1.1 | 4.6 | 2.2 |
| Selenium [5] | 14 | 0.30 | 3.5 | 1.9 |
| Uranium [5] | 14 | 0.34 | 2.3 | 1.1 |

[1] Value is in percent and on an as-received basis.
[2] Value is in British thermal units (Btu).
[3] Value is in pounds per million Btu and on an as-received basis.
[4] Value is in British thermal units on a moist, mineral-matter-free basis.
[5] Value is in parts per million (ppm) on a whole-coal and as-received basis; “L” denotes less than value shown.

Table GQ-3. Summary data for Deadman coal zone in the Black Butte area of the Point of Rocks-Black Butte coalfield , Greater Green River Basin, Wyoming. Calculated from the unpublished U.S. Geological Survey coal quality database (USCHEM), February, 1992; Bragg and others (1994); and proprietary source(s)

| Variable | Number of samples | Range | | Mean |
|---|---|---|---|---|
| | | Minimum | Maximum | |
| Moisture [1] | 408 | 3.8 | 36.35 | 20.01 |
| Ash [1] | 408 | 4.11 | 26.03 | 8.22 |
| Total sulfur [1] | 400 | 0.13 | 2.43 | 0.56 |
| Calorific value [2] | 408 | 5,220 | 10,450 | 9,440 |
| lb $SO_2$ [3] | 400 | 0.31 | 5.13 | 0.88 |
| MMMFBtu [4] | 400 | 5,900 | 11,400 | 10,420 |
| Antimony [5] | 12 | 0.30 | 6.4 | 1.6 |
| Arsenic [5] | 12 | 1.0 | 130 | 44 |
| Beryllium [5] | 12 | 0.33 | 2.0 | 1.0 |
| Cadmium [5] | 12 | 0.06 | 1.2 | 0.55 |
| Chromium [5] | 12 | 8.1 | 55 | 22 |
| Cobalt [5] | 12 | 1.1 | 12 | 4.8 |
| Lead [5] | 12 | 3.6 | 20 | 8.0 |
| Manganese [5] | 12 | 7.0 | 44 | 21 |
| Mercury [5] | 12 | 0.05 | 0.58 | 0.27 |
| Nickel [5] | 12 | 3.3 | 39 | 18 |
| Selenium [5] | 12 | 0.60 | 9.0 | 3.7 |
| Uranium [5] | 12 | 0.74 | 75 | 9.8 |

[1] Value is in percent and on an as-received basis.
[2] Value is in British thermal units (Btu).
[3] Value is in pounds per million Btu and on an as-received basis.
[4] Value is in British thermal units on a moist, mineral-matter-free basis.
[5] Value is in parts per million (ppm) on a whole-coal and as-received basis.