RIVER CORRIDOR SAND AND GRAVEL MINING, LOUISIANA AND MISSISSIPPI: A DATABASE AND COMPARISION OF DIFFERENT DATA SOURCES

Joann Mossa and David Coley, Department of Geography, University of Florida

INTRODUCTION

Because rivers and their floodplains are extraction sites for aggregate resources in most states, a systematic and quantitative examination of mining practices and their impacts can provide useful scientific information to policymakers nationwide. Knowing which rivers are mining sites, and which of those appear to be significantly impacted, is a logical first place to begin. Using geospatial data sets, this study will examine mining in Louisiana and Mississippi, two states have considerable gravel and sand mining activity in some river channels and floodplains yet limited regulations.

There are two widely available data sources with national coverage. One source is the National Atlas (http://nationalatlas.gov/sndgrvm.html), which includes 3,386 sand and gravel operations in the United States. These data were obtained from information reported voluntarily to the USGS by the aggregate producing companies, with active operations in 1998 and production greater than 30,000 tons. Locations have not undergone a rigorous QA-QC process and may omit numerous historic and small operations, thus will likely only provide complementary information. Another source is the national land cover/land use interpreted by the USGS at a scale of 1:100,000 (30m pixel size). The dates of analysis vary, but for Louisiana the most recent data are from 1990 and from Mississippi they are from 1992. One of the land cover/land use categories is quarries/strip mines/gravel pits, which can be mapped to show mining areas across the two states, and specifically in river corridors.

In addition to both of these sources, photography from the most recent digital ortho quarter quadrangles (DOQQs) from both states can be interpreted to map mining sites. This is likely the most accurate approach, as the resolution is approximately 1 m, the information is more recent than the former source, and the analyst is looking for one specific land use activity. However, it is more time consuming, as several images need to be imported into a GIS and then interpreted, which takes considerable time.

Information regarding impacted rivers will be compiled into a data base by state as follows: name of stream impacted, geographic coordinates of the upstream and downstream extent of mining, the length of floodplain between upstream and downstream mining sites, the approximate intensity of mining (what % of this floodplain length has mining activity), and total length mined (product of entire length mined and intensity). The database will include the number and type of discernible channel changes interpreted from different methods. Changes are discernible where a river is located on a county boundary and the boundary and river no longer largely coincide, where rivers shows amorphous shapes, and where change is evidenced by transparency overlays in ARCGIS that compare different date sources. The inventory will also help place the rivers examined in detail in this study in a larger context, both regionally and nationwide.

METHODS

River Corridor Definition

For Louisiana river corridors, the statewide geologic data contain a well-attributed alluvium GIS layer representing riverine deposits at a 1:500,000 scale. By selecting this feature through database query, a ready-made corridor has been defined for the floodplain. A small buffer was then created around these data to account for margin of error at the given scale. Unfortunately, the statewide geologic layer for Mississippi does not possess the same geographic resolution. As such, Mississippi alluviums are not well delineated. An attempt to utilize statewide, soil association data also met with similar problems. While the soil association layer does possess the required resolution, the determination of its origin (i.e. fluvial deposited) is beyond the scope of this project. Therefore, it was decided to buffer the major river centerlines by 2 km, thereby creating a 4 km wide river-corridor. As with the Louisiana alluvial data set, a small buffer distance was added to account for spatial error in the source data.

Unlike the Louisiana corridors, the Mississippi corridors are likely to contain (omit) some upland (floodplain) area as river valleys widen (narrow) with distance downstream (upstream). Naturally, this could lead to the inclusion of some upland mining sites and the omission of downstream mining locations. However, project staff guarded against this via a quality assurance procedure where dubious locations are cross-checked with the use of higher-resolution aerial photographs.

Data Description

US Mineral Information Team Sand and Gravel Operations

The first data source used for this study is the United States Mineral Information Teams' Sand and Gravel (SG) dataset. The SG data are point locations of sand and gravel mining operations within the United States. These data are obtained from information reported voluntarily to the USGS Mineral Information Team by the producing companies. As such, the data may or may not represent the actual mine locations, but are usually in close proximity to river corridors.

At the time of compilation (1998) these operations are considered active, although only companies with production of greater than 30,000 tons annually are represented here (MIT, 2001). Lastly, the data provide limited attribution as to operation type. For Louisiana and Mississippi, the only type listed is "dredge", defined as large floating machinery equipped with excavating devices that are used for underwater mining (MIT, 2001).

National Land Cover Dataset

The National Land Cover Dataset (NLCD) is derived from the early to mid-1990s Landsat Thematic Mapper satellite data at a spatial resolution of 30 meters (Give Internet Source). The end product is a modified Anderson 21-class land cover classification scheme derived from an unsupervised classification algorithm. This classification is applied consistently over the entire United States (USGS, 2006). Within the NLCD, strip mines and quarries are coded as Class 32 and were queried from the data for Louisiana and Mississippi. It is important to note that some sites will have been misclassified (not quarries) and some mine sites will have been reclaimed. As these data represent land cover type, no information is provided as to operation type (sand and gravel extraction, crushed stone, etc) or production volume.

DOQQ Aerial Photographs

Digital orthorectified quarter quadrangle aerial photographs at 1-meter resolution were collected from two online data warehouses in Mississippi (1996) and Louisiana (1998) to verify mine locations identified with the national datasets (Give Internet Sources). These data also served as base map information from which project staff were able to create a more detailed analysis of mining impacts.

Base Map Layers

Various base map data layers from MARIS and ATLAS used include DOQQ indices, small-scale stream and geologic data, road layers, and city polygons. Full documentation of these layers can be found at http://www.maris.state.ms.us/ and http://atlas.lsu.edu/ respectively.

GIS Analysis

To classify the MIT and NLCD as in-corridor or upland, project staff conducted a simple overlay of the mining datasets with the Mississippi and Louisiana river corridor data. As such, in-corridor mining occurs where the extracted strip mines/quarries intersect the river corridors. Once project staff had this information, DOQQs were selected for each state by identifying the DOQQ from the DOQQ index GIS layers that contain the mine sites.

Armed with the high-resolution photos, the project staff was then able to determine if a NLCD site was active (Fig. 1), inactive (Fig. 2) or misclassified (Fig. 3). If a site was deemed active through visual evidence, staff digitized a reasonable boundary around the entire disturbed area. Other extraction features were captured as including pits and spoil mounds. For sites deemed inactive, only the remnant pits were digitized. Misclassified mine sites are identified with a point feature and noted as such in the database.

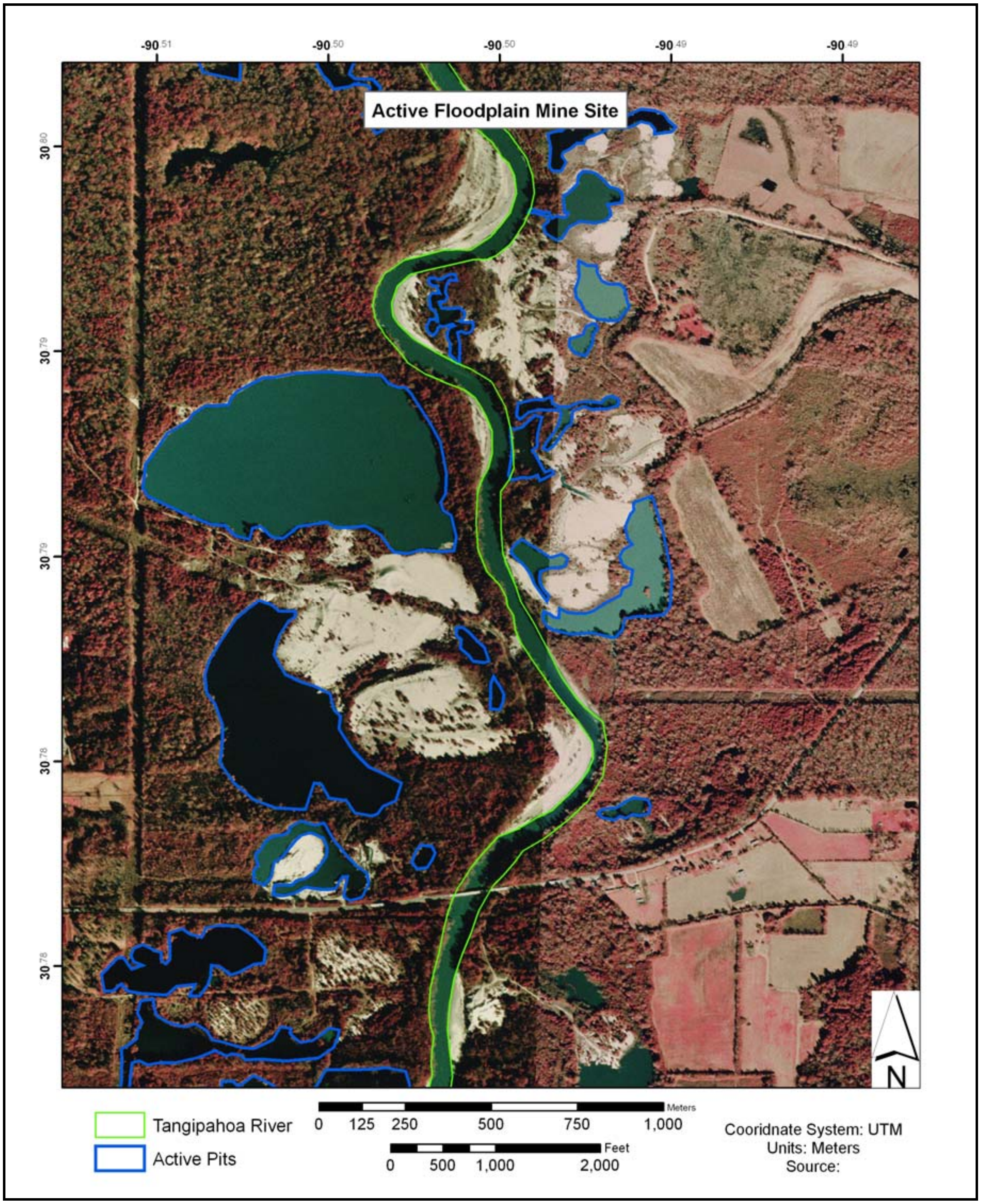

Figure 1. Active floodplain mine site along the Tangipahoa River, LA.

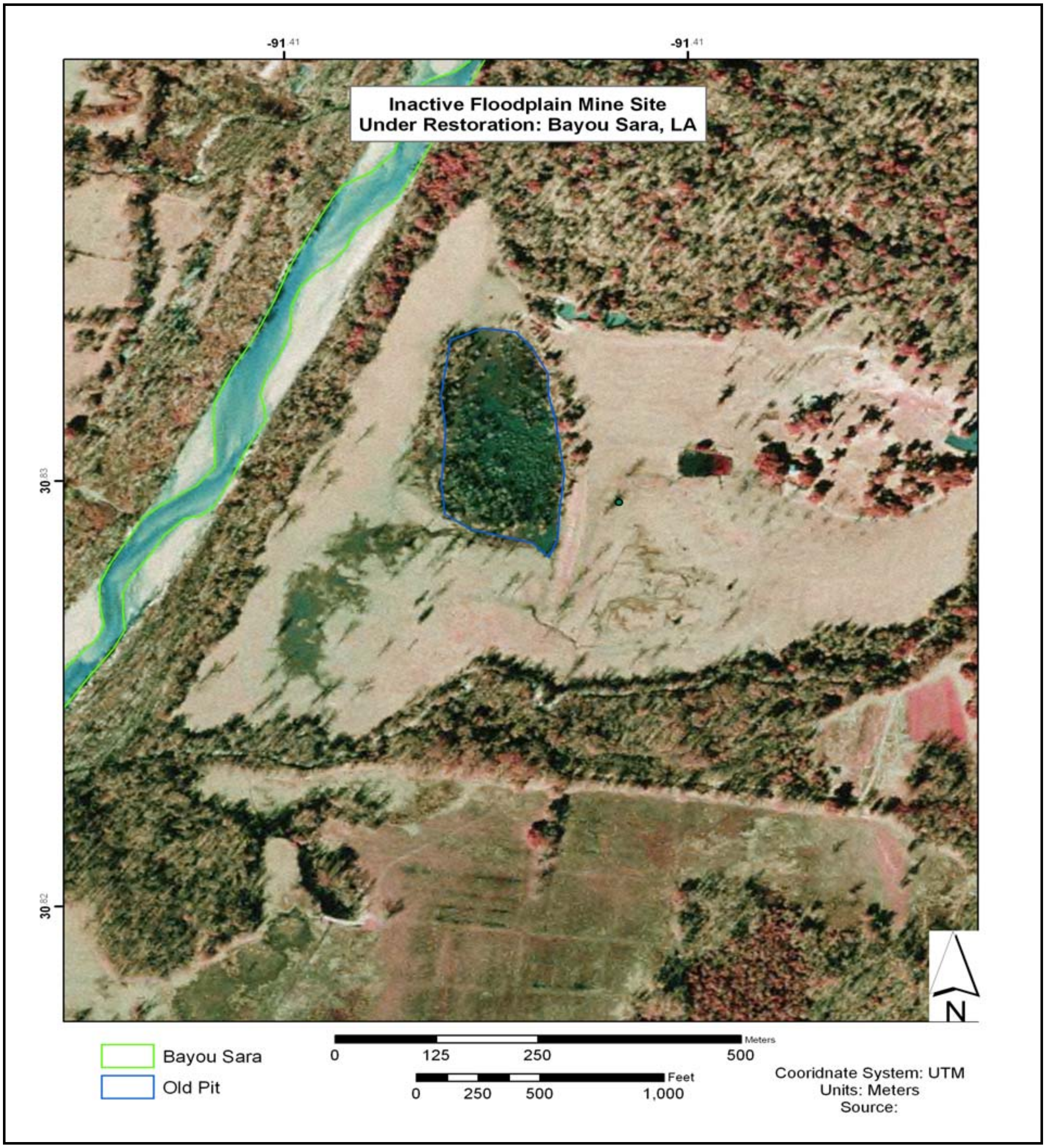

Figure 2. Inactive floodplain mine sit along Bayou Sara, LA.

Figure 3. Misclassified mine sit along Bayou Sara, LA.

RESULTS

River Mining Intensity: National Dataset Statistics

According to the MIT SG data, there are 35 mining operations located in 16 Louisiana counties; 32 (91%) of these are associated with floodplain extraction activity (Fig. 4). At minimum, this represents 1,024,000 tons of aggregate extracted annually. Within Mississippi, there are 56 mining operations located in 25 counties. 37 of these SG mining operations are associated with floodplain extraction representing a minimum of 1,110,000 annual tons of aggregate (Fig. 5). In both states, for an SG operation to be considered as associated with floodplain activity, either the operation location had to be contained by the corridor buffer or, if not, was intersected by NLCD mine sites that in turn were intersected or contained by the river corridors.

According to the NLCD Land Cover Statistics Database, Louisiana contains 24 square miles (15,360 acres), of quarries and strip mining activity. This equates to less than 1% (0.00053%) of the overall acreage in Louisiana, or 1 out of every 1896 acres is classified as a quarry/stripmine/gravel pit. Over the early to mid-1990s, Louisiana had mining operations present in 47 (of 64) counties. Most or 22.4 mi^2 (14, 332 acres, 93.3% of total) can be classified as floodplain extraction activity (Fig. 6). Mississippi contains slightly less at 19 square miles (12,160 acres). Through the same period, the state of Mississippi had 7.1mi^2 (4562 acres, 36% of total) classified as floodplain mining (Fig. 7).

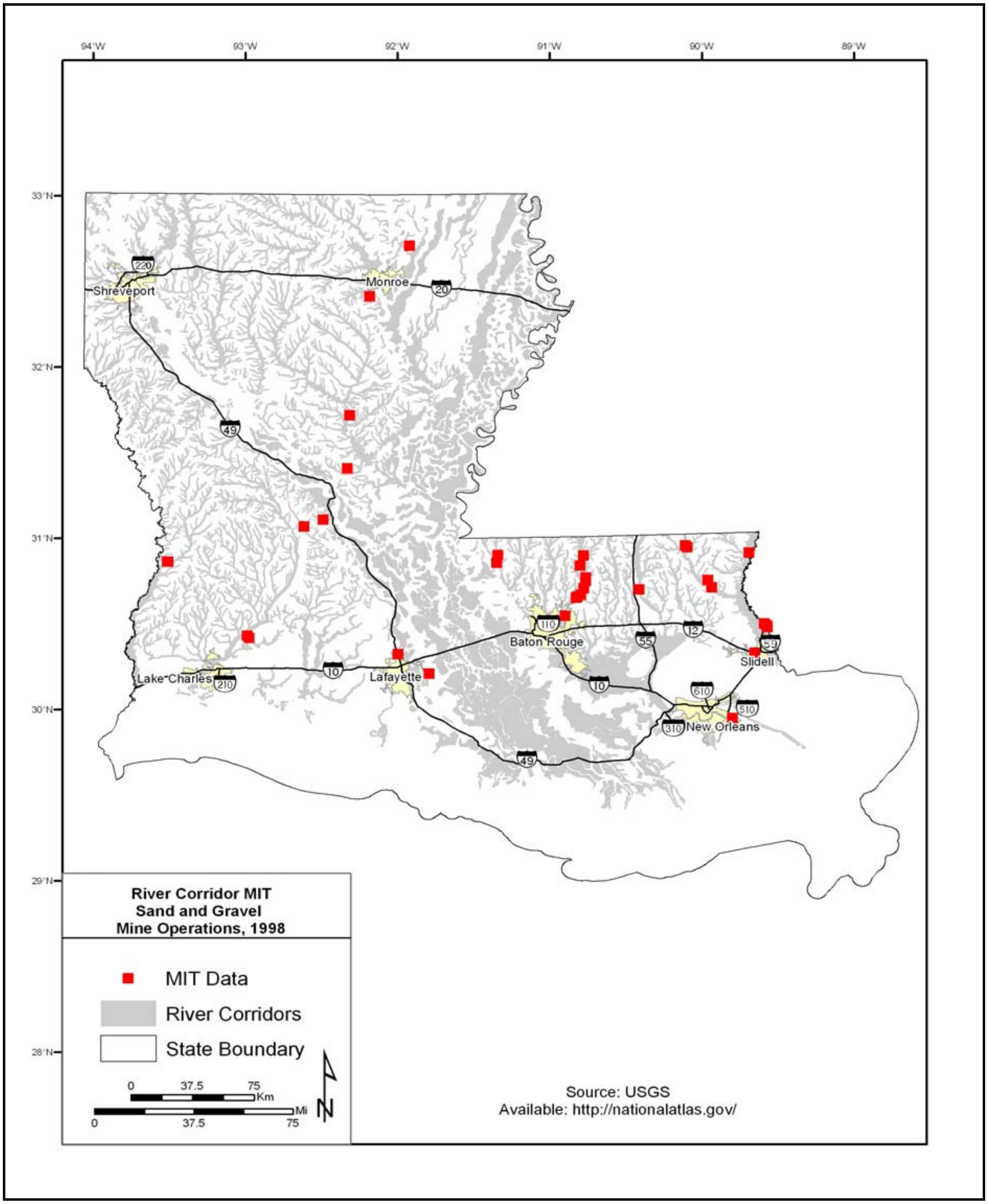

Figure 4. MIT river-corridor mining operations in Louisiana.

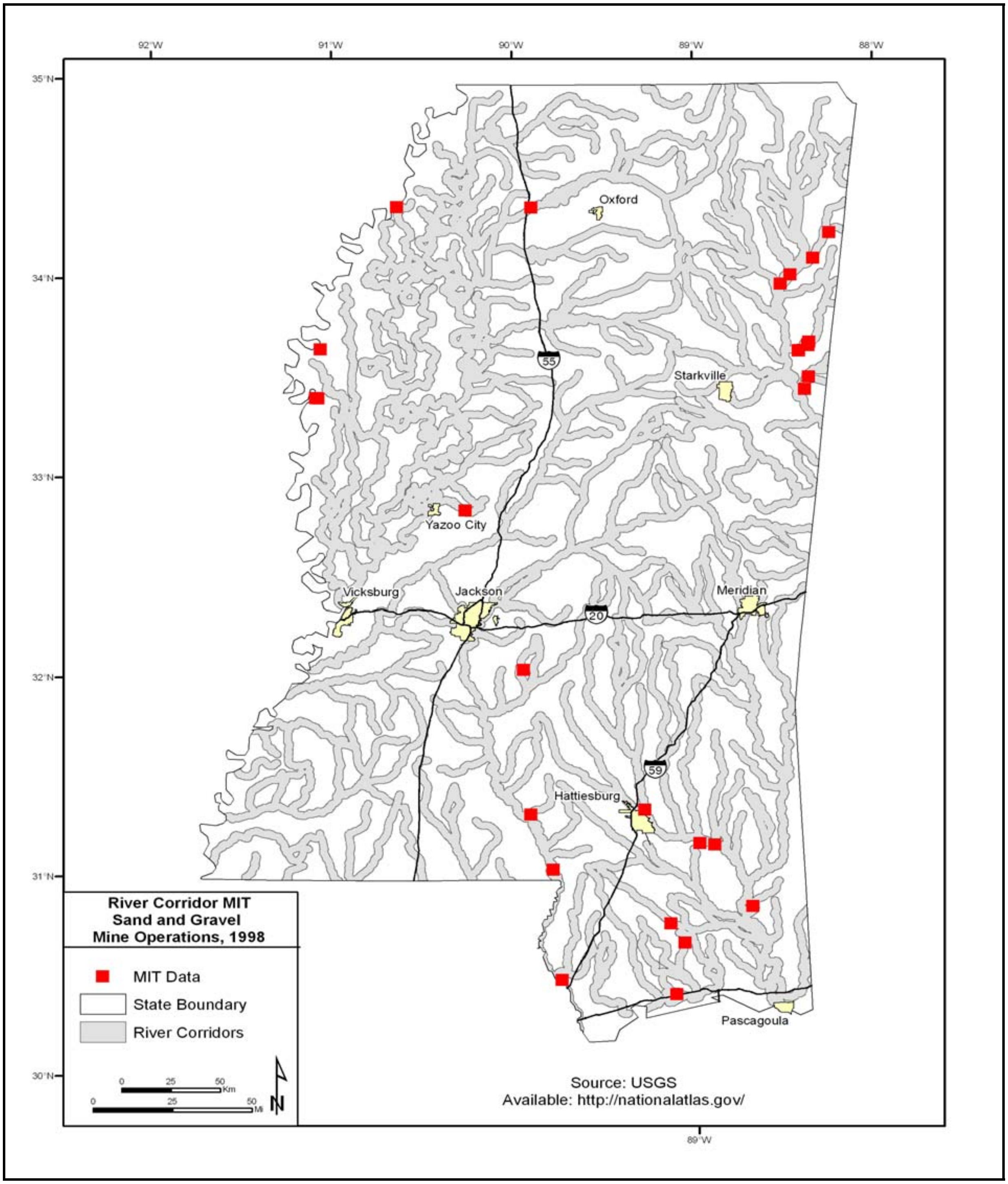

Figure 5. MIT river-corridor mining operations in Mississippi.

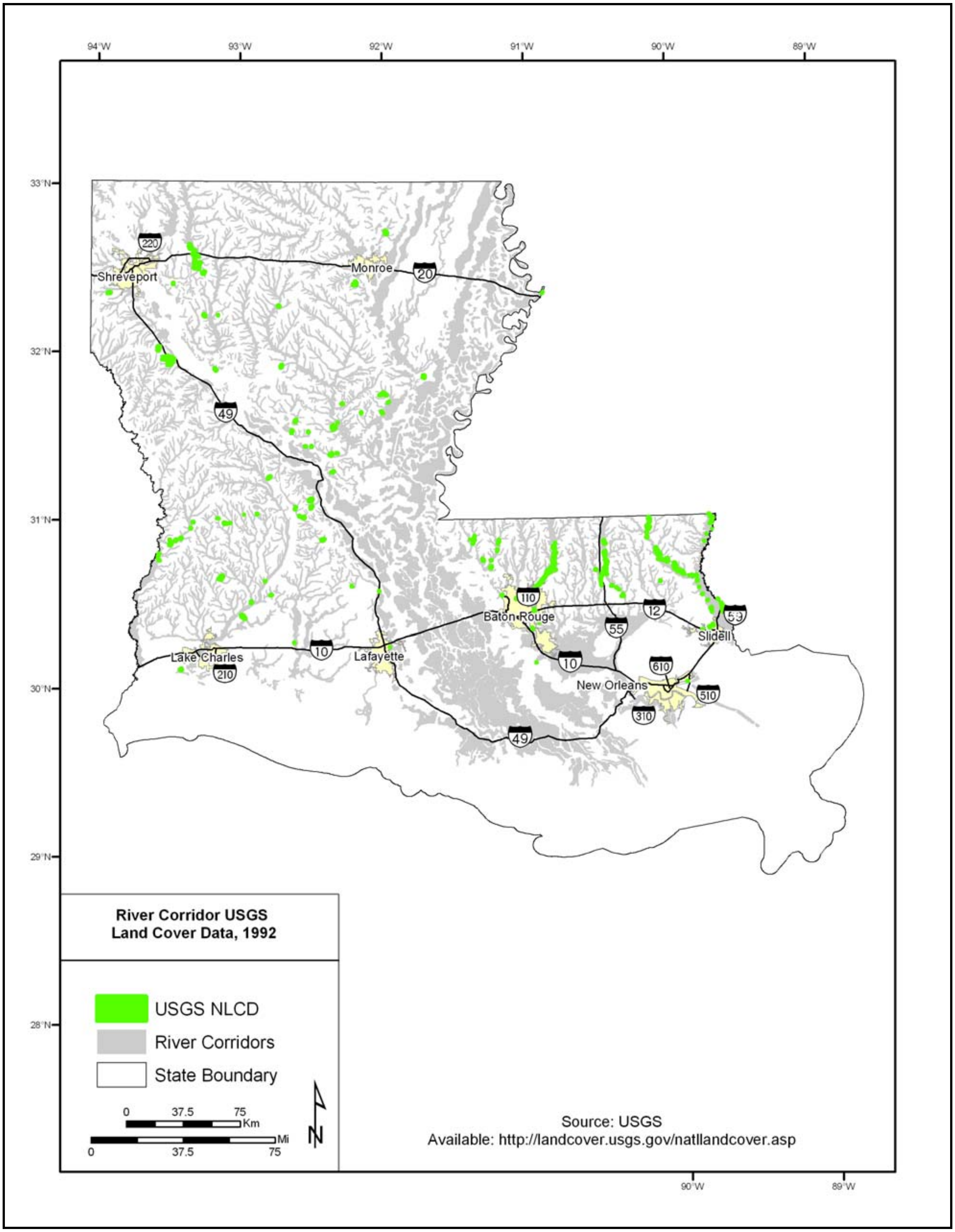

Figure 6. NLCD river corridor quarry sites in Louisiana.

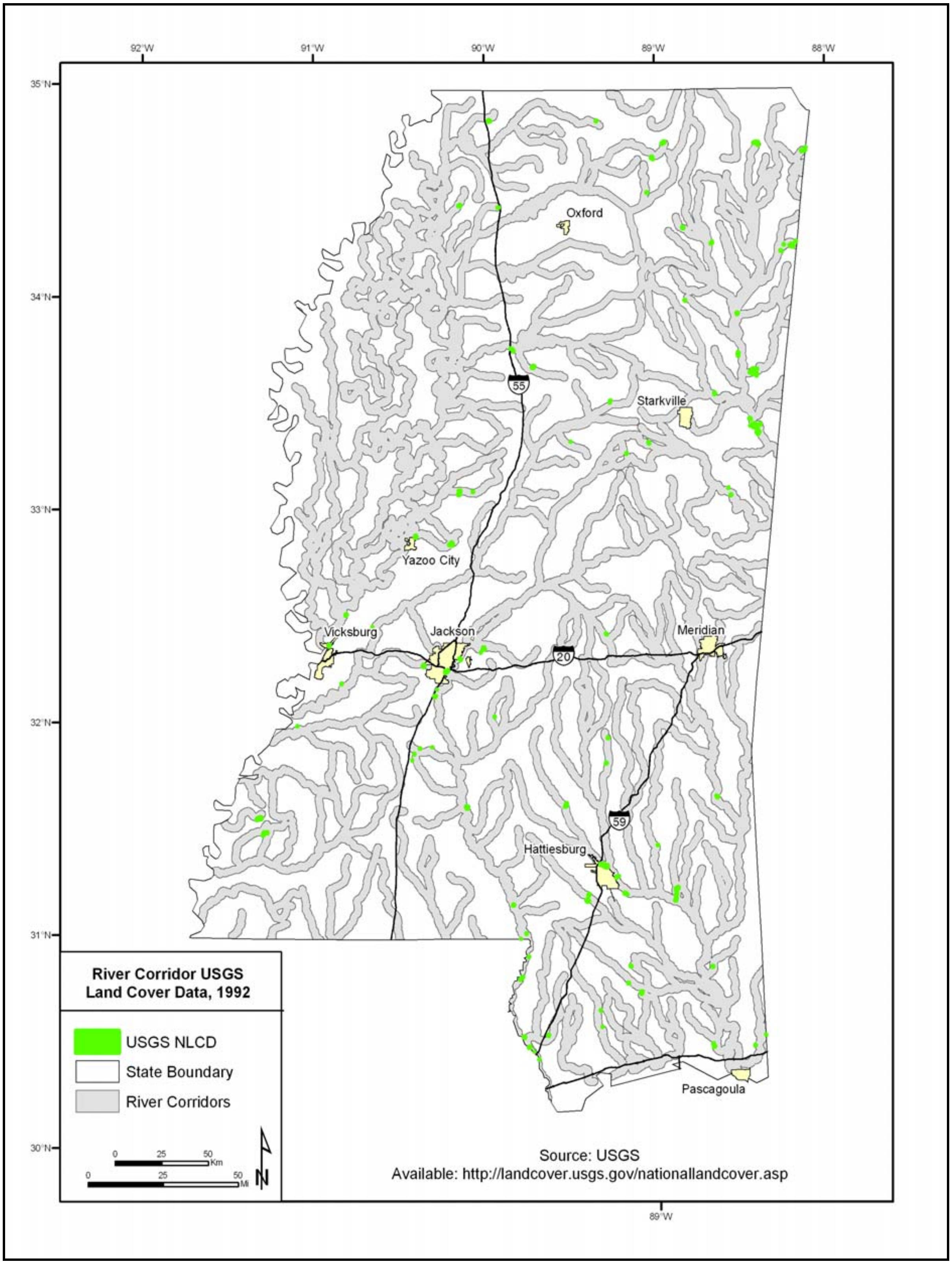

Figure 7. NLCD river corridor quarry sites in Mississippi.

River Mining Intensity: DOQQ Analysis

For a mine site to be included in the project inventory, the mining impact had to be discernable on the 1998/1996 Louisiana/ Mississippi DOQQs. Figure 8 shows mining sites in Louisiana and Figure 9 shows mining sites in Mississippi. A list with the number of sites is also included for each state, where the rivers highlighted in bold text represent locations where mining activity is particularly heavy.

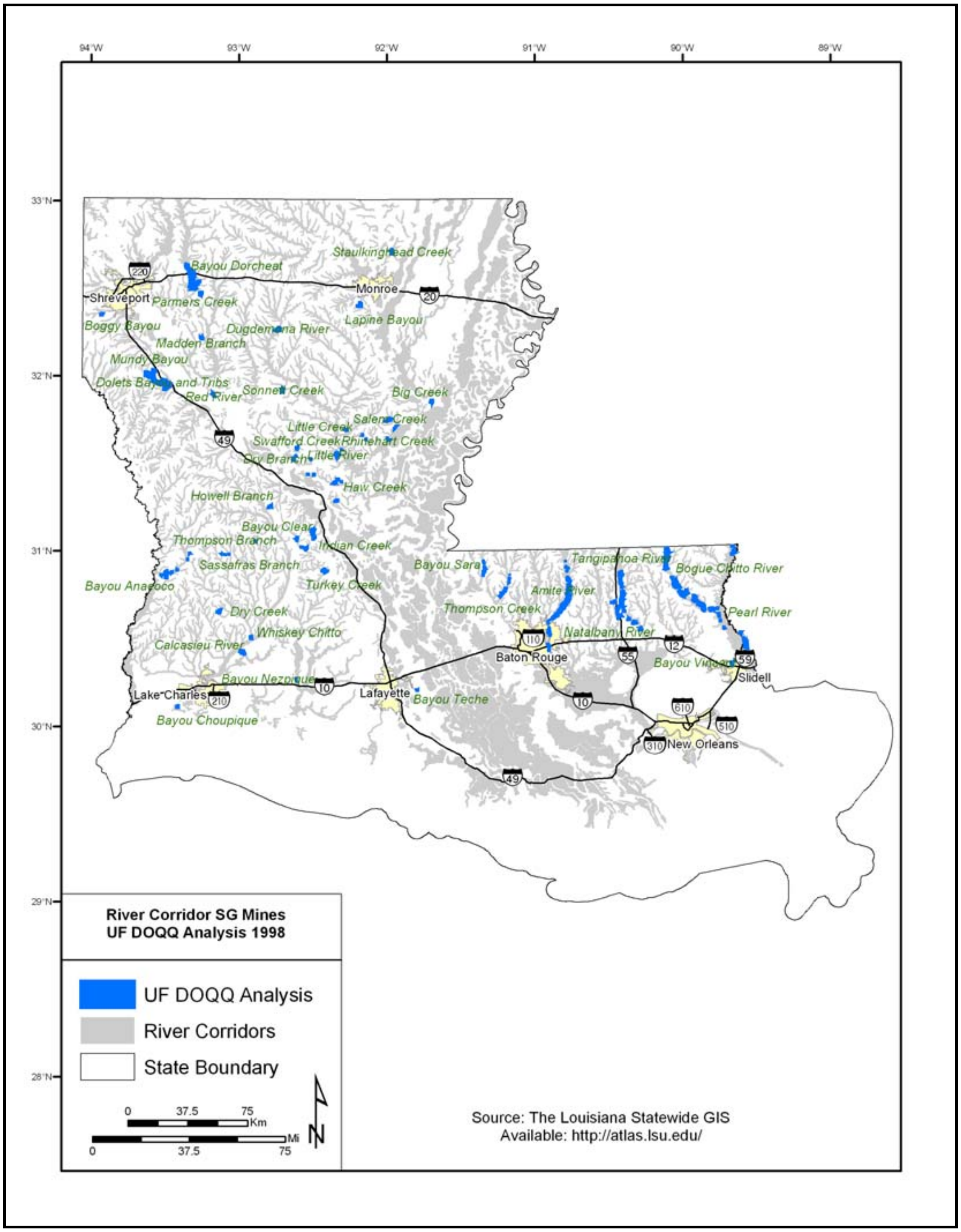

Figure 8. Louisiana river corridor mine locations determined through DOQQ analysis.

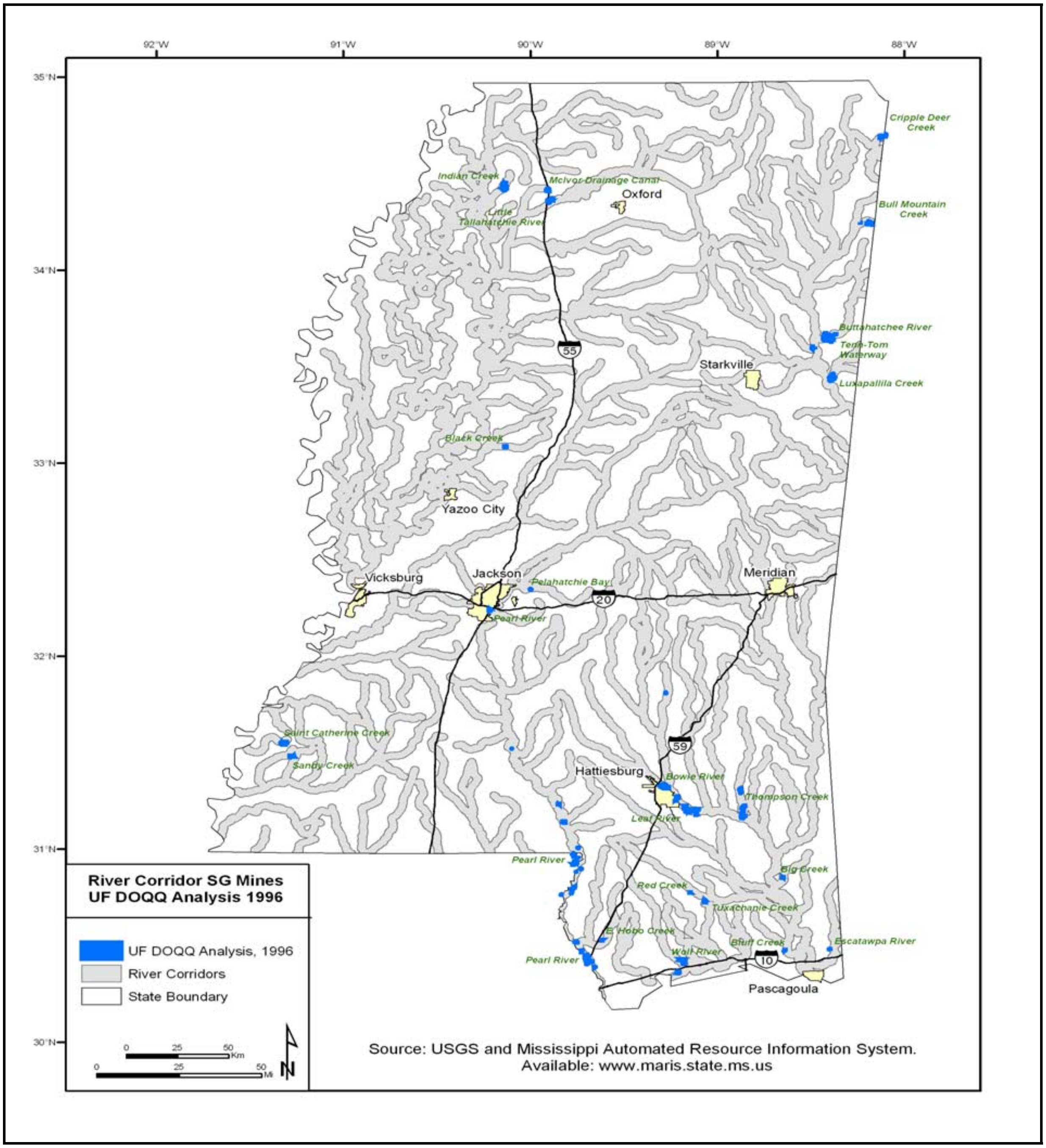

Figure 9. Mississippi river corridor mine locations determined through DOQQ analysis.

This is the inventory of Louisiana rivers with in-corridor mining where impact to the stream/floodplain is discernible:

1. **Amite River (60)**
2. Barber Creek (1)
3. **Bayou Anacoco (10)**
4. Bayou Choupique (1)
5. Bayou Clear (1)
6. **Bayou Dorcheat 15**
7. Bayou Nezpique (1)
8. **Bayou Sara (7)**
9. Bayou Teche (1)
10. Bayou Vincent (1)
11. Beaver Creek (2)
12. Big Branch (1)
13. Big Creek (1)
14. Boggy Bayou (1)
15. **Bogue Chitto River (39)**
16. Brushy Creek (3)
17. Calicasieu Bayou (1)
18. Clearwater Creek (1)
19. Cold Branch (1)
20. Dolets Bayou (1)
21. Dry Branch (1)
22. Dry Creek (1)
23. Dugdemona River (1)
24. Haw Creek (1)
25. Howell Branch (1)
26. Hudson Creek (2)
27. Indian Creek (2)
28. Jordan Creek (1)
29. Lapine Bayou (2)
30. Little Creek (1)
31. Little River (4)
32. Madden Branch (1)
33. Mill Branch (3)
34. Mill Creek (1)
35. Muddy Prong (1)
36. Mundy Bayou (1)
37. Natalbany River 9
38. Nichols Creek (1)
39. Parmers Creek (2)
40. **Pearl River (10)**
41. Pearl River Canal (3)
42. Ponchatoula Creek (2)
43. Red River (2)
44. Rhinehart Creek (1)

45. Salem Creek (2)
46. Sassafras Branch (1)
47. Sonnett Creek (1)
48. Spring Creek (3)
49. Staulkinghead Creek (2)
50. Swafford Creek (1)
51. Tangipahoa River (19)
52. Thompson Branch (1)
53. Thompson Creek (11)
54. Turkey Creek (2)
55. West Pearl River (2)
56. Whisky Chitto Creek (2)

The following lists Mississippi rivers and the number of mine sites detected within each streams' floodplain:

1. Big Creek (1)
2. Upper Black Creek (1)
3. Blue Mountain Creek (1)
4. Bluff Creek (1)
5. Bogue Chitto River (1)
6. **Bowie River (1)**
7. Bull Mountain Creek (4)
8. Buttahatchee River (3)
9. Cripple Deer Creek (4)
10. East Hobo Creek (4)
11. Escatawpaw River (1)
12. Indian Creek (1)
13. **Leaf River (13)**
14. Little Tallahatchie River (4)
15. McIvor Drainage Canal (1)
16. **Pearl River (27)**
17. Upper Red Creek (1)
18. Saint Catherine Creek (1)
19. Sandy Creek (1)
20. Second Creek (1)
21. **Thompson Creek (6)**
22. Tuxachanie Creek (1)
23. Wolf River (2)

DISCUSSION AND CONCLUSIONS

In terms of overall mining intensity, Louisiana rivers have experienced far greater mining activity than the rivers in Mississippi (Table 1).

Table 1. Number of rivers, mine sites and total acreage by state.

State	No. Rivers	No. Sites	Total Acreage
Louisiana	56	251	69675.6
Mississippi	23	81	17611.9

Within the state of Louisiana, the most intensely mined rivers are the Amite and Bogue Chitto. Although the Amite River has a greater number of sites (60) than the Bogue Chitto River (38), the Bogue Chitto has some 1464 more acres of mined area than does the Amite River (9,514 to 8,050). The Amite has a long history of mining and has a variety of channel changes including avulsions, straightening, and various changes in channel position. Most of the mining there is active and close to the channel, whereas several of the pits on the Bogue Chitto are inactive and farther from the channel.

Within Mississippi, the most intensely mined rivers are the Pearl (27) and the Leaf (13). Not only do the number of sites pale in comparison to the Amite and Bogue Chitto, the acreage does as well. The Pearl River totals 3,520 acres while the Leaf River mined acreage totals 896. And while the Bowie River in Mississippi has just one site, the site totals 1745 acres. This river also has a history of more than 40 years of instream mining, which was curtailed in 1995, but the channel still resembles a chain of lakes. The mining appears as water along the current river, thus a land cover/land use data base would not capture its historical use.

In comparison to the NLCD land statistics, the DOQQ analysis revealed nearly five times greater mining activity in Louisiana river floodplains and four times greater mining activity in Mississippi river floodplains (Figures 10 and 11). This is not unexpected, as the number of features that can be extracted at scales of 1:500,000 or less will be considerably less than those at larger scales.

A database accompanies this report, providing more specific information on the additional sites classified in this project using the DOQQs. It has detailed information on the number of sites along each river, the size of different sites, and the location of sites. Our nation would benefit from a detailed inventory for all states to assess potential resources and impacts in greater detail.

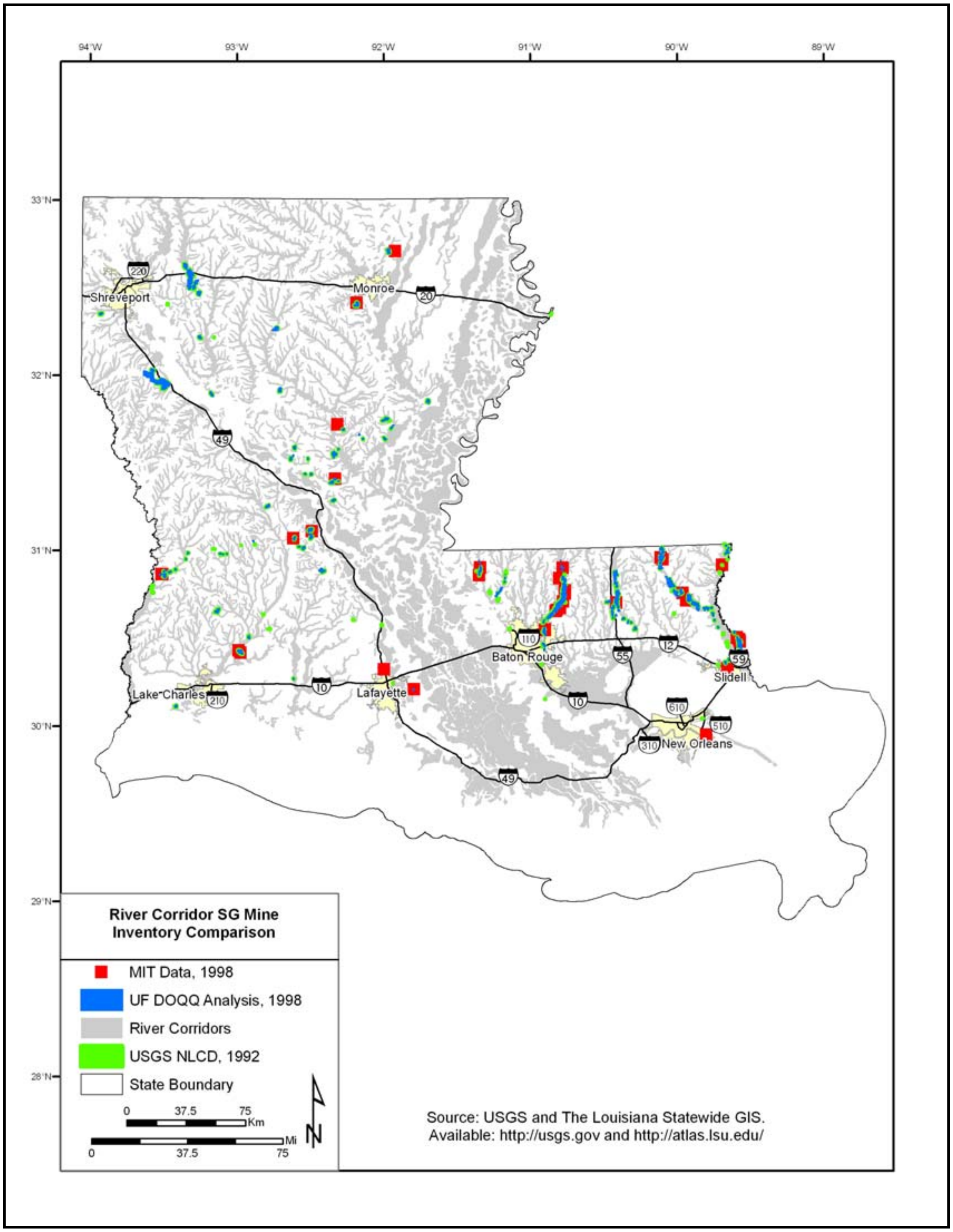

Figure 10. A comparison of mined sites in Louisiana from three different sources.

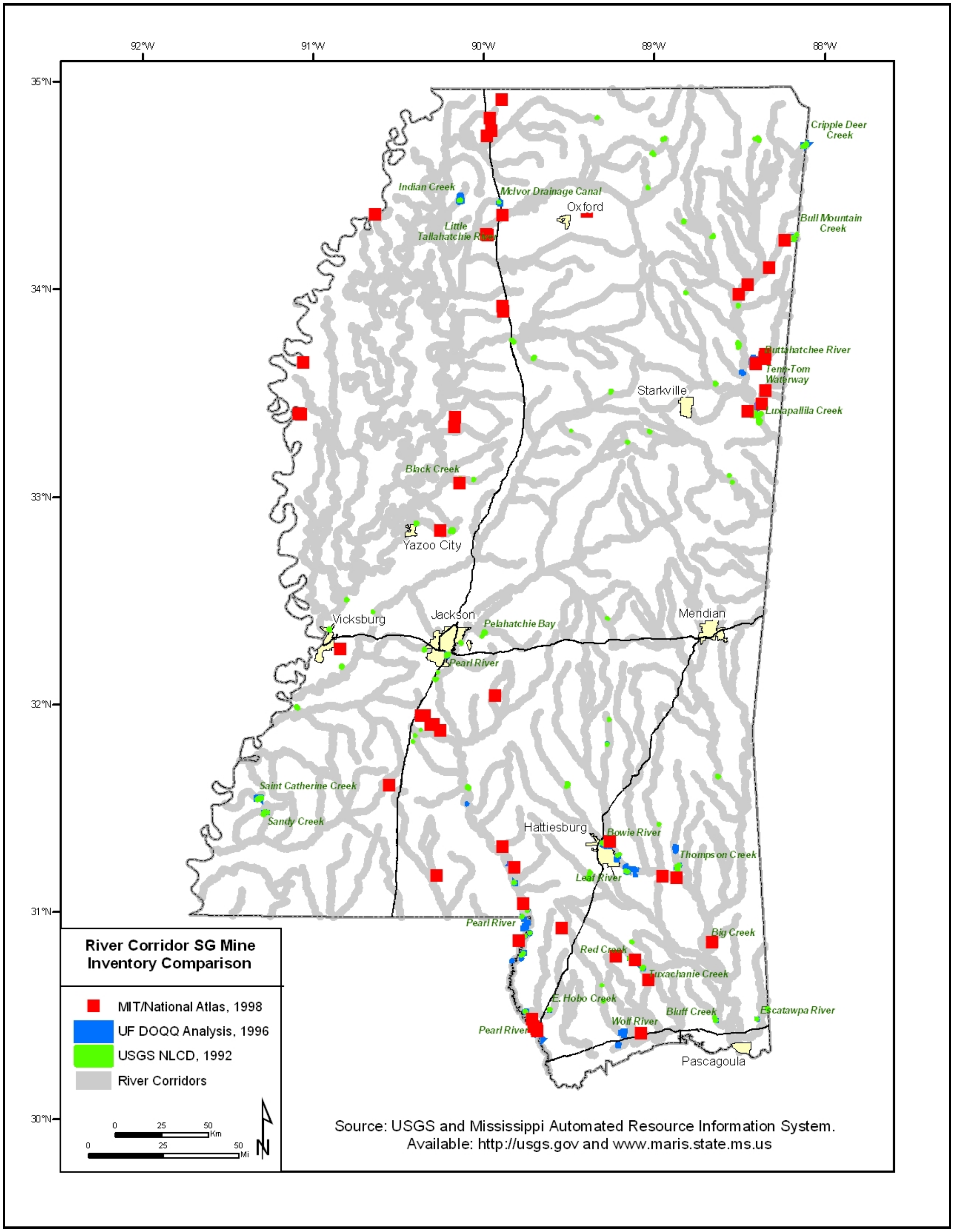

Figure 11 A comparison of mined sites in Mississippi from three different sources.

ACKNOWLEDGEMENTS

This project was supported with funding from the U.S. Geological Survey, Minerals Resources Program. Robert Godfrey and Alexis Villegas assisted with digitizing. The opinions, findings and conclusions expressed in this publication are those of the authors and not necessarily those of the USGS.