Appendix I: Evaluation of Potential for Atrazine to Affect the Three Listed Mussels via Potential Effects to Riparian Vegetation

August 29, 2007

Appendix I: Evaluation of Potential for Atrazine to Affect the Three Listed Mussels via Potential Effects to Riparian Vegetation

I.1 Introduction

Further evaluation of the potential for atrazine to indirectly impact the PCPP mussel, northern riffleshell, and fat pocketbook mussels via potential effects to riparian vegetation was completed. This evaluation is based on an analysis of land cover and use data and the type of riparian vegetation (i.e., grassy versus forested) adjacent to occupied streams. The action area for the fat pocketbook mussel is a large area, encompassing eight states. Therefore, further spatial analysis of land cover data and type of riparian vegetation adjacent to occupied streams for the fat pocketbook was conducted for a number of example watersheds, intended to encompass the range of larger rivers (and surrounding land cover types) that this species inhabits.

Land cover data adjacent to and surrounding occupied watersheds for the three listed mussels were examined to determine the potential for atrazine use and resulting exposure to riparian vegetation. For example, the presence of agricultural crops in the vicinity of surrounding occupied watersheds suggests that atrazine use may occur and that exposure to riparian vegetation is possible. However, the presence of cultivated crops directly adjacent to occupied streams is unlikely to result in sedimentation via impacts to riparian vegetation because no riparian vegetation is present between the agricultural crop margin and the watershed. Further analysis of the type of riparian vegetation (i.e., herbaceous versus forested) adjacent to occupied watersheds was completed via aerial photography for the PCPP mussel and northern riffleshell and via land cover satellite imagery for all listed mussels. As previously discussed, atrazine is not toxic to forested areas containing woody shrubs and trees at levels expected to occur in the environment; therefore, it is unlikely that atrazine will adversely affect these types of riparian vegetation adjacent to use sites and occupied watersheds of the listed mussels.

Based on the information contained in Section 2.5 and Appendix C, the PCPP mussel and northern riffleshell are located in a limited number of watersheds. Table I.1 provides a summary of known current locations of the PCPP mussel and northern riffleshell including the watershed, county, and state in which they occur. As previously mentioned, the fat pocketbook mussel occupies a large area, covering eight states. Given the large range of occupied watersheds, land cover data for a number of example occupied watersheds was evaluated. These watersheds are intended to encompass the range of larger rivers (and surrounding land cover types) occupied by the fat pocketbook mussel.

Table I.1 PCPP Mussel and Northern Riffleshell Locations			
Assessed Mussel	**Watershed**	**State**	**County**
PCPP Mussel	Middle Cumberland River	Tennesee	Smith
	Green River	Kentucky	Warren and Butler
	Killibuck Creek	Ohio	Conshocton
	Walhonding River		
Northern Riffleshell	Fish Creek	Ohio/Indiana	Steuben, DeKalb, and Williams
	Big Darby Creek	Ohio	Union, Madison, Franklin, and Pickaway
	Green River	Kentucky	Warren, Edmonson, Hart, Green Taylor, and Adair
	French Creek (including LeBoeuf Creek and Muddy Creek)	Pennsylvania	Erie, Crawford, Mercer, and Venango
	Allegheny River (including Conewango Creek)	Pennsylvania	Warren, Forest, Venango, Clarion, and Armstrong
	Elk River	West Virginia	Kanawha, Clay, and Braxton
	Detroit River	Michigan	Wayne

Species locations were derived using a mapping process that is an approximation of species' location information from NatureServe data and from information provided by USFWS (summarized in Table I.1). This locational information was matched to stream names from the ERF (enhanced reach file) version 1_2 reach files for those counties where the species has been documented to occur. More detail on the ERF reach files may be found at:

http://www.epa.gov/waters/doc/rfindex.html.

Spatial analysis was completed by comparing landcover data from the 2001 NLCD relative to species' locations. Additional analysis was completed using the ImageConnect toolbar in ArcGIS (available at http://www.globexplorer.com) to provide aerial and satellite imagery. Both analyses were conducted to determine the type of land cover and riparian habitat adjacent to the occupied stream reaches.

Additional analysis was conducted to quantify the proximity of land cover classes adjacent to occupied streams as mapped using information from NatureServe and USFWS. A buffer was applied to each occupied stream reach (for the PCPP mussel and northern riffleshell) in order to identify the specific area associated with the shapefile (streams in the ERF v1_2 are line segments without area). A buffer distance of 100 feet was selected, based on the buffer width of riparian areas required to maintain water quality in aquatic habitats from Fleming et al. (2001). As discussed in Section 5.2.1.5, a buffer width of 18 meters or approximately 60 feet is necessary to maintain excellent

water quality; therefore, use of a 100 foot buffer distance is believed to provide be a conservative approximation of the width of a healthy riparian zone. The buffered stream reach was analyzed using the "Tabulate Area" tool in the Spatial Analyst portion of the ArcToolbox to provide the area of each land cover type from the 2001 NLCD within that zone. This data was then post-processed to provide estimates of the total percentage of each land cover type. The land cover analysis is summarized by area in hectares and by percentage of total area. It should be noted that the land cover classes for developed open, low, medium, and high intensity were aggregated to provide a sense of total developed land, and the classes for deciduous, evergreen, and mixed forests were aggregated similarly for total forested land.

Evaluation of county-level land use data was also completed to provide further information on the likelihood of atrazine use surrounding the occupied watersheds for the PCPP mussel and northern riffleshell. Specifically, the total acreage of each county was obtained from http://www.fedstats.gov, and the percentage of acres of cropland for each county was determined using the following equation: acres cropland/total acres of county. Given that corn and sorghum are representative of the two highest agricultural use patterns for atrazine (see Table 2.2), acreage of corn and sorghum acres harvested within the county were obtained from http://www.ams.usda.gov/statesummaries. Finally, the percentage of total corn and sorghum cropland relative to the entire county was derived to provide an estimation of the likelihood of atrazine use in the counties surrounding occupied watersheds.

If the analysis of land cover data and aerial photography of riparian vegetation described above suggests the potential for atrazine use in proximity to sensitive herbaceous, grassy riparian vegetation, and/or barren areas adjacent to the streams where the three listed mussels occur, a "likely to adversely affect or LAA" determination is made for the species. If, however, land cover data suggest that the extent of potential atrazine exposure to riparian areas is negligible and/or if riparian vegetation adjacent to the streams where the listed mussels occur is not expected to be sensitive to atrazine (i.e., forested areas), a "may affect, but not likely to adversely affect or NLAA" determination is made for the species. These NLAA determinations are based on insignificant effects (ie.., although effects to herbaceous riparian plants may occur, the extent of atrazine use and/or the presence of herbaceous vegetation adjacent to occupied streams/rivers is minimal, and resulting levels of sedimentation cannot be meaningfully measured, detected, or evaluated in the context of a level of effect where "take" occurs for even a single listed mussel. The results of this analysis for the PCPP mussel, northern riffleshell, and fat pocketbook are provided in Sections I.2 and I.4, respectively.

I.2 PCPP Mussel

As noted above, the PCPP mussel has been observed in four creeks/rivers in four counties in Kentucky, Ohio, and Tennessee. A summary of the land cover analysis for the watersheds in the three states in which the PCPP mussel occurs is provided in Table I.2, and county-level data for the PCPP mussel are provided in Table I.3.

Table I.2 Summary of Land cover Classes within 100 feet of Stream/Rivers Occupied by the PCPP Mussel											
Location (State)	**Total Land Area[1]**	**Open Water**	**Developed Land[2]**	**Barren Land**	**Forested Land[3]**	**Shrub/Scrub**	**Herbaceous**	**Hay/Pasture**	**Cultivated Crops**	**Woody Wetland**	**Emergent Herbaceous Wetland**
Area (hectares)											
Middle Cumberland River (TN)	401	140	22	2	180	7	9	127	51	2	1
Green River (KY)	683	47	22	0	273	0	10	79	272	19	7
Walhonding/Kilbuck (OH)	257	44	24	0	91	0	5	42	51	40	3
Percent of Total											
Location (State)	**Total Area**	**Open Water**	**Developed Land[2]**	**Barren Land**	**Forested Land[3]**	**Shrub/Scrub**	**Herbaceous**	**Hay/Pasture**	**Cultivated Crops**	**Woody Wetland**	**Emergent Herbaceous Wetland**
Middle Cumberland River (TN)	100%	NA	6%	0%	45%	2%	2%	32%	13%	0%	0%
Green River (KY)	100%	NA	3%	0%	40%	0%	2%	12%	40%	3%	1%
Walhonding/Kilbuck (OH)	100%	NA	9%	0%	36%	0%	2%	16%	20%	16%	1%

1 – Total land area represents all landcover classes except open water which is excluded from total land area calculation and percentage of land cover class
2 – Developed land is an aggregated of high, medium, and low density developed land and developed open space
3 – Forested land is an aggregate of deciduous, evergreen, and mixed forests

Table I.3. Summary of County-level Cropland Data for the PCPP Mussel				
County (Watershed)	**Square Miles[a]**	**Acres**	**Acres of Cropland[b] (% of total acreage)**	**Acres of corn and sorghum[b] (% of total acreage)**
Smith, TN (Middle Cumberland River)	314	200,960	64,178 (32%)	2,405 (1%)
Warren and Butler, KY (Green River)	793	622,720	252,440 (40%)	43,168 (7%)
Coshocton, OH (Killibuck Creek and Walhonding River)	564	390,960	103,128 (26%)	24,357 (6%)

[a] Total acreage of each county was obtained from http://www.fedstats.gov; percentage of acres cropland for each county was determined using the following equation: acres cropland / total acres of county.
[b] Acreage of corn and sorghum represents the acres harvested from 2002 data from http://www.ams.usda.gov/statesummaries/; percentage of total acreage = acres of corn and sorghum / total acres of county.

In addition, land cover and aerial imagery for the PCPP mussel in occupied streams within Tennessee, Kentucky, and Ohio are depicted in Figures I.1 through I.6.

An evaluation of land cover/use data and aerial imagery for areas/counties surrounding the Middle Cumberland River (TN), the Green River (KY), and Killibuck Creek and Walhonding River (OH) is provided below in Sections I.2.1 through I.2.3, respectively.

I.2.1 Middle Cumberland River, Tennessee

Analysis of the land cover data surrounding occupied reaches of the Middle Cumberland River in Smith County, Tennessee shows that this portion of the watershed is surrounded by a mixture of forested land and hay/pasture[1]. The forested and hay/pasture land cover types represent approximately 77% of the total area of land within 100 feet of the occupied watershed. In contrast, sensitive riparian vegetation (i.e., herbaceous) and barren land account for only 2% of the buffered area surrounding this watershed. The satellite imagery of land cover types and aerial photography, shown in Figures I.1 and I.2, respectively, show that the majority of forested land cover adjacent to the Middle Cumberland River occurs to the east of the city of Carthage, Tennessee, whereas hay/pasture is the dominant land cover type west of Carthage. Further evaluation of county-specific land use data for Smith County shows that approximately 1% of the land use in Smith County (2,405 of the 200,960 acres) was harvested for commodities labeled for atrazine use on corn or sorghum. In addition, the percentage of cultivated crops in the 100 foot buffer surrounding the Middle Cumberland River is low (~ 13%; see Table I.2). The results of this analysis suggest that the extent of riparian areas of the Middle Cumberland River that may be subject to atrazine exposure is minimal. Therefore, potential indirect effects via atrazine-related impacts to riparian areas adjacent to the Middle Cumberland River are expected to be insignificant, such that they cannot be

[1] The hay/pasture land cover class is defined by the NLCD as areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Hay/pasture is not considered as fallow/idle land (agricultural land currently not in production); fallow land classes are grouped under cultivated crop land classes. Therefore, atrazine is not likely to be used on land cover classified as hay/pasture.

meaningfully measured, detected or evaluated in the context of a level of effects where "take" occurs for a single PCPP mussel. The resulting effects determination is "may affect, but not likely to adversely affect or NLAA".

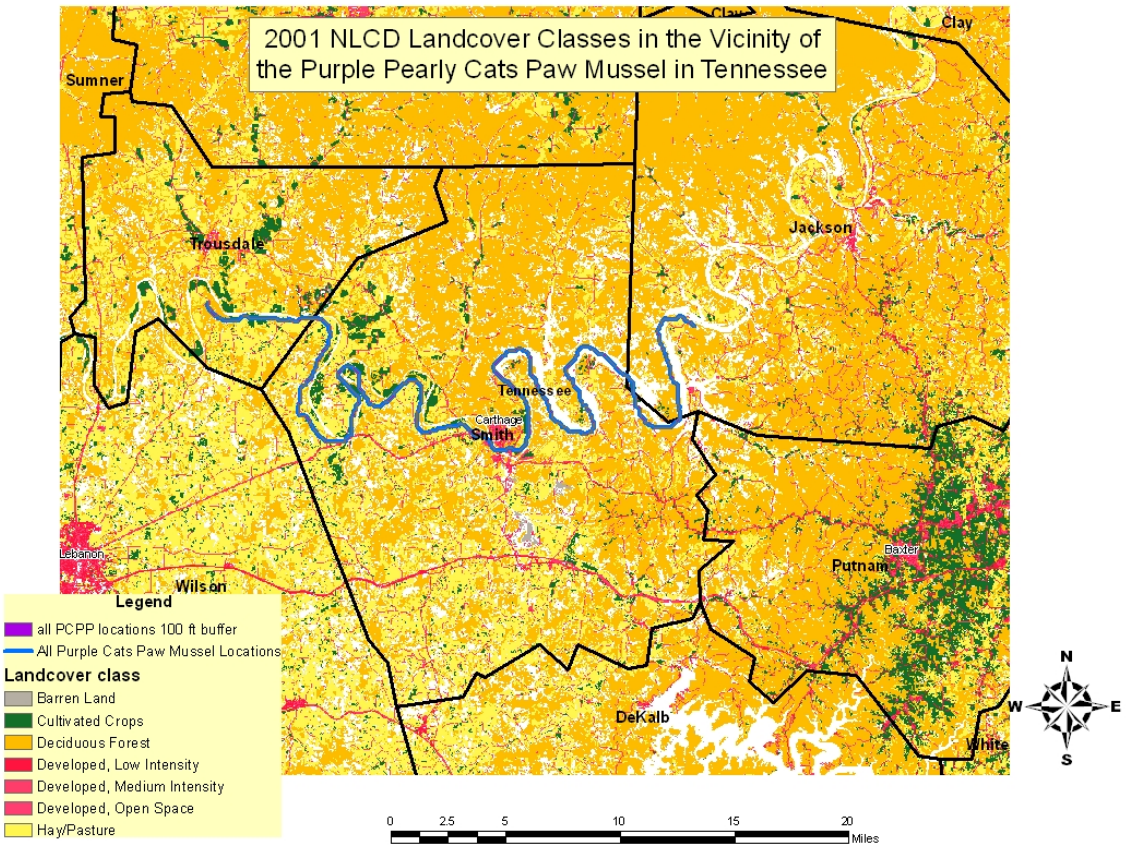

Figure I.1 Location of the PCPP Mussel in the Middle Cumberland River (TN) Relative to 2001 NLCD

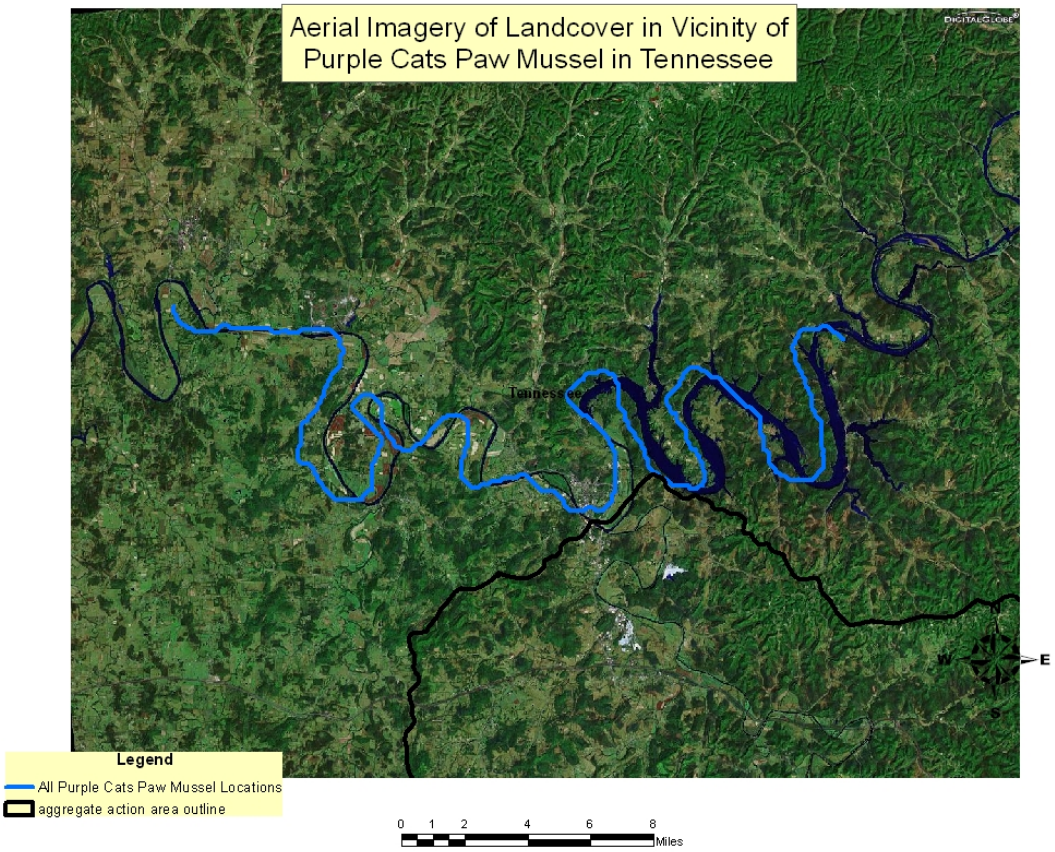

Figure I.2 Location of the PCPP Mussel in the Middle Cumberland River (TN) Relative to Aerial Imagery

I.2.2 Green River, Kentucky

As shown in Table I.2, land cover data surrounding occupied reaches of the Green River in Warren and Butler Counties in Kentucky shows that this portion of the watershed is surrounded by a mixture of forested land and cultivated crops. The percentage of forested and cultivated crop land cover types are equivalent (40%) and represent approximately 80% of the total area of land within 100 feet of the occupied watershed. Evaluation of the aerial satellite imagery in Figures I.3 and I.4 shows that the majority of cultivated crop land cover is directly adjacent to the Green River. Futhermore, sensitive riparian vegetation (i.e., herbaceous) and barren land account for only 1% of the buffered area surrounding the Green River. Therefore, the presence of cultivated crops directly adjacent to occupied streams is unlikely to impact riparian vegetation because little, if any, sensitive riparian vegetation is present. In addition, county-level land use data for Warren and Butler Counties indicates that corn and sorghum acreage represent only 9% of the total county acreage. Potential indirect effects via atrazine-related impacts to riparian vegetation adjacent to the Green River are not expected, based on an analysis of land cover and use data, as well as aerial photography. Therefore, potential indirect effects via atrazine-related impacts to riparian areas adjacent to the Green River are

expected to be insignificant, such that they cannot be meaningfully measured, detected or evaluated in the context of a level of effects where "take" occurs for a single PCPP mussel. Atrazine is not likely to adversely affect PCPP mussels in the Green River via effects to riparian vegetation, and the resulting effects determination is "may affect, but not likely to adversely affect or NLAA".

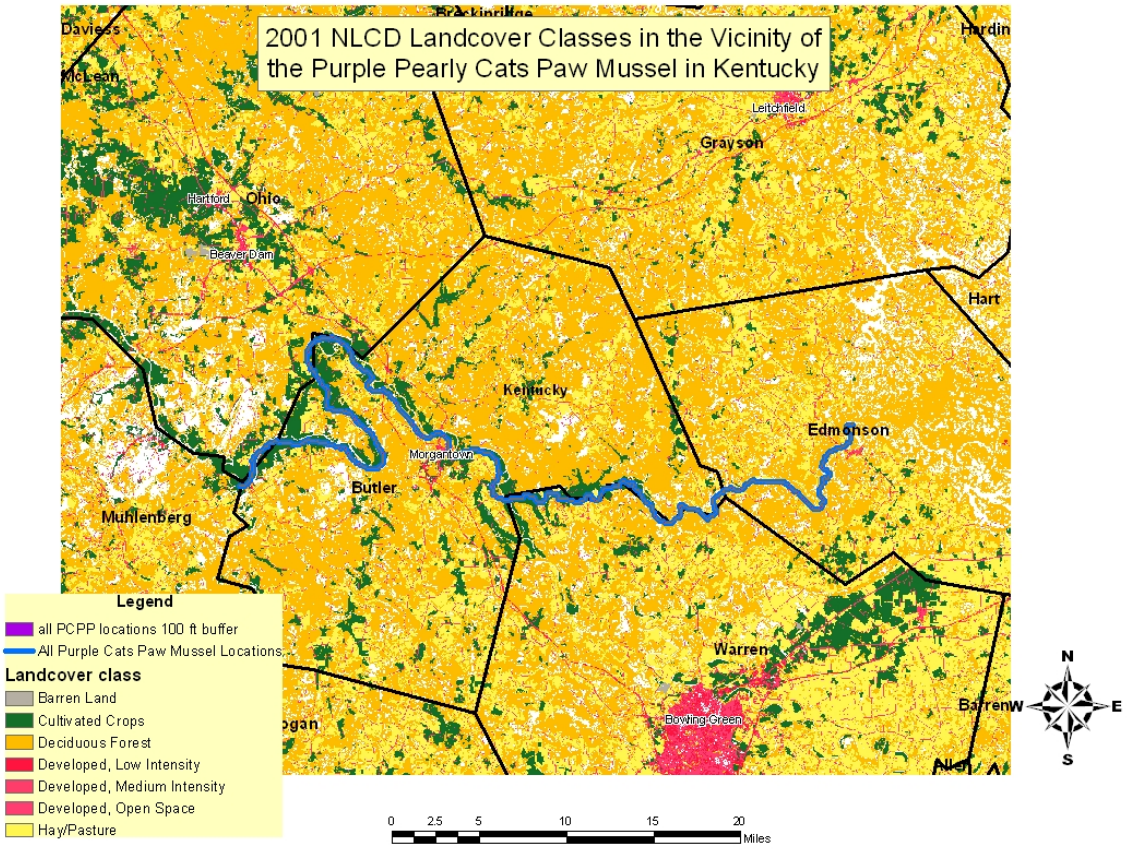

Figure I.3 Location of PCPP Mussel in the Green River (KY) Relative to 2001 NLCD

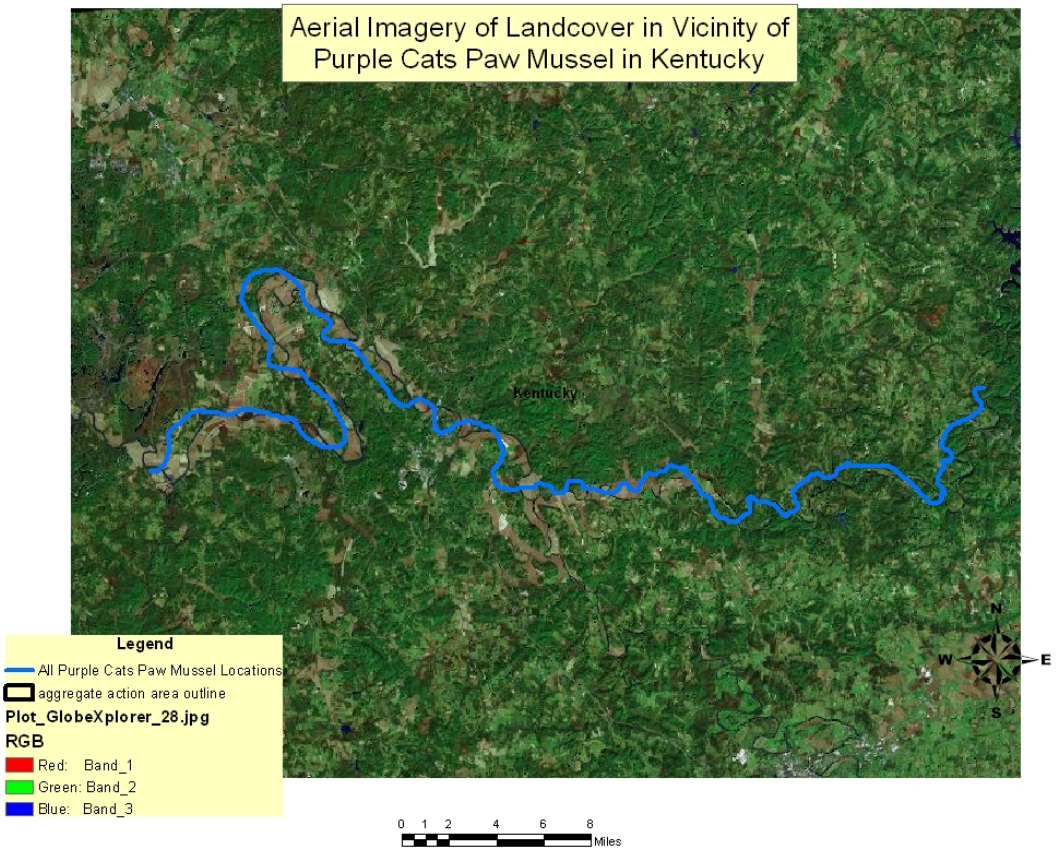

Figure I.4 Location of the PCPP Mussel in the Green River (KY) Relative to Aerial Imagery

I.2.3 Walhonding River and Killibuck Creek, Ohio

Analysis of the land cover data surrounding occupied reaches of the Walhonding River and Killibuck Creek in Conshocton County, Ohio shows that this portion of the watershed is surrounded by a mixture of forested land and cultivated crop. The forested and cultivated crop land cover types represent approximately 56% of the total area of land within 100 feet of the occupied watershed. In addition, woody wetland land cover accounts for approximately 16% of the total area. In contrast, sensitive riparian vegetation (i.e., herbaceous) and barren land account for only 1% of the buffered area surrounding the occupied watersheds. The satellite imagery of land cover types and aerial photography, shown in Figures I.5 and I.6, respectively, show that the majority of cultivated crop land cover is directly adjacent to the occupied watersheds. Further evaluation of county-specific land use data for Conshocton County shows that approximately 6% of the land use was harvested for commodities labeled for atrazine use on corn or sorghum. In addition, the percentage of cultivated crops in the 100 foot buffer surrounding the two occupied watersheds in only 20%). Potential indirect effects via atrazine-related impacts to riparian vegetation adjacent to Walhonding River and Killibuck Creek are not expected, given the low percentage of sensitive herbaceous

riparian vegetation and spatial analysis of surrounding land cover and use data. Potential indirect effects via atrazine-related impacts to riparian areas adjacent to these occupied watersheds are expected to be insignificant (i.e., cannot be meaningfully measured, detected or evaluated in the context of a level of effects where "take" occurs for a single PCPP mussel). Therefore, atrazine is not likely to adversely affect PCPP mussels in Walhonding River and Killibuck Creek via effects to riparian vegetation, and the resulting effects determination is "may affect, but not likely to adversely affect or NLAA".

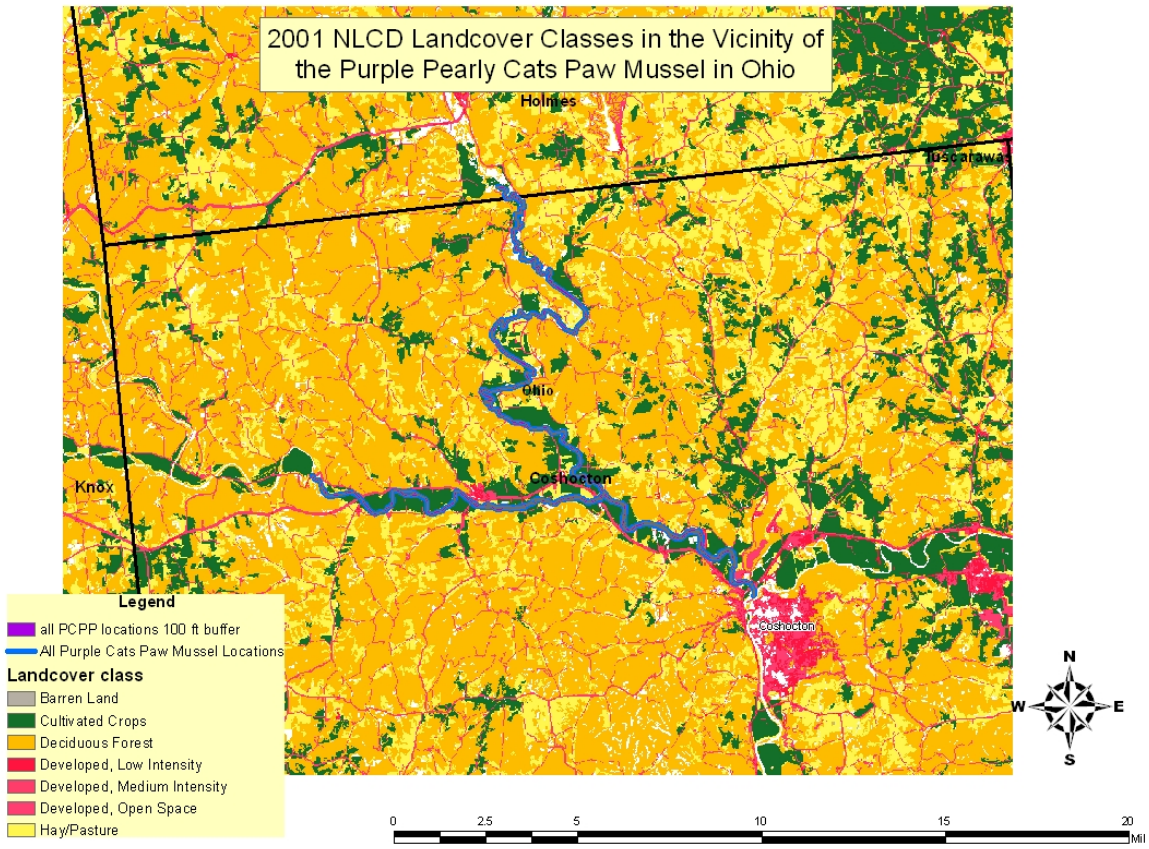

Figure I.5 Location of PCPP Mussel in Killibuck Creek and Walhonding River (OH) Relative to 2001 NLCD

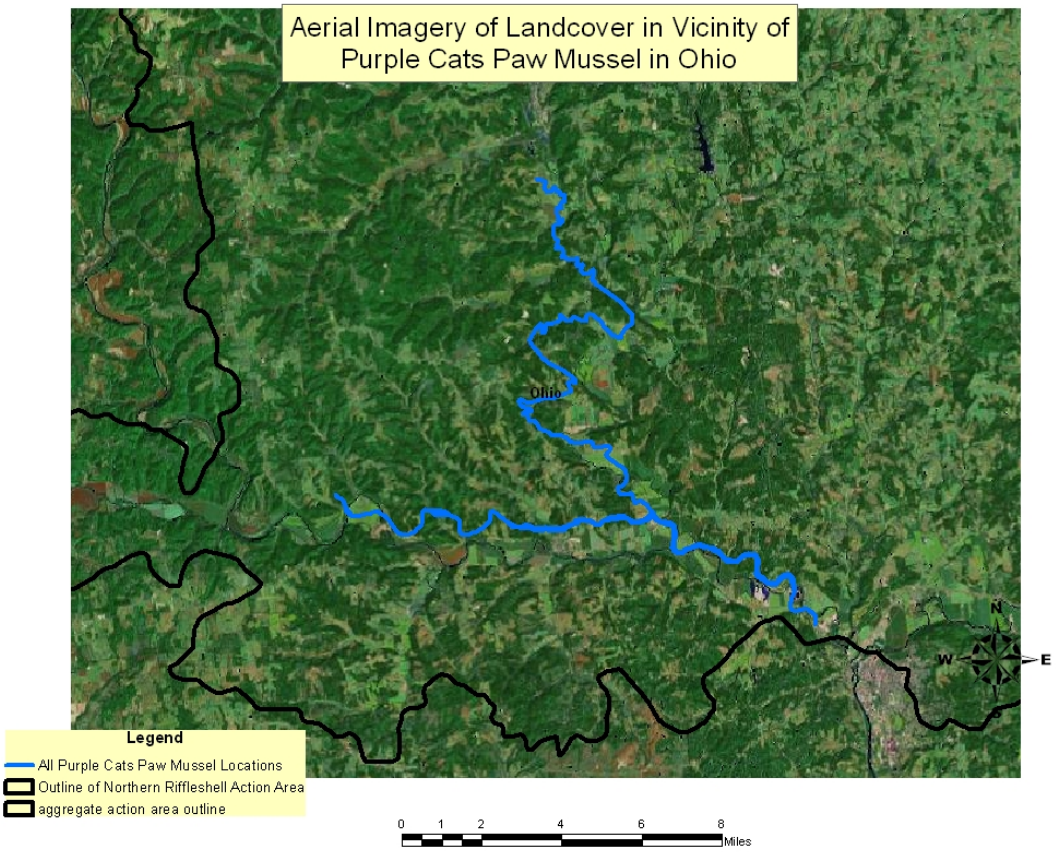

Figure I.6 Location of PCPP Mussel in Killibuck Creek and Walhonding River (OH) Relative to Aerial Imagery

I.3 Northern Riffleshell

As shown in Table I.1, the northern riffleshell has been observed in ten creeks/rivers in Ohio, Indiana, Kentucky, Pennsylvania, West Virginia, and Michigan. A summary of the land cover analysis for the watersheds in which the northern riffleshell occurs is provided in Table I.4. County-level land use data are summarized for the northern riffleshell in Table I.5. In addition, land cover and aerial imagery for the northern riffleshell in occupied streams are depicted in Figures I.7 through I.18.

An evaluation of land cover/use data and aerial imagery for areas/counties surrounding occupied streams and rivers of the northern riffleshell mussel in Fish Creek, Big Darby Creek, Green River, French Creek (including LeBoeuf Creek and Muddy Creek), Allegheny River (including Conewango Creek), Elk River, and Detroit River is provided below in Sections I.3.1 through I.3.7, respectively.

Table I.4 Summary of Land cover Classes within 100 feet of Stream/Rivers Occupied by the Northern Riffleshell											
Location (State)	**Total Land Area[1]**	**Open Water**	**Developed Land[2]**	**Barren Land**	**Forested Land[3]**	**Shrub/Scrub**	**Herbaceous**	**Hay/Pasture**	**Cultivated Crops**	**Woody Wetland**	**Emergent Herbaceous Wetland**
Area (hectares)											
Fish Creek (OH/IN)	272	2	15	0	20	0	3	91	84	57	0
Big Darby Creek (OH)	596	13	64	0	115	0	7	45	351	1	1
Green River (KY)	1604	80	62	1	837	1	55	409	138	19	2
French Creek (PA)	637	27	103	0	304	5	13	46	93	36	12
Allegheny River (PA)	1750	428	246	4	939	5	8	36	14	50	19
Elk River (WV)	991	56	184	1	712	0	11	20	7	0	0
Detroit River (MI)	43	41	2	0	0	0	0	0	0	0	0
Percent of Total											
Location	**Total Area**	**Open Water**	**Developed Land[2]**	**Barren Land**	**Forested Land[3]**	**Shrub/Scrub**	**Herbaceous**	**Hay/Pasture**	**Cultivated Crops**	**Woody Wetland**	**Emergent Herbaceous Wetland**
Fish Creek (OH/IN)	100	NA	6	0	7	0	1	34	31	21	0
Big Darby Creek (OH)	100	NA	11	0	20	0	1	8	60	0	0
Green River (KY)	100	NA	4	0	55	0	4	27	9	1	0
French Creek (PA)	100	NA	17	0	50	1	2	7	15	6	2
Allegheny River (PA)	100	NA	19	0	71	0	1	3	1	4	1

Table I.4 Summary of Land cover Classes within 100 feet of Stream/Rivers Occupied by the Northern Riffleshell											
Location (State)	**Total Land Area[1]**	**Open Water**	**Developed Land[2]**	**Barren Land**	**Forested Land[3]**	**Shrub/Scrub**	**Herbaceous**	**Hay/Pasture**	**Cultivated Crops**	**Woody Wetland**	**Emergent Herbaceous Wetland**
Elk River (WV)	100	NA	20	0	76	0	1	2	1	0	0
Detroit River (MI)	100	95	5	0	0	0	0	0	0	0	0

1 – Total land area represents all landcover classes except open water which is excluded from total land area calculation and percentage of land cover class
2 – Developed land is an aggregated of high, medium, and low density developed land and developed open space
3 – Forested land is an aggregate of deciduous, evergreen, and mixed forests

Table I.5. Summary of County-level Cropland Data for the Northern Riffleshell				
County (Watershed)	**Square Miles[a]**	**Acres**	**Average Acres of Cropland[b] (% of total acreage)**	**Average Acres of corn and sorghum[b] (% of total acreage)**
Steuben, DeKalb (IN) and Williams (OH) **Fish Creek**	1093	699,738	421,059 (60%) County range = 46 - 66%	116,319 (17%) County range = 14 - 19%
Union, Madison, Franklin, and Pickaway (OH) **Big Darby Creek**	1944	1,244,077	766,752 (62%) County range = 19 – 82%	222,276 (18%) County range = 5 – 26%
Warren, Edmonson, Hart, Green, Taylor, and Adair (KY) **Green River**	2233	1,429,178	568,816 (40%) County range = 25 – 49%	51,625 (4%) County range = 1 – 9%
Erie, Crawford, Mercer, and Venago (PA) **French Creek**	3162	2,023,379	381,011 (19%) County range = 7 – 25%	92,357 (5%) County range = 2 – 7%
Warren, Forest, Venago, Clarion, and Armstrong (PA) **Allegheny River**	3243	2,075,507	222,117 (11%) County range = 1 – 20%	37,566 (2%) County range = 0 – 3%
Kanawha, Clay, and Braxton (WV) **Elk River**	1759	1,125,747	30,844 (3%) County range = 1 – 6%	34 (0.003%) County range = 0 – 0.01%
Wayne (MI) **Detroit River**	614	393,056	2,350 (1%)	2,350 (1%)

[a] Total acreage of each county was obtained from http://www.fedstats.gov; percentage of acres cropland for each county was determined using the following equation: acres cropland / total acres of county. The average and range of county-level percentages of total cropland are provided for those watersheds that occur in multiple counties.

[b] Acreage of corn and sorghum represents the acres harvested from 2002 data from http://www.ams.usda.gov/statesummaries/; percentage of total acreage = acres of corn and sorghum / total acres of county. The average and range of county-level percentages of total corn and sorghum crops are provided for those watersheds that occur in multiple counties.

I.3.1 Fish Creek, Ohio and Indiana

Analysis of the land cover data surrounding occupied reaches of Fish Creek in Indiana (Steuben and De Kalb Counties) and Ohio (Williams County) shows that this portion of the watershed is surrounded by a mixture of hay/pasture and cultivated crop. The hay/pasture and cultivated crop land cover types represent approximately 65% of the total area of land within 100 feet of the occupied watershed. In addition, there appears to be a significant amount (21%) of woody wetland adjacent to Fish Creek as compared with a low percentage (1%) of sensitive riparian vegetation (i.e., herbaceous) and barren land. The satellite imagery of land cover types and aerial photography, shown in Figures I.7 and I.8, respectively, confirms the presence of cultivated crops and hay/pasture land cover types immediately surrounding Fish Creek. Further evaluation of county-specific land use data shows that approximately 17% of the land use in Steuben, De Kalb, and Williams Counties (116,319 of the 699,738 acres) was harvested for commodities labeled for atrazine use on corn or sorghum, with a fairly consistent range of this type of land use across the three counties (14 to 19%). Given the large spatial scale of the watershed, it is not possible to accurately determine whether the cultivated crops are directly adjacent to Fish Creek or separated from the watershed by riparian vegetation. However, based on the results of the land cover data, it appears that the dominant riparian land cover is comprised of woody wetlands, rather than sensitive herbaceous vegetation or bare ground. Therefore, atrazine use in the counties surrounding French Creek is unlikely to affect populations of northern riffleshell mussels via direct effects to sensitive riparian vegetation. Potential indirect effects via atrazine-related impacts to riparian areas adjacent to Fish Creek are expected to insignificant, such that take of a single listed northern riffleshell mussel in this watershed cannot be meaningfully measured, detected, or evaluated. Therefore, atrazine is not likely to adversely affect northern riffleshell mussels in French Creek via effects to riparian vegetation, and the resulting effects determination is “may affect, but not likely to adversely affect or NLAA”.

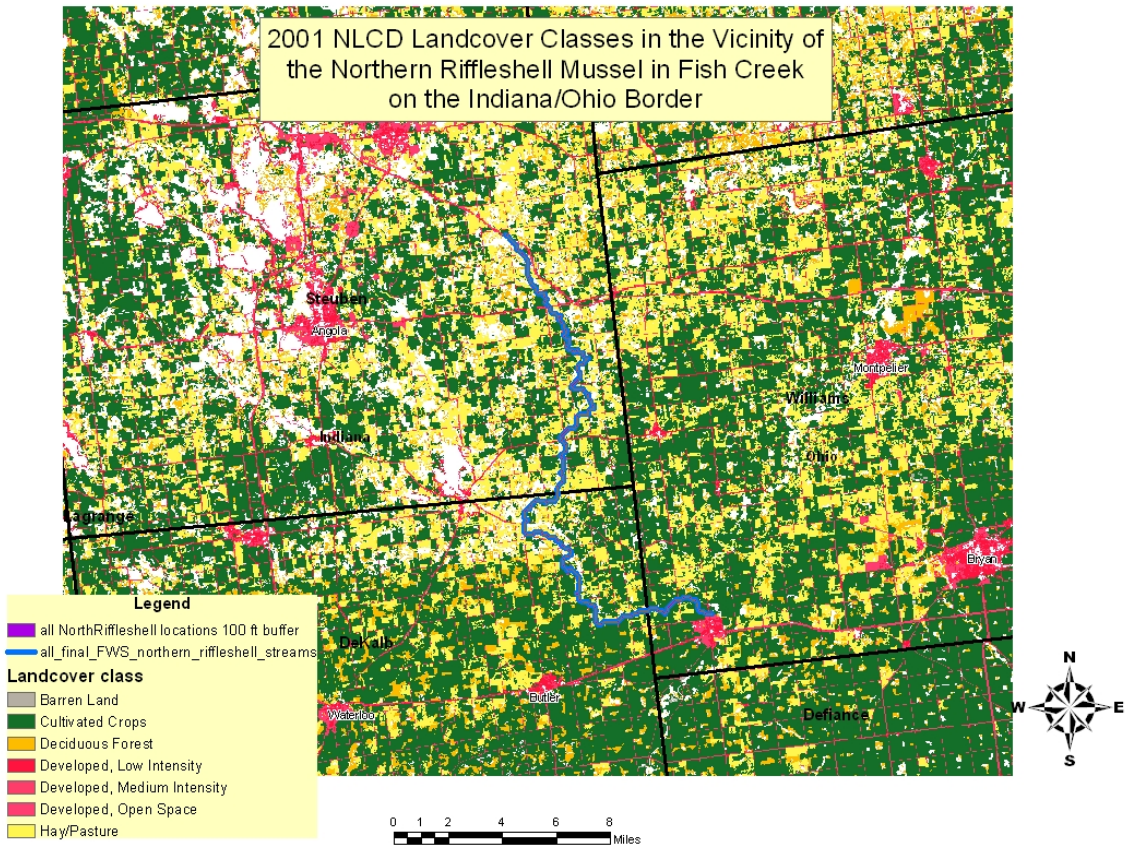

Figure I.7 Location of Northern Riffleshell Mussel in Fish Creek on the Ohio/Indiana Border Relative to 2001 NLCD

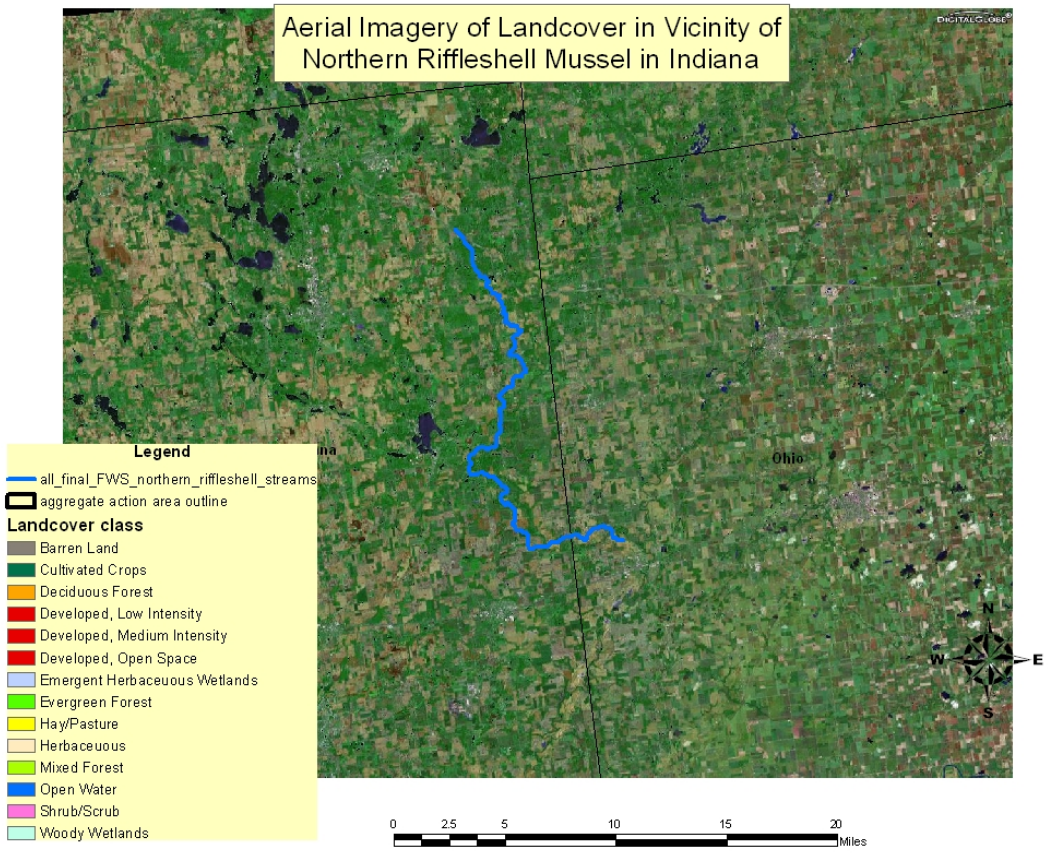

Figure I.8 Location of Northern Riffleshell Mussel in Fish Creek on the Ohio/Indiana Border Relative to Aerial Imagery

I.3.2 Big Darby Creek, Ohio

As shown in Table I.4, land cover data surrounding occupied reaches of Big Darby Creek in Union, Madison, Franklin, and Pickaway Counties in Ohio shows that this watershed is surrounded by a mixture of cultivated crops and forested lands. The percentage of cultivated crop and forested land cover types is 60% and 20%, respectively, of the total area of land within 100 feet of Big Darby Creek. Developed land (near Columbus, Ohio) and hay/pasture also account for approximately 11% and 8%, respectively, of the land cover within this area. Evaluation of the land cover imagery in Figure I.9 (and to a lesser extent the aerial imagery in Figure I.10) indicates that much of the forested land cover is located adjacent to Big Darby Creek. Futhermore, sensitive riparian vegetation (i.e., herbaceous) and barren land account for only 1% of the buffered area surrounding Big Darby Creek. County-level land use data shows that corn and sorghum acreage represent approximately 18% of the total acreage for the four counties surrounding Big Darby Creek. Although cultivated crops represent the majority of land cover surrounding Big Darby Creek, it appears that much of the riparian vegetation consists of forested land, rather than sensitive herbaceous vegetation and/or barren land. Potential indirect effects via atrazine-related impacts to riparian vegetation adjacent to Big Darby Creek are

expected to be insignificant (i.e., cannot be meaningfully measured, detected or evaluated in the context of a level of effects where "take" occurs for a single northern riffleshell), based on an analysis of land cover and use data. Therefore, atrazine is not likely to adversely affect the northern riffleshell in Big Darby Creek via effects to riparian vegetation, and the resulting effects determination is "may affect, but not likely to adversely affect or NLAA".

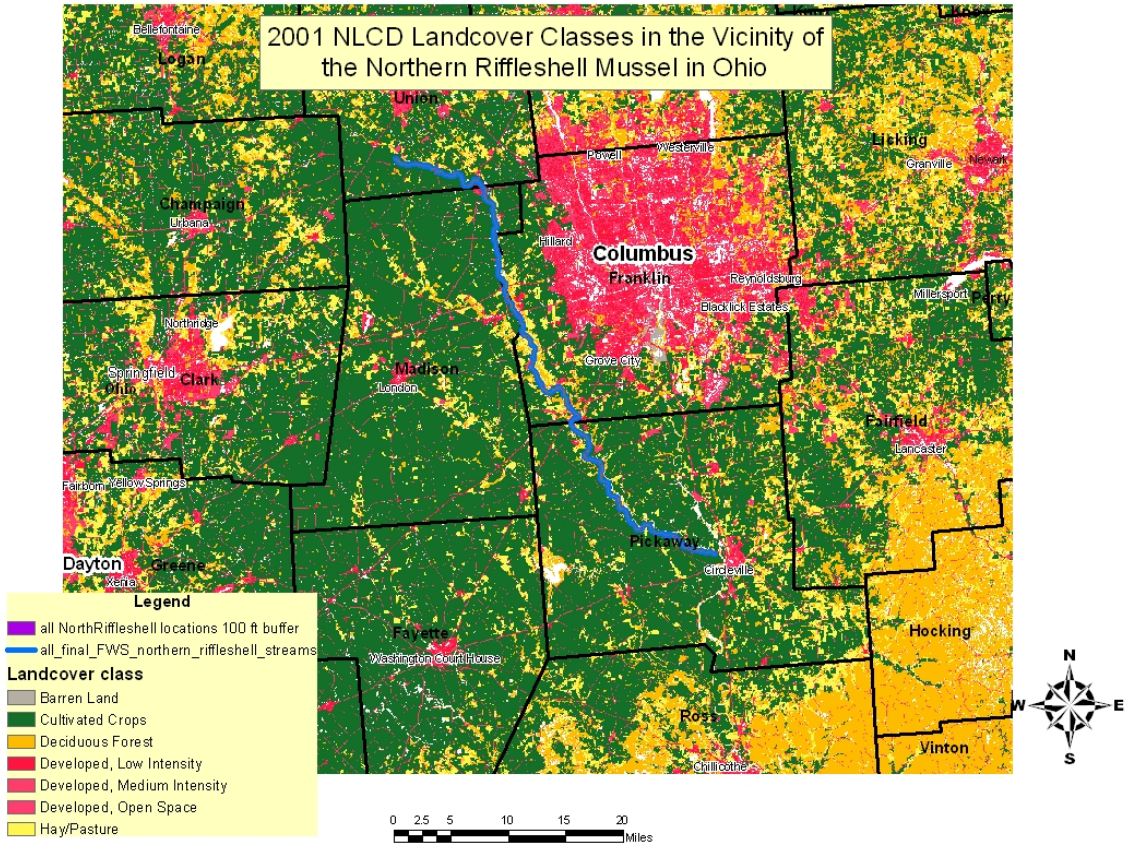

Figure I.9 Location of Northern Riffleshell Mussel in Big Darby Creek (OH) Relative to 2001 NLCD

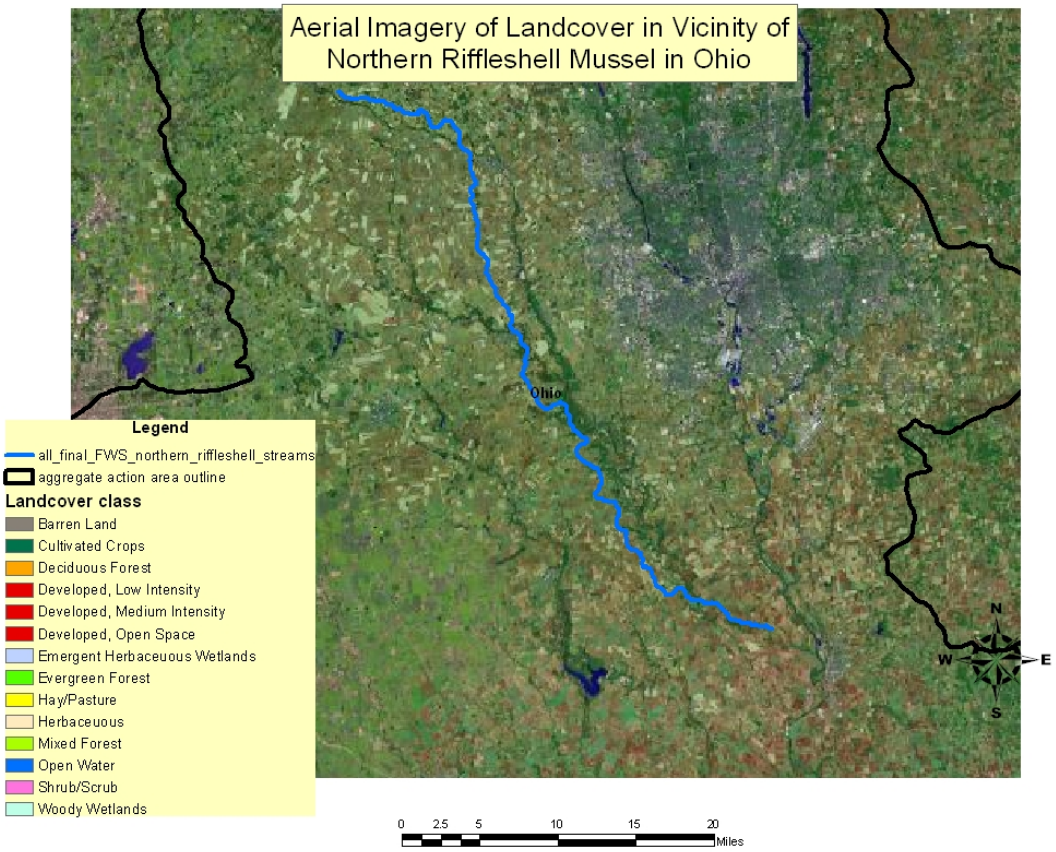

Figure I.10 Location of Northern Riffleshell Mussel in Big Darby Creek (OH) Relative to Aerial Imagery

I.3.3 Green River, Kentucky

Land cover data surrounding occupied reaches of the Green River in Kentucky shows that this portion of the watershed is surrounded by a mixture of forested land and hay/pasture. The respective percentages of forested and hay/pasture land cover types are approximately 55% and 27% of the total area of land within 100 feet of the Green River. In contrast, sensitive riparian vegetation (i.e., herbaceous) and barren land account for only 4% of the buffered area surrounding the Green River. Evaluation of the aerial satellite imagery in Figures I.11 and I.12 confirms that the majority of land cover surrounding the Green River is comprised of forested and hay/pasture land. In addition, the percentage of cultivated crops in the 100 foot buffer surrounding the Green River is low (~ 9%; see Table I.4). Further evaluation of the county-level land use data substantiates the low occurrence of cropland relative to the Green River, with corn and sorghum acreage representing only 4% of the total acreage for the six counties (i.e., Warren, Edmonson, Hart, Green, Taylor, and Adair) surrounding the watershed. The results of this analysis suggest that the extent of riparian areas of the Green River that may be subject to atrazine exposure is minimal. Futhermore, sensitive riparian vegetation (i.e., herbaceous) and barren land account for only 4% of the buffered area

surrounding this watershed. Potential indirect effects via atrazine-related impacts to riparian vegetation adjacent to the Green River are not expected, based on an analysis of land cover and use data, as well as aerial photography. Therefore, potential indirect effects via atrazine-related impacts to riparian areas adjacent to the Green River are expected to be insignificant (i.e., cannot be meaningfully measured, detected or evaluated in the context of a level of effects where "take" occurs for a single northern riffleshell). Therefore, atrazine is not likely to adversely affect northern riffleshell mussels in the Green River via effects to riparian vegetation, and the resulting effects determination is "may affect, but not likely to adversely affect or NLAA".

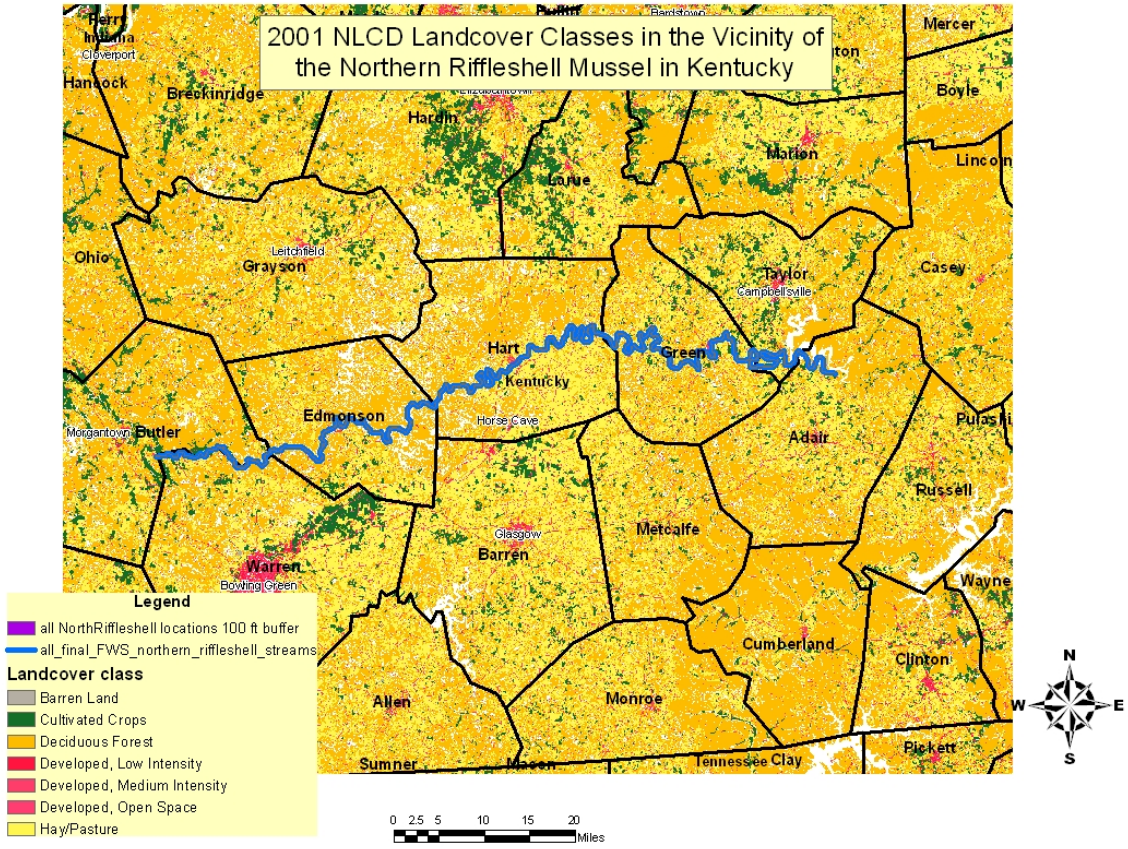

Figure I.11 Location of Northern Riffleshell Mussel in the Green River (KY) Relative to 2001 NLCD

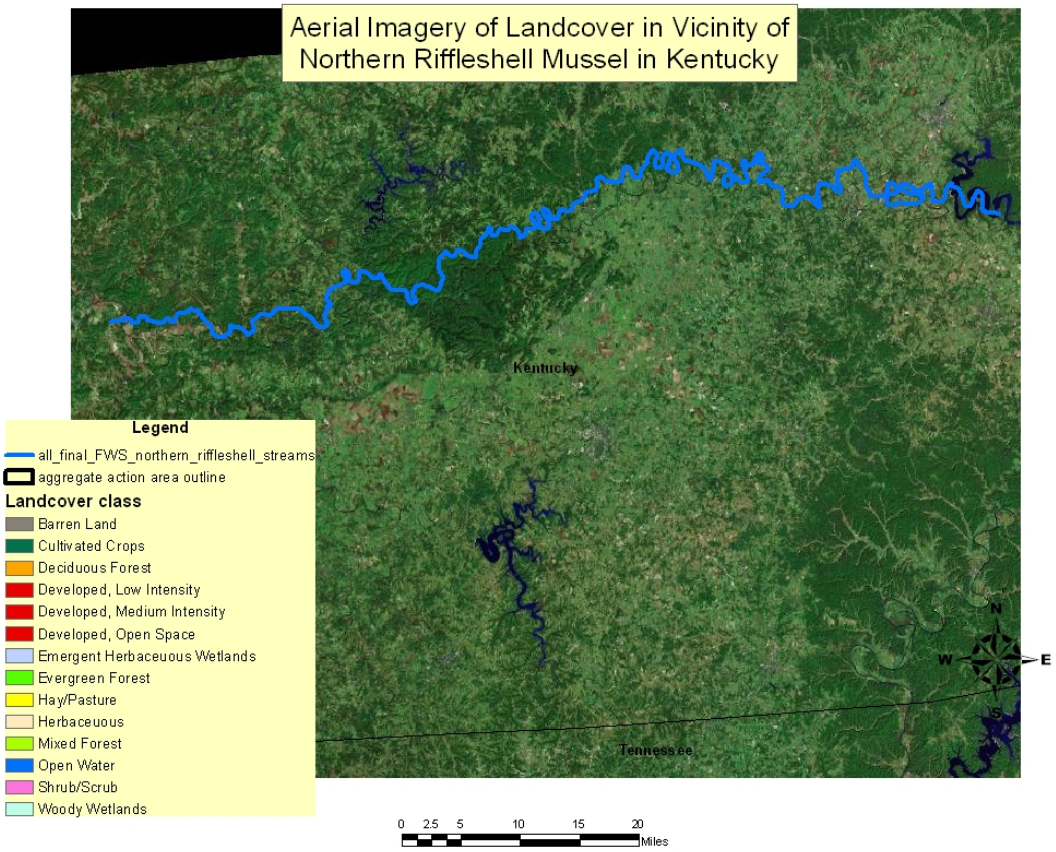

Figure I.12 Location of Northern Riffleshell Mussel in the Green River (KY) Relative to Aerial Imagery

I.3.4 French Creek, Pennsylvania

Analysis of the land cover data within 100 feet of occupied reaches of French Creek (including LeBoeuf Creek and Muddy Creek) in Erie, Crawford, Mercer, and Venango Counties in Pennsylvania shows that this watershed is predominantly surrounded by forested land (50%), with smaller percentages of cultivated crop (15%) and developed land (17%) cover. In addition, woody wetland land cover accounts for approximately 6% of the total area. Sensitive riparian vegetation (i.e., herbaceous) and barren land account for only 2% of the buffered area surrounding the occupied watersheds. The satellite imagery of land cover types and aerial photography, shown in Figures I.13 and I.14, respectively, also shows that the majority of land cover directly adjacent to French Creek is comprised of forested land. Further evaluation of county-specific land use data for the four counties surrounding French Creek shows that only 2% of the land use (37,566 of approximately 2 million acres) was harvested for commodities labeled for atrazine use on corn or sorghum. In addition, the percentage of cultivated crops within the 100 foot buffer surrounding the occupied watersheds is 15%). Potential indirect effects via atrazine-related impacts to riparian vegetation adjacent to French Creek (including LeBoeuf Creek and Muddy Creek) are not expected, given the low percentage of

sensitive herbaceous riparian vegetation and spatial analysis of surrounding land cover and use data. Potential indirect effects via atrazine-related impacts to riparian areas adjacent to these occupied watersheds are expected to be insignificant, such that take of a single listed northern riffleshell mussel is not anticipated. Therefore, atrazine is not likely to adversely affect northern riffleshell mussels in French Creek (including LeBoeuf Creek and Muddy Creek) via effects to riparian vegetation, and the resulting effects determination is "may affect, but not likely to adversely affect or NLAA".

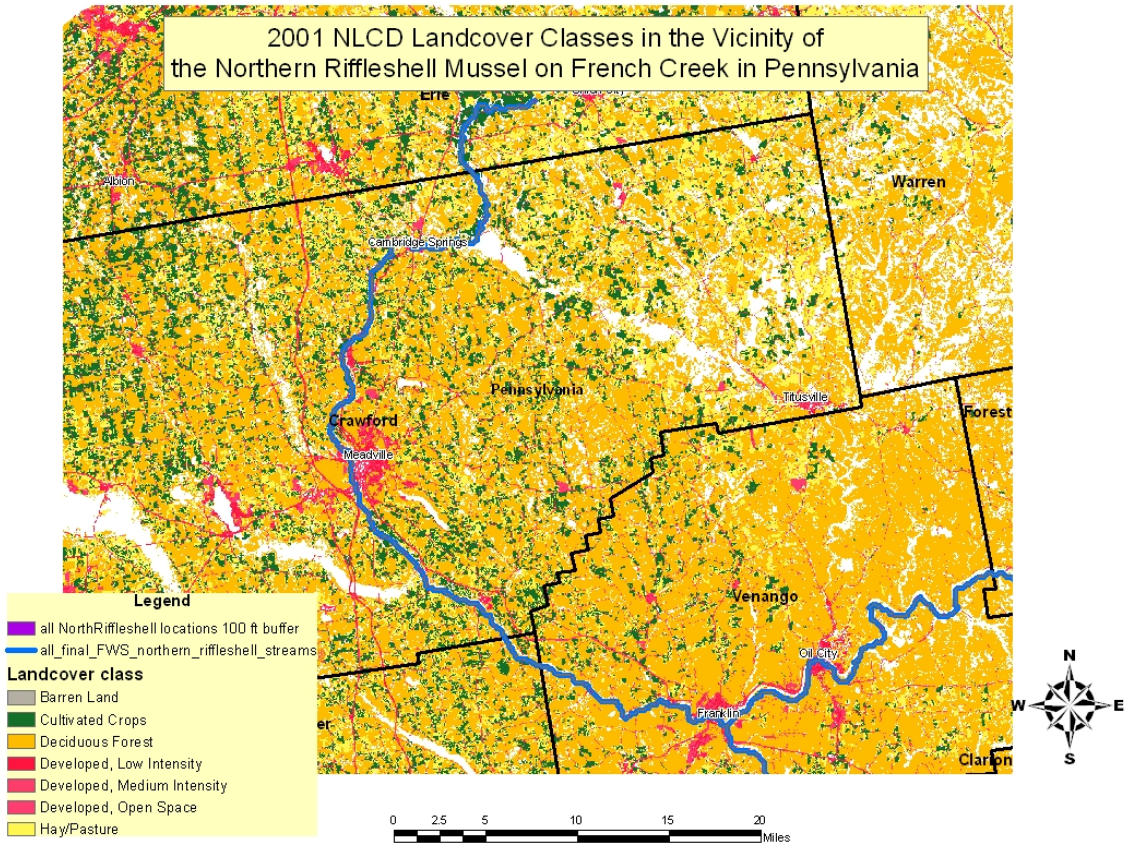

Figure I.13 Location of Northern Riffleshell Mussel in French Creek (PA) Relative to 2001 NLCD

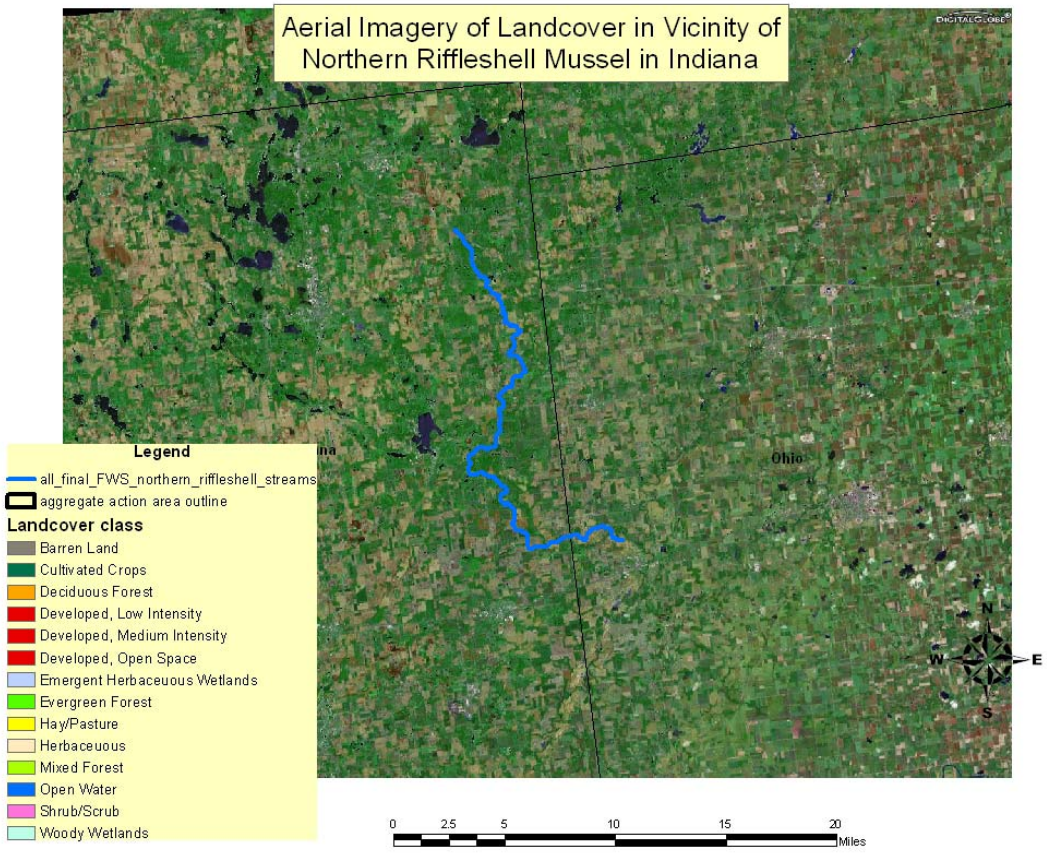

Figure I.14 Location of Northern Riffleshell Mussel in French Creek (PA) Relative to Aerial Imagery

I.3.5 Allegheny River, Pennsylvania

Land cover data within 100 feet of occupied reaches of the Allegheny River (including Conewango Creek) in Warren, Forest, Venango, Clarion, and Armstrong Counties in Pennsylvania shows that the majority of the watershed is surrounded by forested land (71%), with smaller areas of developed land (19%) and woody wetland (4%). Evaluation of the aerial land cover and satellite imagery in Figures I.15 and I.16 shows that forested land cover dominates the area surrounding this watershed. In addition, sensitive riparian vegetation (i.e., herbaceous) and barren land account for only 1% of the buffered 100 foot area surrounding Allegheny River and Conewango Creek. County-level land use data shows that corn and sorghum acreage represent only 2% (37,566 out of approximately 2 million acres) of the total acreage for the five counties surrounding Allegheny River. Therefore, the extent of riparian areas of the Allegheny River that may be subject to atrazine exposure is expected to be minimal. Potential indirect effects via atrazine-related impacts to riparian vegetation adjacent to the Allegheny River, including Conewango Creek, are not expected, based on an analysis of land cover and county-level use data, as well as aerial photography. Therefore, potential indirect effects via atrazine-related impacts to riparian areas adjacent to the Allegheny River and Conewango Creek

are expected to be insignificant (i.e., cannot be meaningfully measured, detected or evaluated in the context of a level of effects where "take" occurs for a single northern riffleshell). The resulting effects determination is "may affect, but not likely to adversely affect or NLAA".

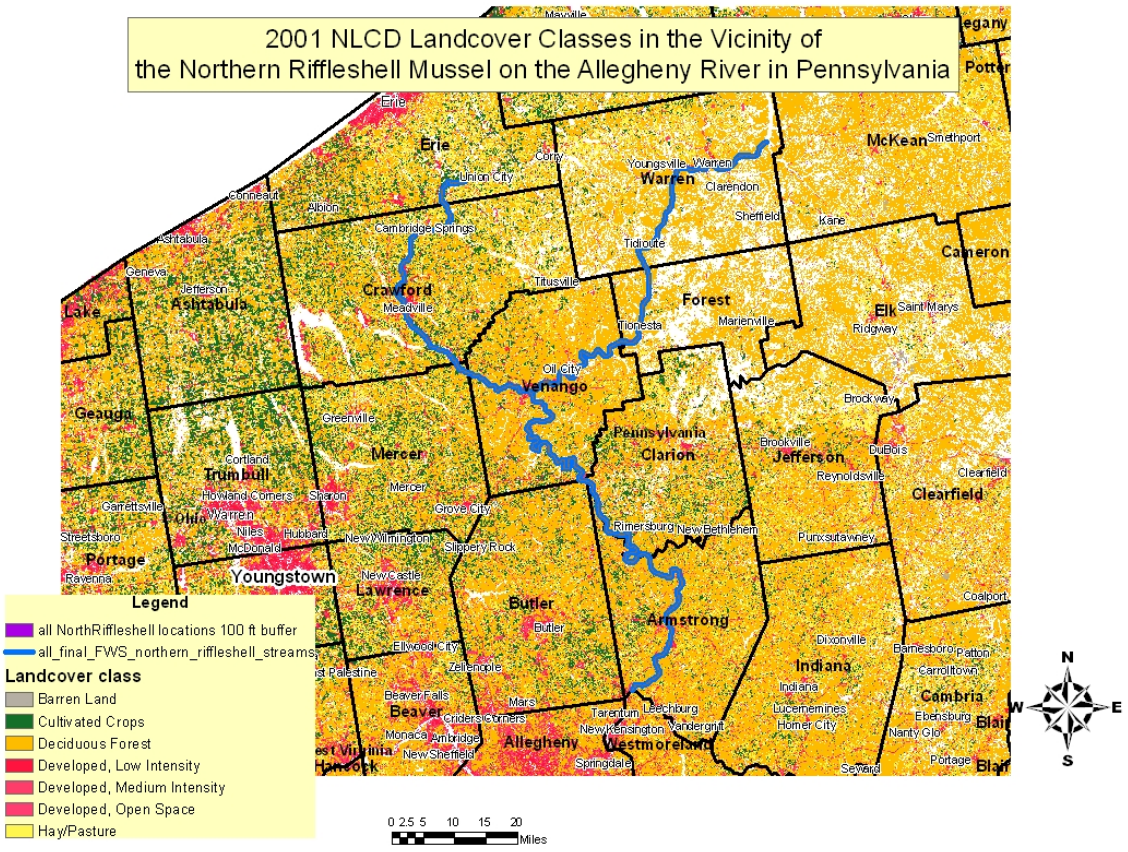

Figure I.15 Location of Northern Riffleshell Mussel in the Allegheny River (PA) Relative to 2001 NLCD

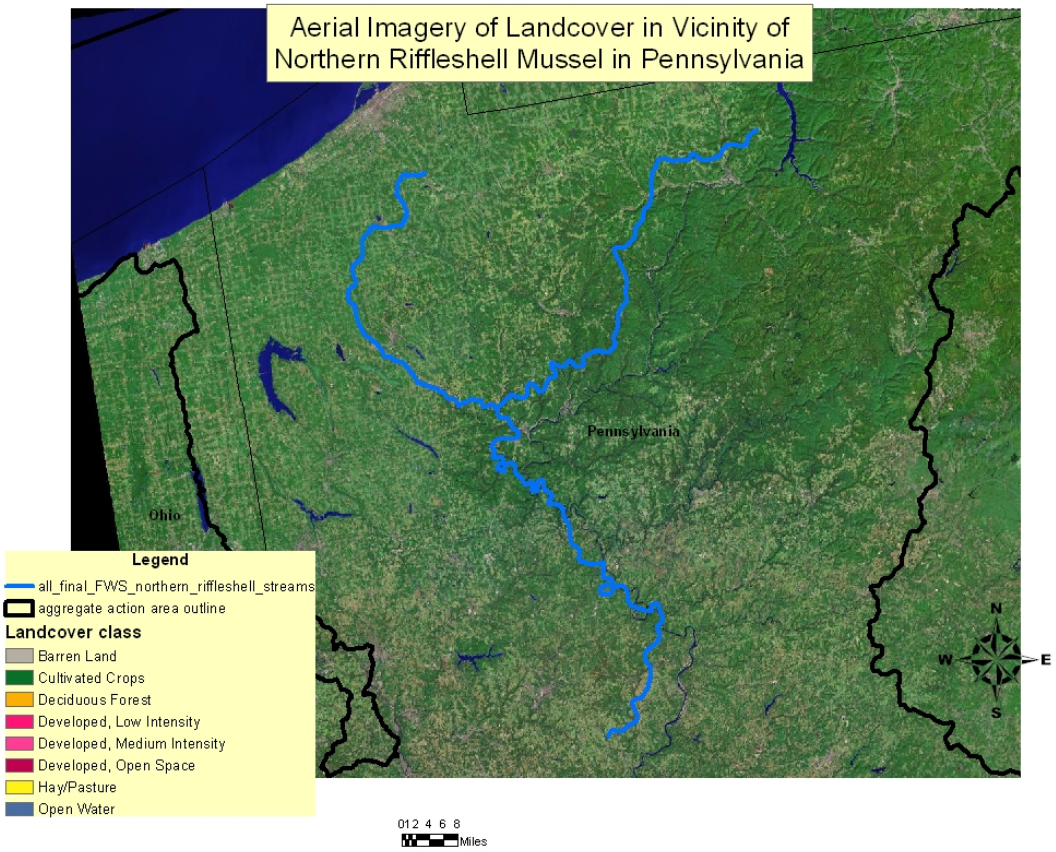

Figure I.16 Location of Northern Riffleshell Mussel in the Allegheny River (PA) Relative to Aerial Imagery

I.3.6 Elk River, West Virginia

Forested land is the predominant land cover type within 100 feet of the Elk River in Kanawha, Clay, and Braxton Counties in West Virginia, comprising 76% of the total land area. Developed land (Charleston, West Virginia) also occurs within 20% of this area, but is limited to the most downstream, southwestern portion of Elk River. Aerial land use and satellite imagery maps, depicted in Figures I.17 and I.18, confirm the presence of forested and developed land in the area surrounding Elk River. In addition, the county-level use data show limited corn and sorghum cropland acreage (< 1%) in tri-county area surrounding Elk River. Therefore, indirect effects via atrazine-related impacts to riparian vegetation adjacent to the Elk River are not expected, based on the low acreage of cropland and the relative abundance of forested land adjacent to the Elk River watershed. Therefore, potential indirect effects via atrazine-related impacts to riparian areas adjacent to the Elk River are expected to be insignificant, such that take of a single listed northern riffleshell mussel in this watershed is cannot be meaningfully measured, detected, or evaluated. Atrazine is not likely to adversely affect northern riffleshell mussels in the Elk River via effects to riparian vegetation, and the resulting effects determination is “may affect, but not likely to adversely affect or NLAA”.

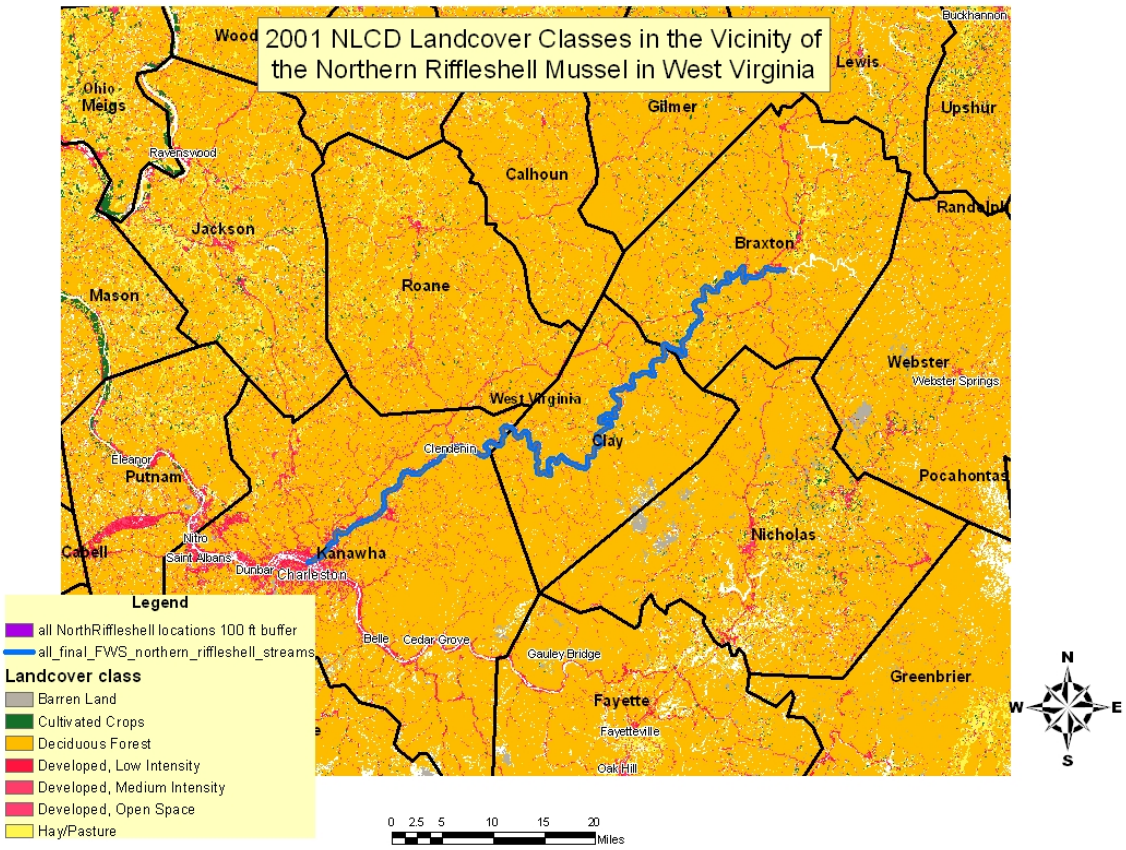

Figure I.17 Location of Northern Riffleshell Mussel in the Kanawha River (WV) Relative to 2001 NLCD

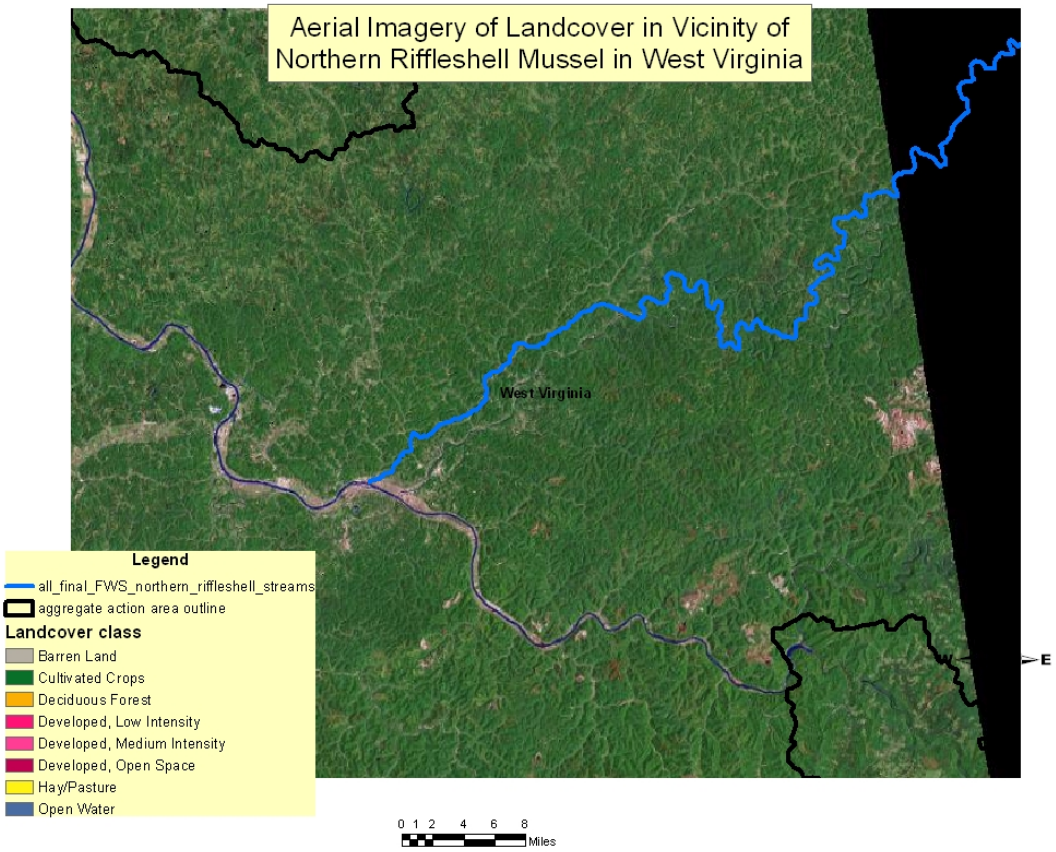

Figure I.18 Location of Northern Riffleshell Mussel in the Kanawha River (WV) Relative to Aerial Imagery

I.3.7 Detroit River, Michigan

As shown in the aerial land cover map, depicted in Figure I.19, the portion of the Detroit River occupied by the northern riffleshell is a small segment, dominated by open water. Open water comprises 95% of the land cover type within 100 feet of this watershed; the remaining 5% includes developed land. County-level land use data suggests that the percentage of cropland, including corn and sorghum crops, is low at 1%. In addition, the land cover data indicates that no sensitive herbaceous riparian vegetation or barren land occurs within the 100 foot buffer surrounding the Detroit River. Based on the land cover and use data, including analysis of the aerial satellite imagery, atrazine use in the area surrounding the Detroit River is expected to minimal, and indirect effects to riparian vegetation adjacent to the watershed are not expected. Therefore, potential indirect effects via atrazine-related impacts to riparian areas adjacent to the Detroit River are expected to be insignificant, such that take of a single listed northern riffleshell mussel in this watershed cannot be meaningfully measured, detected, or evaluated. Atrazine is not likely to adversely affect northern riffleshell mussels in the Detroit River via effects to

riparian vegetation; therefore, the resulting effects determination is “may affect, but not likely to adversely affect or NLAA”.

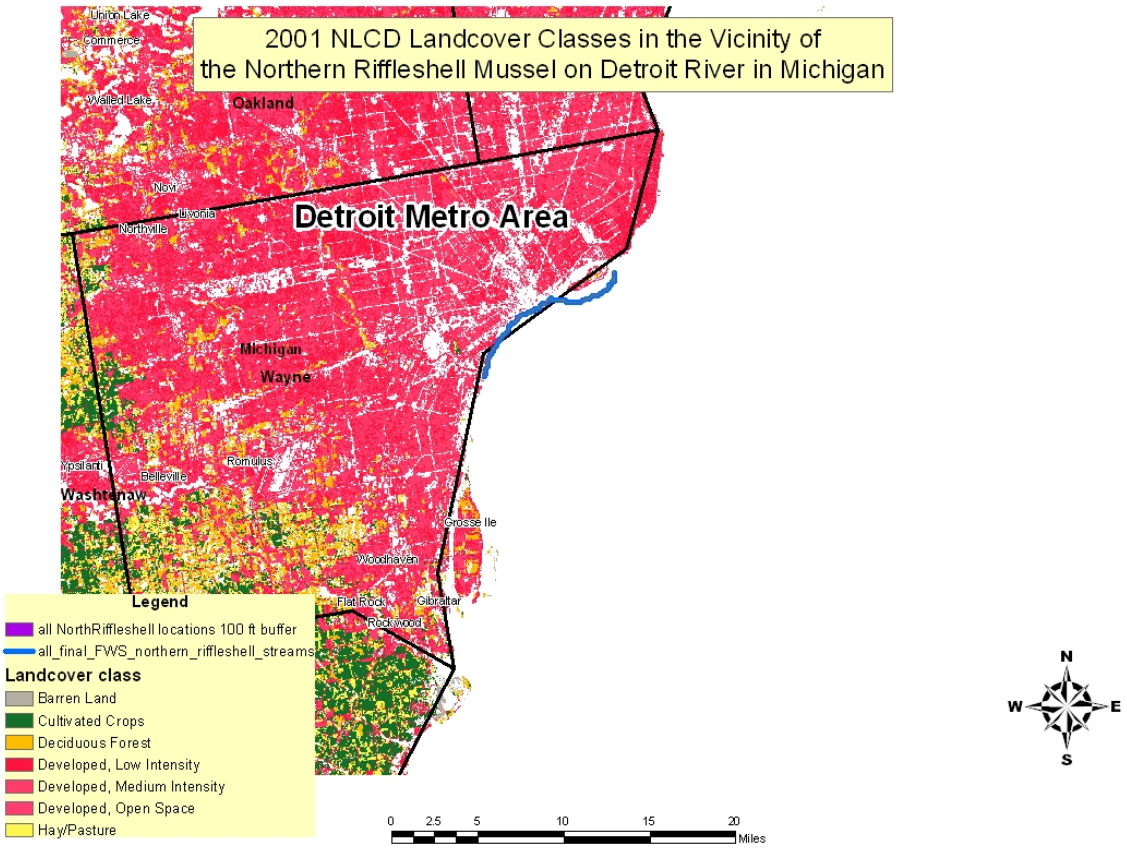

Figure I.19 Location of Northern Riffleshell Mussel in the Detroit River (MI) Relative to 2001 NLCD

I.4 Fat Pocketbook Mussel

As previously discussed in Section I.1, the action area for the fat pocketbook mussel is a large area, encompassing eight states. Given the large action area for this listed species, it was not possible to provide a spatially-explicit evaluation of each occupied watershed. Therefore, further spatial analysis of land cover data and type of riparian vegetation adjacent to occupied rivers for the fat pocketbook was conducted for seven example watersheds, intended to encompass the range of larger rivers (and surrounding land cover types) that this species inhabits. These watersheds include the Big Sunflower River in Mississippi, the Wabash River in Illinois, the White River and Lower Ohio River in Indiana, the Upper Ohio River in Kentucky, and the St. Francis and White Rivers in Arkansas. Land cover imagery is depicted for each of these occupied watersheds in Figures I.20 through I.26. It should be noted that the fat pocketbook also inhabits other smaller streams and chutes, for which no land cover data is available. In these areas, the

effects determination for indirect effects to the fat pocketbook mussels via direct atrazine effects on riparian vegetation is dependant on the presence of forested (woody shrubs and trees) versus herbaceous (grassy and non-woody) riparian vegetation adjacent to the streams and rivers within the fat pocketbook mussel's action area. For areas where the riparian habitat is predominantly forested with shrubs and trees, the effects determination for the fat pocketbook is "may affect, but not likely to adversely affect or NLAA". This finding is based on insignificance of effects (i.e., the effect cannot be meaningfully measured, detected or evaluated in the context of a level of effects where "take" occurs for a single fat pocketbook mussel). For watersheds that are in close proximity to potential atrazine use sites and where the riparian vegetation is comprised of grasses and non-woody plants, the effects determination is "may affect and likely to adversely affect or LAA".

The results of the spatial analysis show that very little, if any, sensitive herbaceous riparian vegetation or barren land is located adjacent to the occupied big rivers of the fat pocketbook mussel. As shown in Table I.6, the majority of land cover directly adjacent to occupied watersheds appears to be cultivated crop, forested vegetation, or woody wetlands. Given the lack of sensitive herbaceous vegetation and barren land, atrazine-related impacts to riparian vegetation adjacent to these larger watersheds are not expected. Although it is possible that the fat pocketbook may occupy similar watersheds where the percentage of herbaceous land cover surrounding the watershed is higher than that observed in the seven example watersheds, the available land cover data for all three listed species indicates the majority of riparian vegetation directly adjacent to occupied rivers is comprised of deciduous forest and woody wetlands that are not sensitive to atrazine at environmentally relevant concentrations. Therefore, potential indirect effects via atrazine-related impacts to riparian areas adjacent to large rivers occupied by the fat pocketbook are expected to be insignificant (i.e., cannot be meaningfully measured, detected or evaluated in the context of a level of effects where "take" occurs for a single fat pocketbook), and the resulting effects determination is "may affect, but not likely to adversely affect or NLAA".

Table I.2 Summary of Land cover Classes within 100 feet of Stream/Rivers Occupied by the Fat Pocketbook Mussel											
Location (State)	**Total Land Area[1]**	**Open Water**	**Developed Land[2]**	**Barren Land**	**Forested Land[3]**	**Shrub/Scrub**	**Herbaceous**	**Hay/Pasture**	**Cultivated Crops**	**Woody Wetland**	**Emergent Herbaceous Wetland**
Area (hectares)											
Ohio River (IN/KY)	2157	2346	204	21	807	0	10	166	821	97	31
Wabash River (IL)	2870	713	277	12	768	0	31	104	1450	223	5
White River (IN)	4741	701	649	29	758	7	20	78	1857	1291	52
Mississippi River (MS)	4232	4809	172	294	249	30	59	35	760	2468	165
St Francis River (AR)	2668	224	106	1	83	1	2	21	1466	975	13
Big Sunflower River (MS)	1946	94	114	0	20	0	0	10	1381	417	4
Percent of Total											
Location (State)	**Total Area**	**Open Water**	**Developed Land[2]**	**Barren Land**	**Forested Land[3]**	**Shrub/Scrub**	**Herbaceous**	**Hay/Pasture**	**Cultivated Crops**	**Woody Wetland**	**Emergent Herbaceous Wetland**
Ohio River (IN/KY)	100	NA	9	1	37	0	0	8	38	4	1
Wabash River (IL)	100	NA	13	0	36	0	1	4	51	8	0
White River (IN)	100	NA	30	1	35	0	0	2	39	27	1
Mississippi River (MS)	100	NA	8	7	12	1	1	1	18	58	4
St Francis River (AR)	100	NA	5	0	4	0	0	1	55	37	0
Big Sunflower River (MS)	100	NA	5	0	1	0	0	0	71	21	0

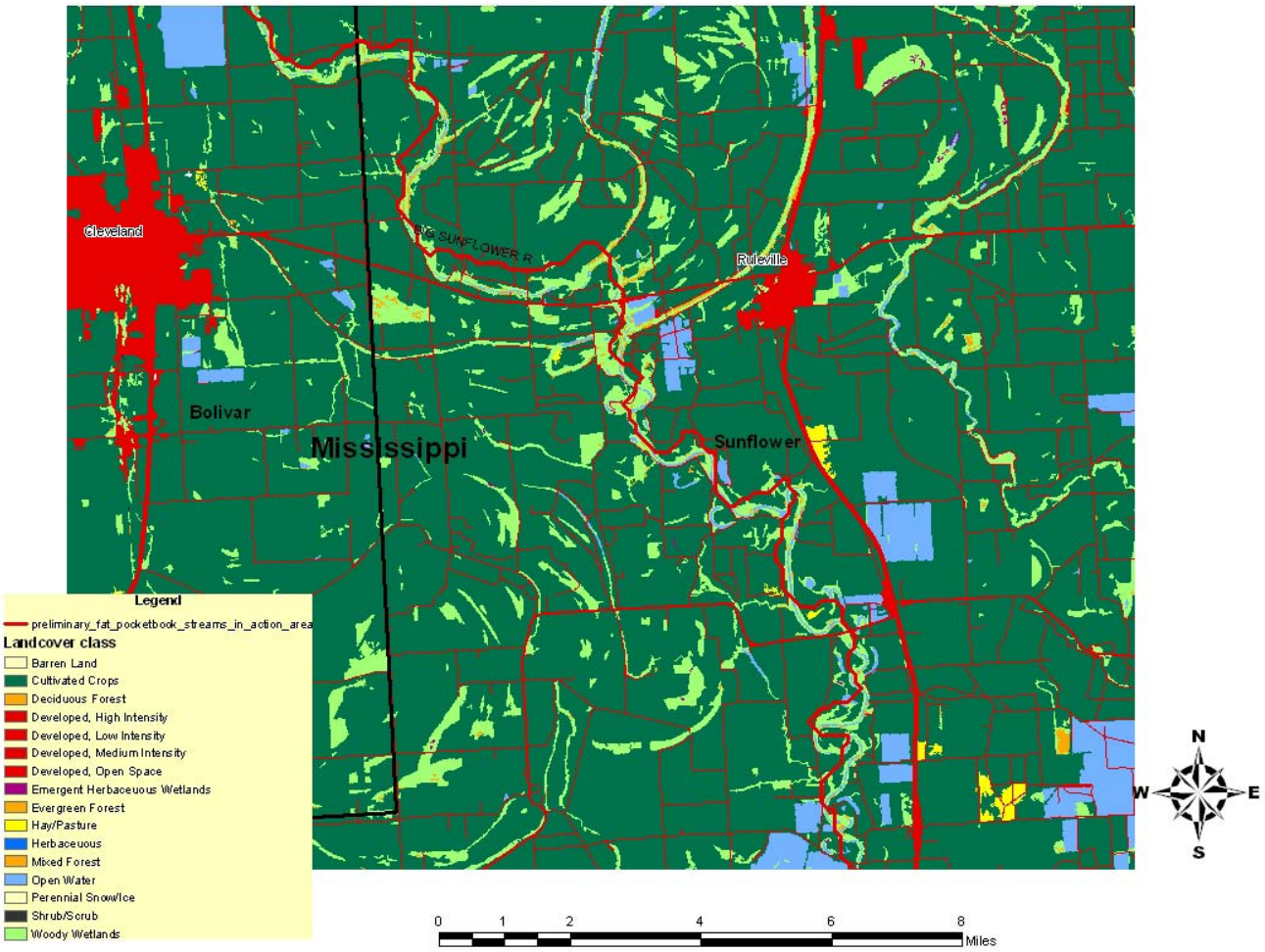

Figure I.20 Location of Fat Pocketbook Mussel in the Sunflower River (MS) Relative to 2001 NLCD

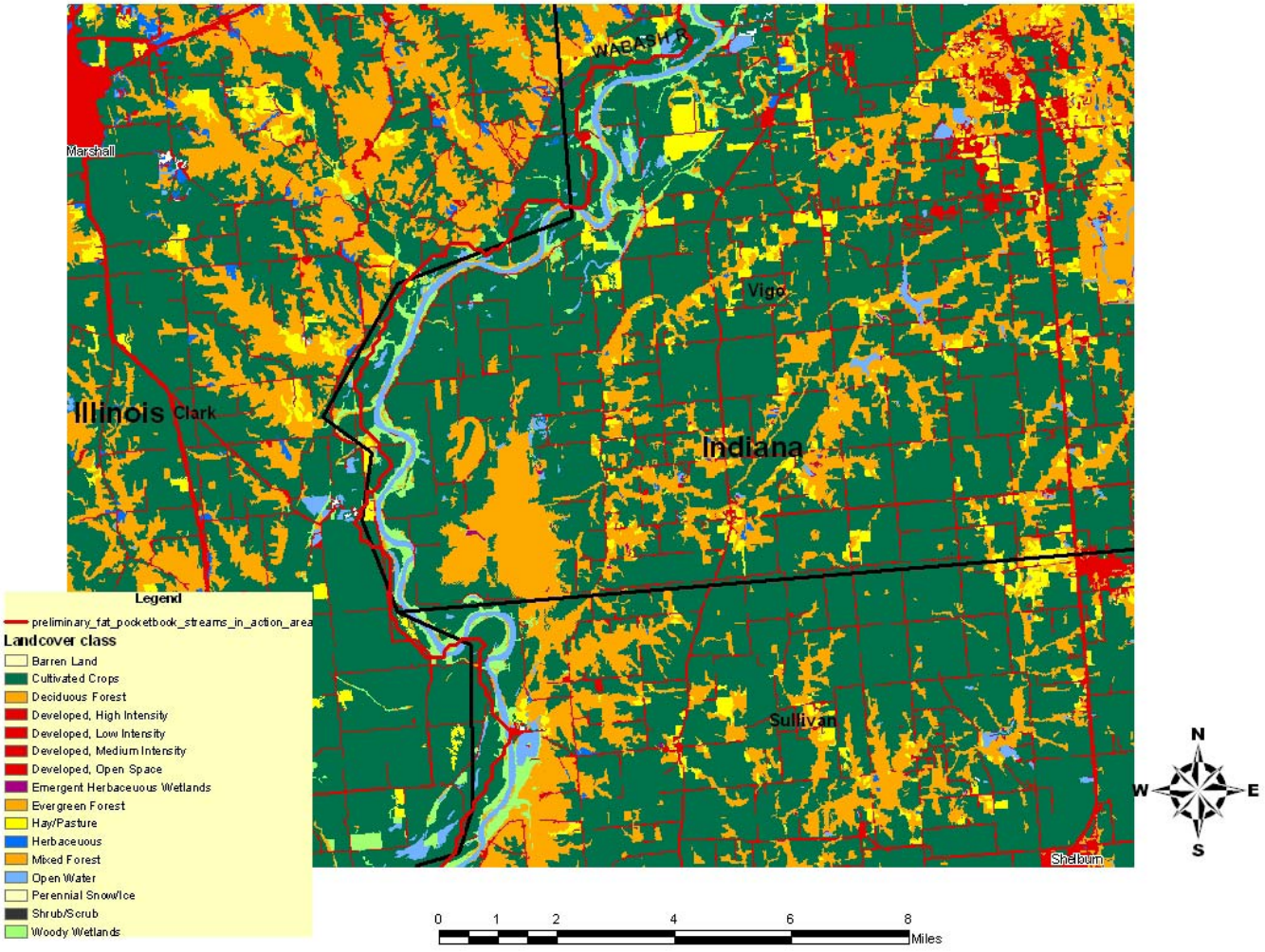

Figure I.21 Location of Fat Pocketbook Mussel in the Wabash River (IL) Relative to 2001 NLCD

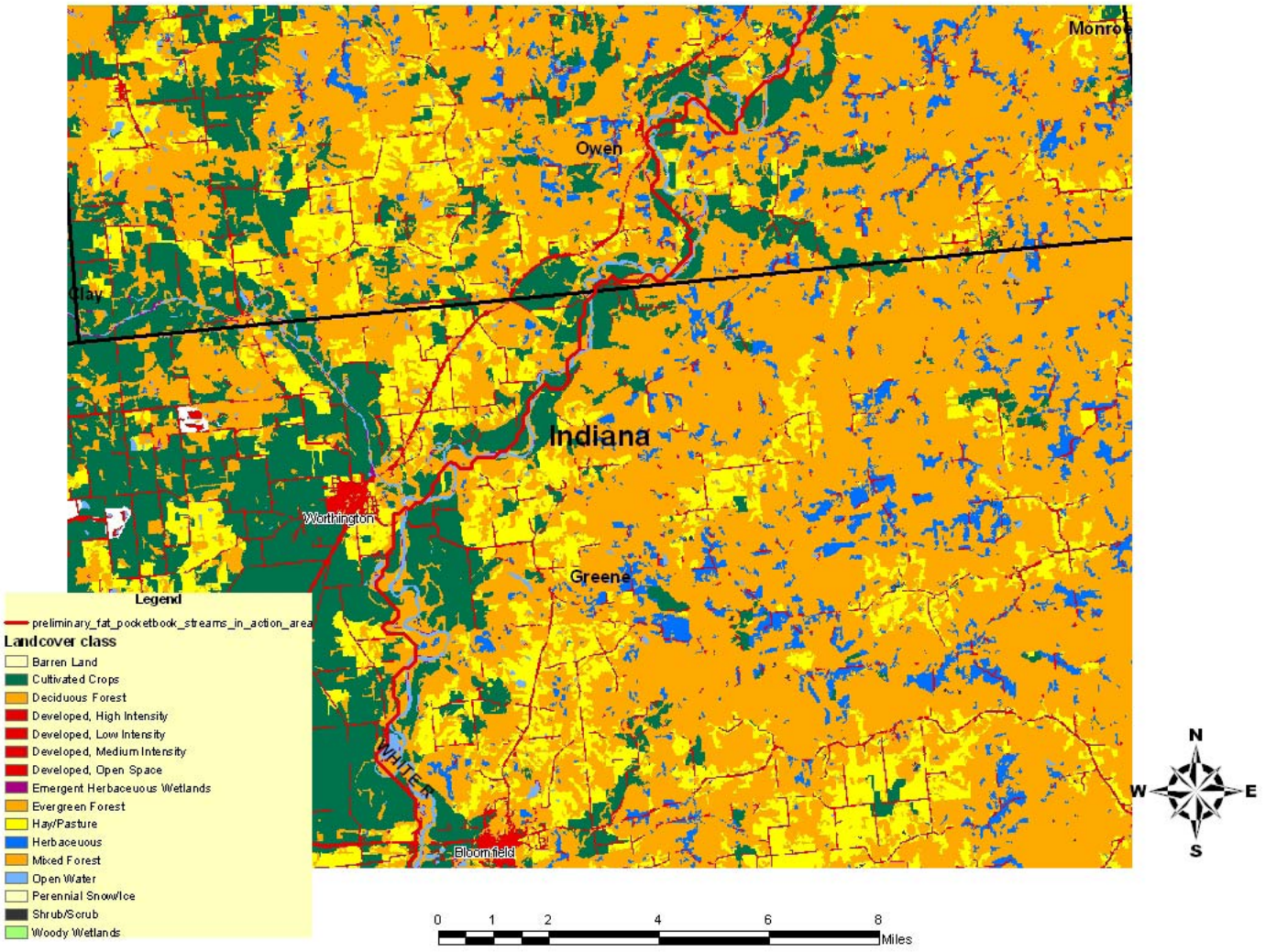

Figure I.22 Location of Fat Pocketbook Mussel in the White River (IN) Relative to 2001 NLCD

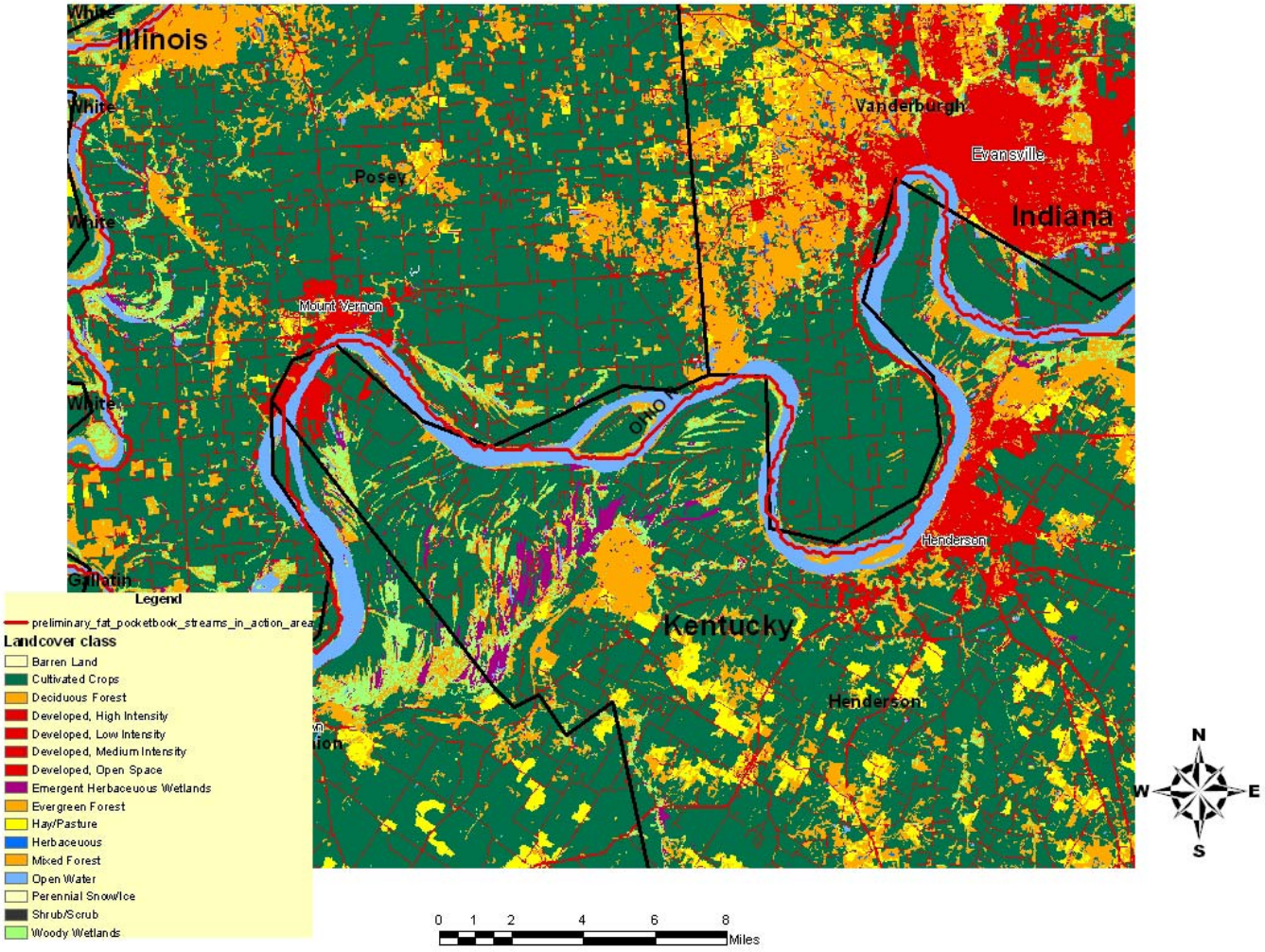

Figure I.23 Location of Fat Pocketbook Mussel in the Lower Ohio River (IN) Relative to 2001 NLCD

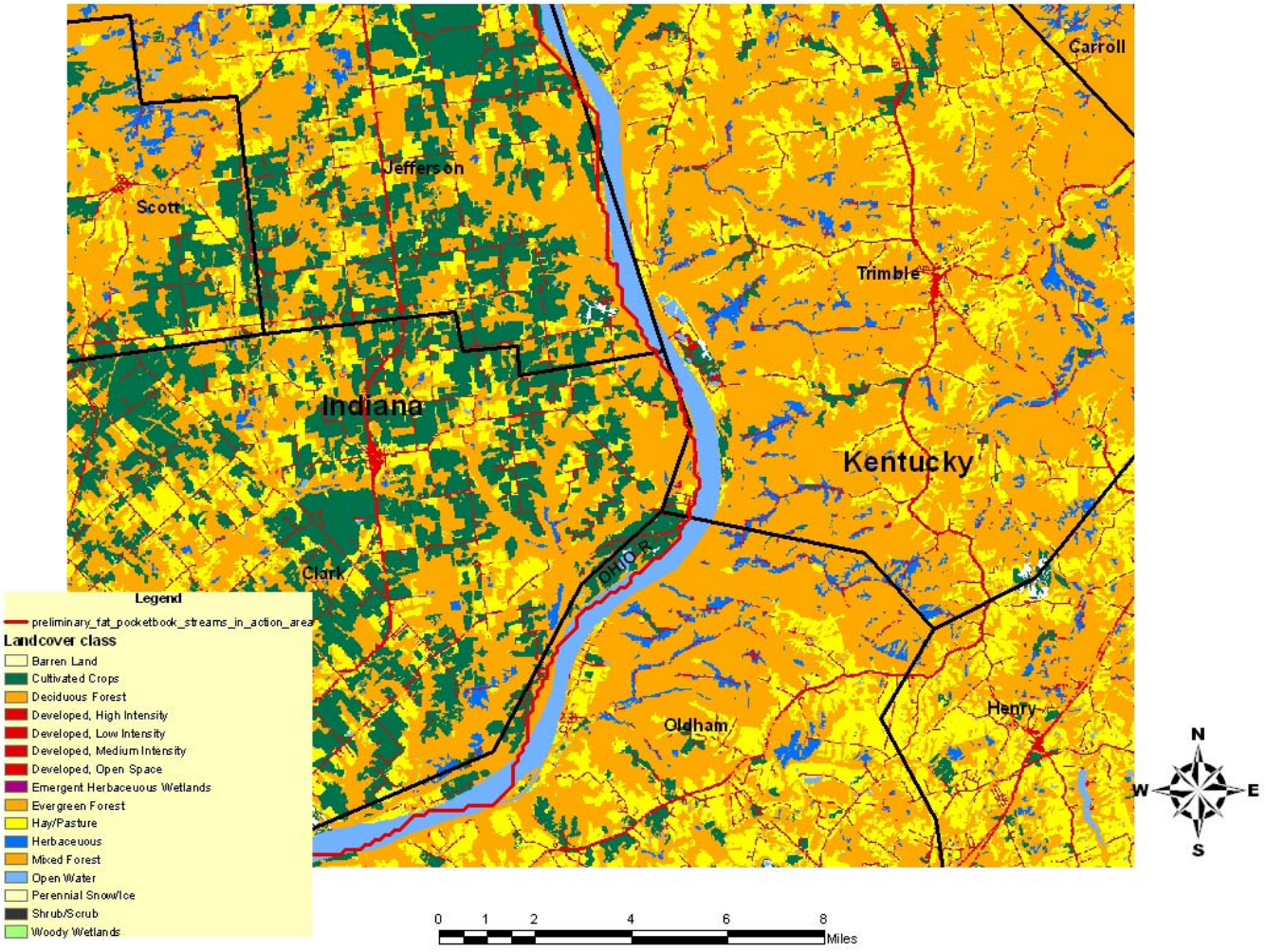

Figure I.24 Location of Fat Pocketbook Mussel in the Upper Ohio River (KY) Relative to 2001 NLCD

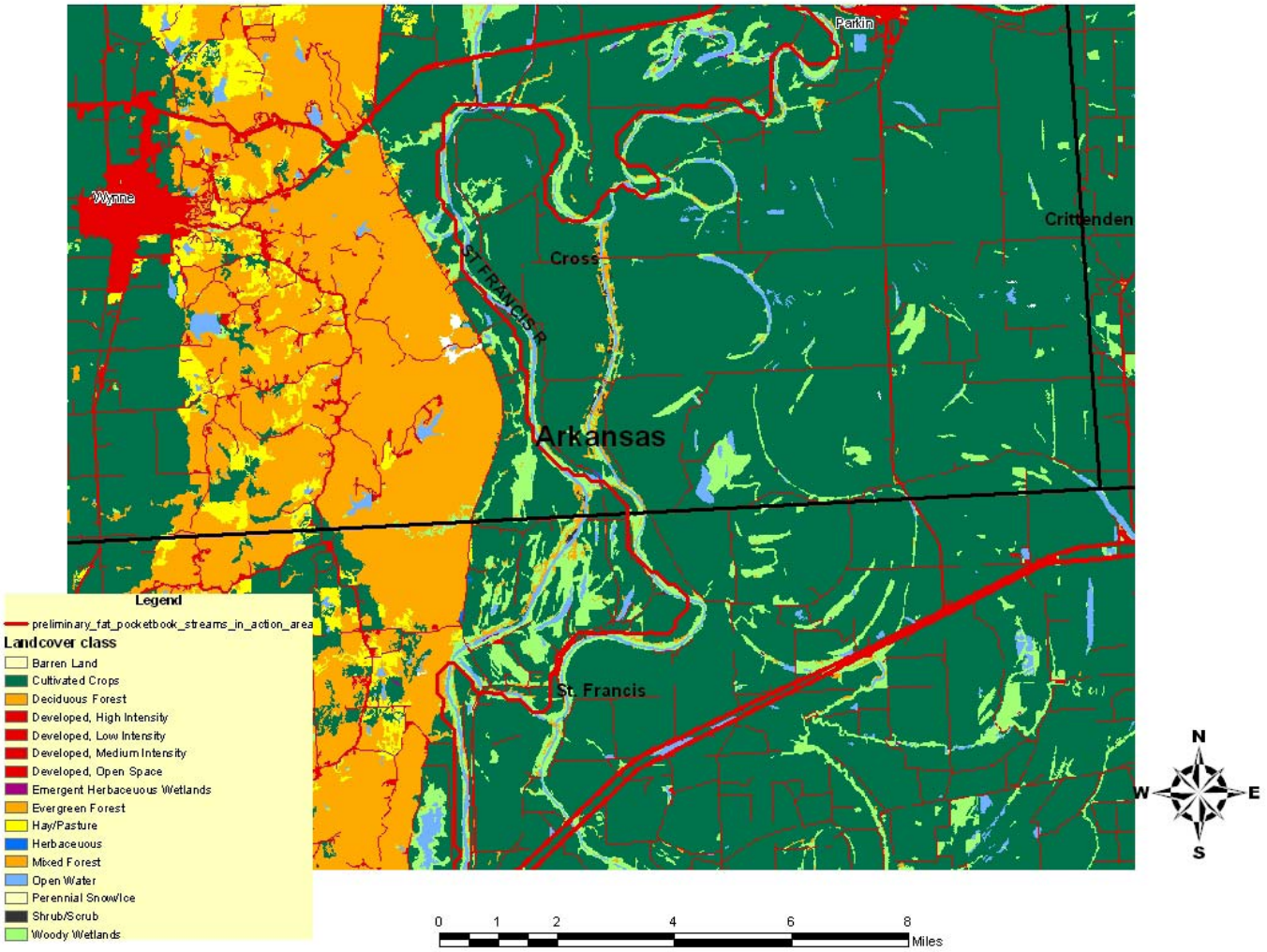

Figure I.25 Location of Fat Pocketbook Mussel in the St. Francis River (AR) Relative to 2001 NLCD

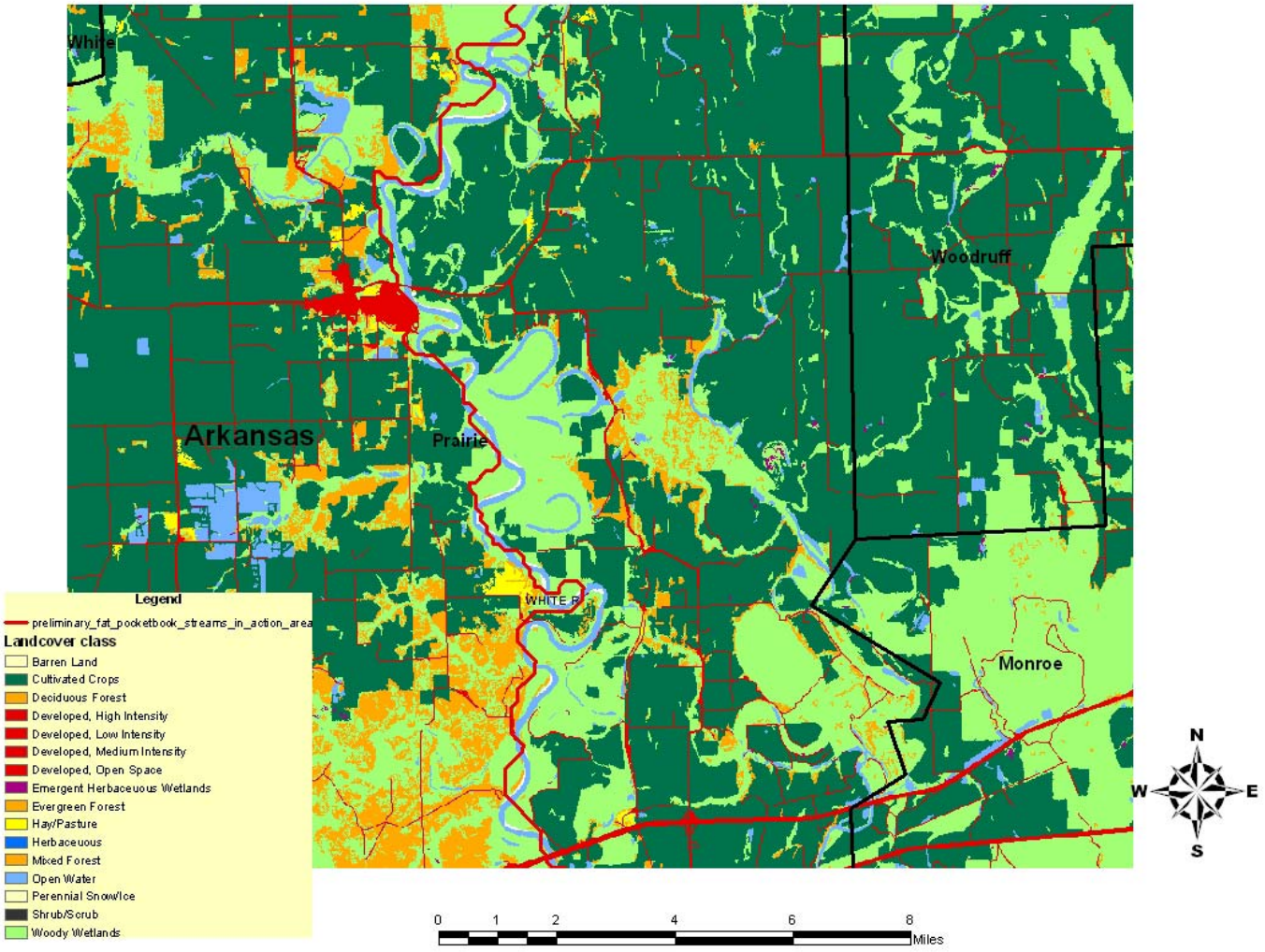

Figure I.26 Location of Fat Pocketbook Mussel in the White River (AR) Relative to 2001 NLCD