Department of Defense
Legacy Resource Management Program

09-432

Inventory and Prioritization of Impaired Sites in the Yellow River Watershed in Alabama and Florida

Final Report

Steven J. Herrington, Ph.D.
The Nature Conservancy: Florida Chapter
November 2011

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Inventory and Prioritization of Impaired Sites in the Yellow River Watershed in Alabama and Florida.

Steven J. Herrington, The Nature Conservancy, Florida

DoD Legacy Program project number: 09-432

30 November 2011

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1. Project Final Report and Appendices: One printed copy, one digital copy (Adobe PDF format)
2. Project Fact Sheet: One printed copy, one digital copy (MS Word format)
3. Project Technical Note: One printed copy, one digital copy (MS Word format)
4. Project Databases and Data Dictionaries for (MS Access and Excel formats):
    - Stream Habitat Evaluation
    - Unpaved Roads Evaluation
5. Global Information Systems (GIS) Data for:
    - Focal Areas and Areas of Interest
    - Impoundments
    - All River Sites
    - Unpaved Roads in Alabama
    - Unpaved Roads in Florida
6. Google Earth Presentation of All Sites Assessed, with Google Earth v5.1. This presentation is intended for rapid review and presentation of all data collected. Please note that this presentation works with Google Earth v5.1 but may not be compatible with later versions of Google Earth. Also, this feature and software may not be loadable on certain networked computers and may need to be viewed on dedicated computers.
7. Impoundments Data (MS Excel format)
8. Courtesy Image Files of Select Site Pictures and All Report Figures with Image Files Directory (.JPG and MS Excel Formats)
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10. Read Me File (Adobe PDF format)

Project Title

Inventory and Prioritization of Impaired Sites in the Yellow River Watershed in Alabama and Florida.

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ABSTRACT

The Yellow River is a large, softwater river which flows through Alabama and Florida into Pensacola Bay and the Gulf of Mexico. Historically considered a relatively undisturbed system, the Yellow River is increasingly impacted by human population growth and development. Excessive sedimentation resulting from bank instability and unpaved road crossings is believed to be the primary factor causing degradation and imperilment of river habitat and biological communities in the basin.

This project was divided into two phases. The goal of Phase 1 was to identify areas contributing to habitat degradation and impairment in the Yellow River Basin as an initial step in conserving and restoring natural function and biodiversity throughout the system. The goal of Phase 2 was restore one of the sites identified as a high-priority restoration location. The objectives of this study were to (1) inventory and assess the magnitude of habitat degradation and fish passage impacts within the river corridor and at unpaved road crossings throughout the Yellow River Basin; (2) summarize impacts and restoration potential at each impaired location; (3) develop a prioritized basin restoration plan for state, federal, and local agencies and stakeholders for implementing conservation and restoration efforts in the basin; and (4) restore one of the sites identified as a high-priority restoration location during the assessment. We used a stream severity index developed by the U. S. Fish and Wildlife Service to characterize impairments within the corridor of the Yellow River and its major tributaries. We also used a sediment risk index (SRI) to characterize potential for excessive sediment loading at unpaved road stream crossings throughout the basin. We estimated the number of impoundments by reviewing aerial photographs of land use in the basin. Lastly, we used standard river corridor restoration techniques which have been employed successfully elsewhere in the Yellow River and nearby river drainages.

For Phase I, we assessed approximately 209 river miles and identified 140 impaired river corridor sites and identified moderate or high degrees of sedimentation risk at 339 unpaved road crossings throughout the basin. Site-level erosion and sedimentation was by far the predominant factor impairing all sites. These risk factors commonly resulted in degradation or loss of instream habitat and connectivity at site locations as well as up- and downstream of impaired sites. We estimated 2,890 possible man-made (86%) and natural impoundments (14%) which could result likely resulted in barriers to fish passage and further loss of in-stream habitat and connectivity. Impaired river corridor and unpaved road sites were often clustered near each other, affected by a common feature such as a single unpaved road, and were at or near priority ecological resources and designations throughout the basin. Based on these patterns, we defined seven “Focal Areas” to maximize restoration potential while minimizing the cost for completing restoration actions. We recommend focusing future aquatic restoration efforts in the Yellow River Basin in these Focal Areas, particularly at unpaved roads which impair a number of streams they cross and nearby impaired river corridors.

Based on the results and recommendations of Phase I, we restored site co-0610-001in the Conecuh National Forest Focal Area for Phase II of the project. This site, referred to locally as “Dripping Rock”, was characterized by a denuded and breached riverbank and an unpaved road which terminated at the site. It is also directly adjacent to one of five potential Gulf sturgeon spawning sites and is the only site from which sturgeon eggs have been documented in the Yellow River. Phase I identified this site as contributing excessive sedimentation to the Yellow River and this spawning area. We restored the site by grading, filling, stabilizing, and revegetating the unpaved road, and contouring, stabilizing, and revegetating the riverbank.

ACKNOWLEDGMENTS

We thank Barbara Albrecht, Mary Bryant, Ben DeLosier, Karen Herrington, Kevin Kemp, Mike McManus, Chris Metcalf, Sandy Pursifull, Ad Platt, Channing St. Aubin, Bill Tate, Jeff Van Vranken, and the Covington County Sheriff's Office for field training and assistance, GIS support and analysis, and helpful guidance on data analysis and interpretation. We thank Eilene Beard, Rick Jones, Charles Roland, and Forrest Tinklepaugh for private lands access and project collaboration on the Dripping Rock restoration. This project was funded by Florida Fish and Wildlife Conservation Commission's program, Florida's Wildlife Legacy Initiative, and the U.S. Fish and Wildlife Service's State Wildlife Grants program (grant number FL T-17-1, FWC agreement number 08232), the U. S. Department of Defense Legacy Resource Management Program (contract number W912DY-09-2-0021), the Lydia B. Stokes Foundation, and the Elizabeth Ordway Dunn Foundation.

TABLE OF CONTENTS

INTRODUCTION

Habitat degradation is a primary factor in the decline of biodiversity in aquatic ecosystems of the southeastern United States. Many of the rivers and streams in this region, which contain among the highest aquatic biodiversity in North America, have been impacted by habitat degradation, alteration, conversion, and loss. Excessive sedimentation is among the leading nonpoint source pollutants impairing these rivers, including in the Gulf Coastal Plain ecoregion (Abell et al. 2000). Anthropogenic activities such as urbanization, agriculture and silviculture, road construction, removal of riparian vegetation, and channelization increase sedimentation (Karr et al 1986, Rabini and Smale 1995) and have long been recognized as factors contributing to the stream degradation (Berkman and Rabini 1987, Poff and Allen 1995, Marschall and Crowder 1996). Excessive sedimentation commonly results in the loss of in-stream habitat heterogeneity and quality by filling, increasing bank destabilization and subsequent bank erosion (Rosgen 1996). This continuing sedimentation further degrades stream channel morphology, often resulting in widening of the stream channel and further loss of in-stream habitats (Rosgen 1996).

Unpaved roads are increasingly recognized as a primary vector for excessive sedimentation in rivers and streams in this ecoregion (USEPA 2002). Improperly sized and positioned culverts and poor vegetation buffers of ditches and outlets commonly cause road erosion and alteration of overland and in-stream flow patterns, further facilitating sedimentation of streams at road crossings (Grayson et al. 1993, Forman and Alexander 1998, Jones et al. 2000). This frequently results in barriers to fish passage and conversion of in-stream habitat from lotic to lentic conditions upstream from affected road crossings (Forman and Alexander 1998). Excessive sediment can impact riverine biota by limiting the light availability for photosynthetic phytoplankton and macrophytes and by filling interstitial spaces in the substrate,

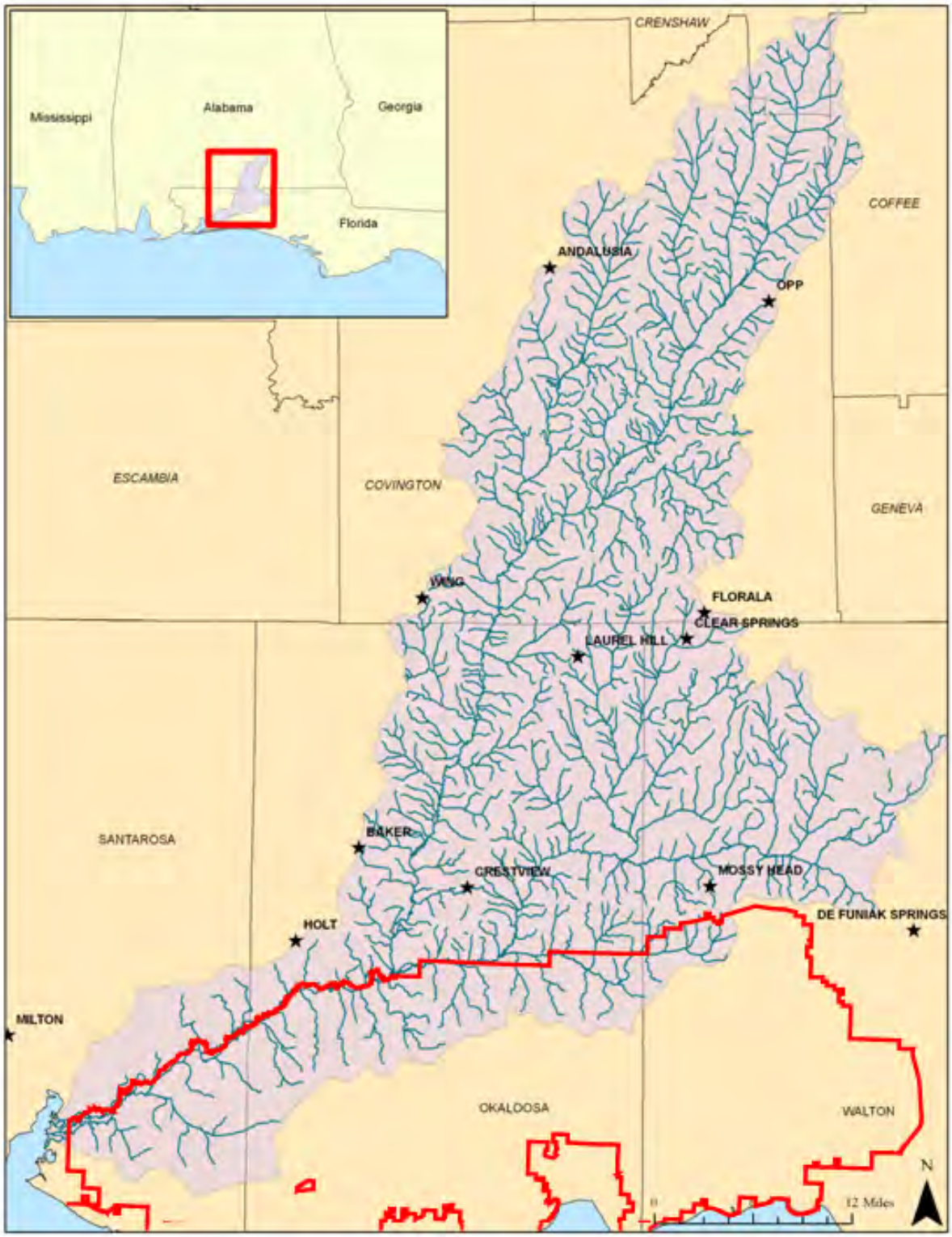
increasing stress and mortality to eggs, larvae, adults of macroinvertebrate and fish communities (Wilbur 1983, Morton 1986, Waters 1995, Marschall and Crowder 1996). Increased turbidity from excessive sedimentation can also decrease reproductive efficiency and interfere with filter-feeding mechanisms of invertebrates and fishes (Page and Smith 1970, Wilbur 1983, McCabe and Sandretto 1985).

One of the four rivers discharging into Pensacola Bay, the Yellow River is a 110-mi long, sandy, softwater (i.e., blackwater) river which flows through Alabama and Florida in the Gulf Coastal Plain ecoregion, with a watershed area of 1,372 mi^2 and average annual flow of 1,181 cfs (Fig. 1) (Seaman 1985, Thorpe et al. 1997). The Yellow River watershed is noted for relatively high fish and mollusk biodiversity (Seaman 1985, Thorpe et al. 1997). Although historically considered a fairly undisturbed system, the Yellow River is being impacted by sedimentation resulting from river bank instability and unpaved road crossings, as well as a variety of other nonpoint sources of pollution (Thorpe et al. 1997). These factors have increasingly contributed to habitat degradation, been identified as impacting federally listed and candidate species, and increasingly threaten aquatic biodiversity in the basin (Thorpe et al. 1997).

The Yellow River is classified as a “Softwater Stream” in Florida's Comprehensive Wildlife Conservation Strategy, or CWCS (FWC 2005). Softwater Streams are one among the most imperiled habitats identified in the CWCS and one of the six habitats chosen for the state’s Wildlife Legacy Initiative goals. The aforementioned impacts affecting this system are “High Ranking Sources of Stress” to softwater streams, categorized under the headings “surface water withdrawal”, “conversion to agriculture”, nutrient loads – agriculture”, and “roads” in the CWCS.

Approximately 35 river miles of the lower portion of the Yellow River mainstem as well as several tributaries abut and/or drain the northwestern portion of land owned and operated by the U.S Department of Defense Eglin Air Force Base (Eglin AFB). Located in the Florida Panhandle eight miles northwest of the city of Fort Walton Beach, the Eglin AFB maintains an ecosystem management program that provides flexibility in its military missions and stewardship of its natural resources (EAFB 2002). The Eglin AFB has been historically active in wetland and stream habitat protection, restoration, and conservation management of its lands. However, both Eglin AFB and the U.S. Fish and Wildlife Service recognize that the Eglin AFB range road system – primarily comprised of unpaved roads - is experiencing accelerated rates of erosion resulting in excessive sedimentation and habitat loss that adversely impacts the environment and road system management (Rainer 2001; USFWS 2007). Recent stream restoration to reduce sedimentation by stabilizing unpaved roads, providing fish passage by replacing culverts, and improving bridge crossings has benefited its military and stewardship missions by (1) providing reliable throughways; (2) reducing long-term road maintenance costs; (3), and by reducing regulatory burden through the recovery of the federally protected fish the Okaloosa darter (*Etheostoma okaloosae*; Fed. Reg. 2010). The Eglin AFB believes that these impairments affect its mission and stewardship objectives as well as federally listed and candidate species in the area drained by the Yellow River and its tributaries, and restoration of impaired locations may provide similar benefits (Stephen Seiber, Eglin AFB, pers. comm.).

Figure 1. The Yellow River Basin in Alabama and Florida. Red outline indicates DoD Eglin Air Force Base boundary.



This project was divided into two phases. The goal of Phase I was to identify areas contributing to habitat degradation and impairment in the Yellow River Basin as an initial step in conserving and restoring natural function and biodiversity throughout the system. The goal of Phase II was to restore one of the sites identified as a high-priority restoration location. The objectives of this study were to (1) inventory and assess the magnitude of habitat degradation and fish passage impacts within the river corridor and at unpaved road crossings throughout the Yellow River Basin; (2) summarize impacts and restoration potential at each impaired location; (3) develop a prioritized basin restoration plan for state, federal, and local agencies and stakeholders for implementing conservation and restoration efforts in the basin; and (4) restore one of the sites identified as a high-priority restoration location during the assessment.

METHODS

Inventory and Prioritization

A quantitative and qualitative approach was used to characterize potential impairments within the river corridor and at unpaved road crossing sites of the mainstem and tributaries of the Yellow River Basin. Standard methods and equipment for collecting field data followed the methodologies described below. Digital photographs, GPS coordinates using a Garmin GPSmap 76CS, and field notes were recorded at all impaired sites. All field data were recorded using a Trimble GeoXT handheld computer with Terrasync software and deposited into Microsoft Access and Excel for data management and analysis, respectively.

River Corridor Assessment

We identified potential impacts to the corridor of the Yellow River and its tributaries in public waters traversable by motor-boat or canoe. We identified potentially impaired river corridor

sites based on the observation of one or a combination of risk factors described below. Once a site was identified, we used methods developed by the U.S Fish and Wildlife Service, Panama City Ecological Services and Fisheries Resource Office, to calculate the severity of impacts within the river corridor at the site (USFWS 2006). The methodology is comprised of a combination of formalized quantitative and qualitative measurements for assessing the ecological condition of stream corridors (NRCS 2001) modified by the USFWS for drainages in the Gulf Coastal Plain ecoregion. This method has been used by the USFWS to characterize river corridor condition in other drainages of Florida and Alabama (USFWS 2005a).

Specific definitions and calculations described below are detailed in USFWS (2005a) and USFWS (2006). This method consists of ranking 11 "risk factors" which are assigned a score based on observed and measured river corridor characteristics at a given location (Table 1), including the Bank Erosion Hazard Index (BEHI) (Rosgen 1996). There are four scores categories for each risk factor ranging from "0" to "1.5", in 0.5 increments, with higher scores indicating higher impairment. The sum of scores assigned for the 11 risk factors is termed the "Severity Score" index, which ranges from 0 – 16.50. We subjectively assigned each Severity Score into three categories of increasing impairment: "Low" (scores 0 – 4.00), "Moderate" (scores 4.25 – 7.25), and "High" (scores 7.50 – 16.50) for comparison purposes.

Unpaved Road Crossing Assessment

We identified potential impacts of all known publically accessible unpaved roads where they crossed a given river or stream throughout the Yellow River Basin. We traveled to each unpaved road crossing and calculated potential impacts using the Sediment Risk Index, or SRI (Witmer 2009). The SRI is a combination of quantitative and qualitative measurements developed to characterize the extent of sediment and other impacts of unpaved road crossings to aquatic

Table 1. Severity score index criteria for river corridor sites.

Risk Factor	0	0.5	1	1.5	Max Possible Score
Channel stability	Excellent	Good	Fair	Poor	1.5
Channel alteration	None	Historic, Mostly Recovered	In Recovery	Recent, No Recovery	1.5
Bank erosion	Not Eroding	Historic	Active	Mass-wasting	1.5
BEHI	Low-Very Low	Moderate	High	Extreme-Very High	1.5
Local non point source pollution	No Evidence	Slight	Moderate Potential	Obvious Sources	1.5
Shoring structures	Not Present			Present	1.5
Pipe discharge	Not Present			Present	1.5
Water odors	Not Present			Present	1.5
Fish passage barrier	Not Present			Present	1.5
Riparian buffer width	0	0.25	0.5	0.75	
Right bank	100^{+}ft	50-99ft	30-49ft	0-29ft	0.75
Left bank	100^{+}ft	50-99ft	30-49ft	0-29ft	0.75
Floodplain access	0	0.25		0.75	
Right bank	Full	Partial		None	0.75
Left bank	Full	Partial		None	0.75

resources in north Florida and the Gulf Coastal Plain ecoregion (USFWS 2005a, Witmer 2009, Witmer et al. 2009).

Specific definitions and calculations described below are detailed in Witmer (2009). This method consist of ranking 12 "risk factors" which are assigned a score based on observed and measured unpaved road characteristics at a given river or stream crossing (Table 2). There are three score categories for each risk factor, "Low Risk" (5), "Moderate Risk" (3), and "High Risk" (1), with higher scores indicating higher risk of impairment. Scores for Outlet and Drainage systems at each crossing were calculated using the Unpaved Road Outlet and Ditch Scoring Criteria (Table 3). The subtotal of the criteria for outlets and drainage systems were assigned a numerical value. Those numerical values were then incorporated as the score for Outlet and Drainage systems, respectively, and assigned one the three risk factor score categories as described above. The sum of scores assigned for the 12 risk factors is termed the SRI for that location. We assigned each SRI into three categories of increasing impairment according to Witmer (2009): "High" (scores 12 – 36), "Moderate" (scores 37 – 44), and "Low" (scores 45 – 60).

Fish Passage Barriers

We characterized the potential for each impaired river corridor and unpaved road site to be a barrier to fish passage using the "River Corridor" assessment methods described above. However, we also attempted to identify other fish passage barriers not identified in the field. We characterized the potential for fish passage barriers within the entire drainage by reviewing aerial photography available via Google Earth (Google Earth 2010). We considered a stream site to be impounded if (1) review of aerial photography indicated a relatively large standing water body, and (2) that water body occurred within the course of a river or stream. We categorized each

Table 2. Sediment Risk Index (SRI) scoring criteria for unpaved road crossing sites.

Risk factor	Low Risk	Moderate Risk	High Risk
	5	3	1
Upstream channel morphology	A B C E Wetland	DA Beaver Dam	D F G Ponded
Downstream channel morphology	A B C E Wetland	DA Beaver Dam	D F G Ponded
Downstream channel/bank alteration	Natural	Minor or Partial	High
Upstream culvert skew angle (worst)	$\leq 5^o$	$5^o \leq x \leq 30^o$	$\geq 30^o$
Crossing fill condition (dominant)	Good/vegetated	Fair/rip-rap	Poor/bare soil
Crossing inlet/outlet condition	No impairment	Sediment islands/scouring	Blocked
Potential eroded volume (mean)	$\leq 21\ y^3$	$21y^3 \leq x \leq 40\ y^3$	$\geq 40\ y^3$
Soil K factor	≤ 0.20	$0.21 \leq x \leq 0.40$	≥ 0.40
Road approach slope (mean)	$\leq 2.0\%$	$2.1\% \leq x \leq 4.0\%$	$\geq 4.0\%$
Road approach surface material	All aggregate Or 1 Approach: All sand/clay 1 Approach: All aggregate	All sand/clay Or 1 Approach: All aggregate 1 Approach: All native soil	All native soil Or 1 Approach: All sand clay 1 Approach: All native soil
Outlet system[a]	Improved	Partially improved	Unimproved
Drainage system[a]	Improved	Partially improved	Unimproved

a. Referencing calculations made utilizing Table 3.

Table 3. Unpaved road outlet and ditch scoring criteria.

Outlet ID					Score	Ditch ID				Score
	Left outlet	Vegetated	Rip-rap	Synthetic	1	Left ditch	Vegetated	Rip-rap	Synthetic	1
US		Bare soil	Concrete	Other	0		Bare soil	Concrete	Other	0
	Right outlet	Vegetated	Rip-rap	Synthetic	1	Right ditch	Vegetated	Rip-rap	Synthetic	1
		Bare soil	Concrete	Other	0		Bare soil	Concrete	Other	0
	Left outlet	Vegetated	Rip-rap	Synthetic	1	Left ditch	Vegetated	Rip-rap	Synthetic	1
DS		Bare soil	Concrete	Other	0		Bare soil	Concrete	Other	0
	Right outlet	Vegetated	Rip-rap	Synthetic	1	Right ditch	Vegetated	Rip-rap	Synthetic	1
		Bare soil	Concrete	Other	0		Bare soil	Concrete	Other	0

Improved outlet system	Sum:	_____	Improved drainage system	Sum	_____
	If sum= 4, 2, or 0	+1		If sum= 4, 2, or 0	+1
	If sum = 1	+2		If sum = 1	+2
	If sum= 3	+0		If sum= 3	+0

impoundment as either “man-made” or “natural”. An impoundment was considered man-made if it (1) occurred directly upstream or downstream of a road crossing, (2) was impounded by a visible dam, typified by a long, straight bank shape on the downstream end of the impoundment, and/or (3) had visible human-based land use or features (e.g., cleared land with a visible pier) in the immediate vicinity of the impoundment. An impoundment was considered natural if it occurred within the course of a river or stream but lacked the features of sites categorized as man-made.

Site Prioritization

We subjectively prioritized impaired river corridor and unpaved road sites for restoration by identifying patterns in the location and severity of impairments to each other and priority ecological resources and designations as determined by the states of Alabama and/or Florida and the federal government. These patterns were generally identified by overlaying impaired sites, priority resources, and designations within a Geographic Information Systems (GIS) environment. Geospatial GIS data we used included Gulf sturgeon (*Acipenser oxyrinchus desotoi*) critical habitat (USFWS 2003); Gulf sturgeon spawning sites in the Yellow River Basin (USFWS 2001); collection localities (including with the Eglin AFB) of five mussels which are proposed candidates for protection under the Endangered Species Act, hereafter referred to as “candidate mussels” (USFWS 2009); watersheds containing rare and imperiled fish in Florida (FWC 2003); priority wetlands habitats in Florida (FWC 1989); special outstanding Florida waters (FWC 1996); rare and imperiled fishes in Alabama (Mirarchi et al. 2004); and waters impaired under the Clean Water Act Section 303(d) in Florida and Alabama (FDEP 1998, ADEM 2008). We used geology, land cover, and land use (Florida only; land use in Alabama information was unavailable during the during the study period) to help identify physical

characteristics which might influence site impairments in the basin (FDEP 2001, GSA 2003, Homer et al 2005, UFGC 2007). Aerial photography available via Google Earth was also used to interpret site-level impacts within the broader landscape (Google Earth 2010).

Site Restoration

We selected a site for on-the-ground restoration based on a combination of factors including (1) river corridor (severity scale) and/or unpaved road crossing (Sediment Risk Index) ranking as developed herein during Phase I of the study; (2) ecological resources potentially affected by site-specific impairments; (3) optimizing the benefit to ecological resources by restoring the site; (4) willingness of land owner(s) to collaborate in the restoration (if applicable); (5) total cost of restoration; and (6) other factors such as logistics, permit requirements, etc. In addition, the U.S. Fish and Wildlife Service, Panama City Field Office agreed to develop technical plans to guide the restoration upon selection of the site. Although restoration methods vary according to site-specific impairments, we used standard methods for restoring unpaved roads in the Gulf Coastal Plan Ecoregion (USFWS 2005b) and river corridors (FISRWG 1998) as the template for designing technical restoration plans for the selected site.

RESULTS

Inventory and Prioritization

The Yellow River and its tributaries drain primarily over residuum geology (i.e., an accumulation or rock debris formed by weathering and remaining essentially in place after all but the least soluble constituents have been removed) and sand in Alabama (Fig. 2); whereas it drains primarily over medium-fine sand and silt and sandy-clay and clay in Florida (Fig. 3). The Yellow River Drainage flows through primarily forested and hay/pasture land (Fig. 4). Land use

within Yellow River Drainage in Florida was predominately public/semi-public and institutional (e.g., Eglin Air Force Base) (Fig. 5). We identified 2,890 possible man-made (86%) and natural impoundments (14%) which could result in barriers to fish passage in the Yellow River Basin (Fig. 6). There were 1,607 impoundments in Alabama, comprised of 1,357 man-made and 250 natural impoundments. There were 1,283 impoundments in Florida, comprised of 1,140 man-made and 143 natural impoundments, including 25 man-made and 5 natural impoundments within Eglin AFB.

River Corridor and Unpaved Road Crossing Assessments

We assessed river corridor impairments of approximately 209 river miles of the mainstem of the Yellow River and its tributaries (Table 4). We identified 140 river corridor sites with "Low-", "Moderate-", and "High-" ranked impairments throughout the basin (Table 5, Appendix A), with 39 sites located in Alabama (Table 6) and 101 sites located in Florida (Table 7). The majority of the river corridor impaired sites were identified within Florida because rivers and streams in Alabama were generally too small traverse via motor-boat or canoe. We identified 339 unpaved road crossing sites with "Low-", "Moderate-", and "High-" ranked impairments throughout the basin (Table 8, Appendix B), with 184 sites located in Alabama (Table 9) and 155 sites located in Florida (Table 10). In total, 479 river corridor and unpaved road crossing impaired sites were identified and assessed throughout the Yellow River Basin (Fig. 7).

Figure 2. Geology of the Yellow River Basin, Alabama.

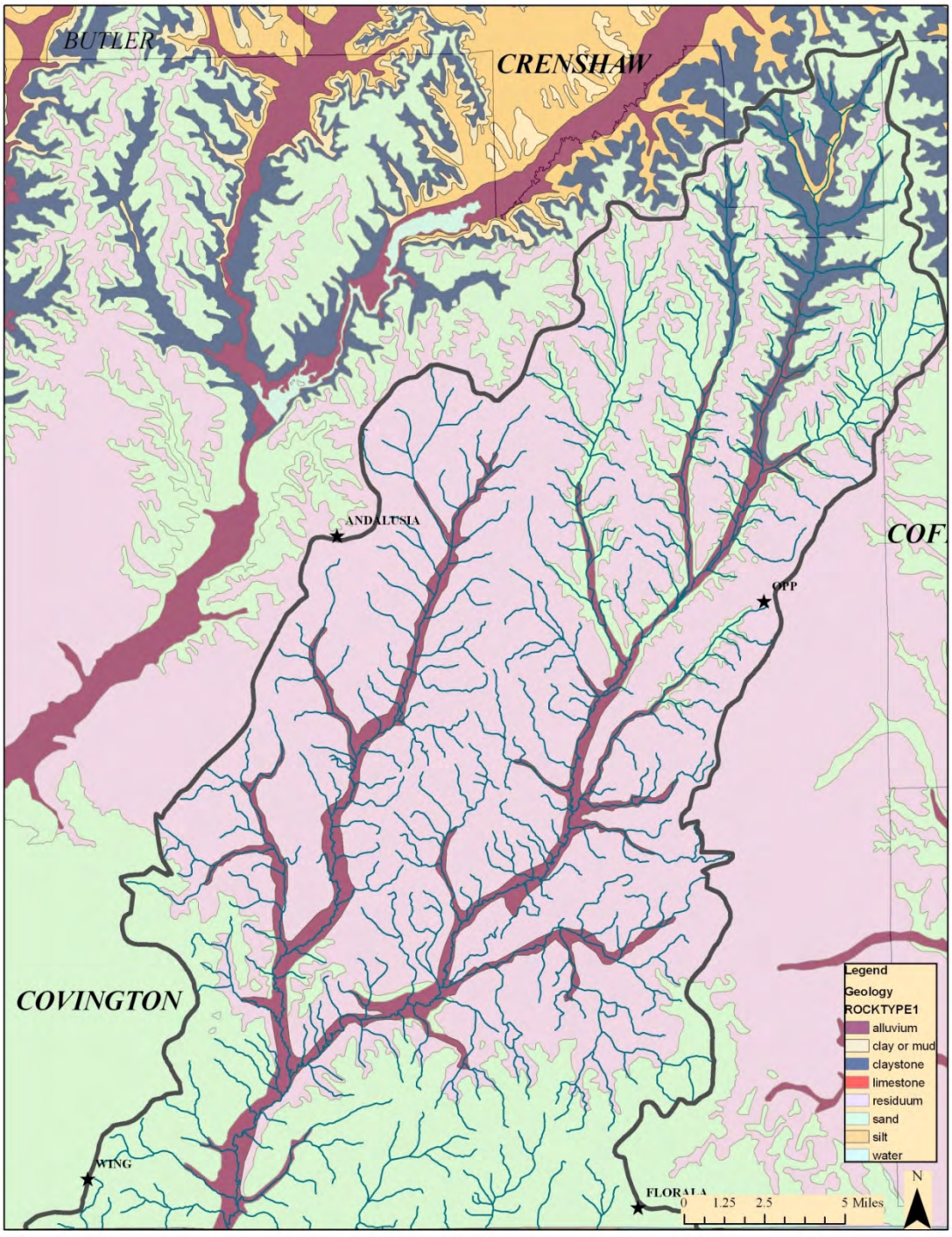


Figure 3. Geology of the Yellow River Basin, Florida. Red outline indicates DoD Eglin Air Force Base boundary.

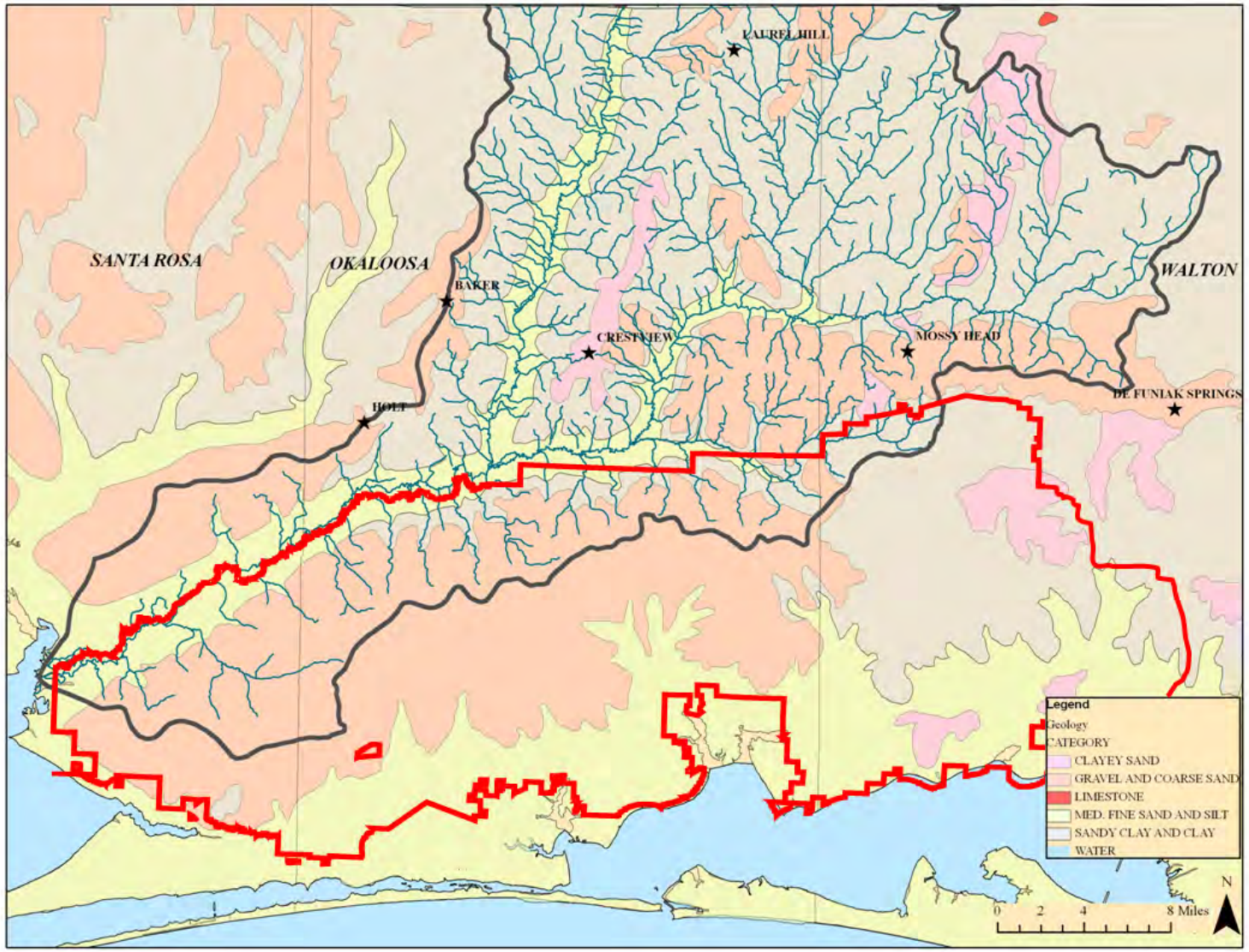


Figure 4. Land cover in the Yellow River Basin, Alabama and Florida.

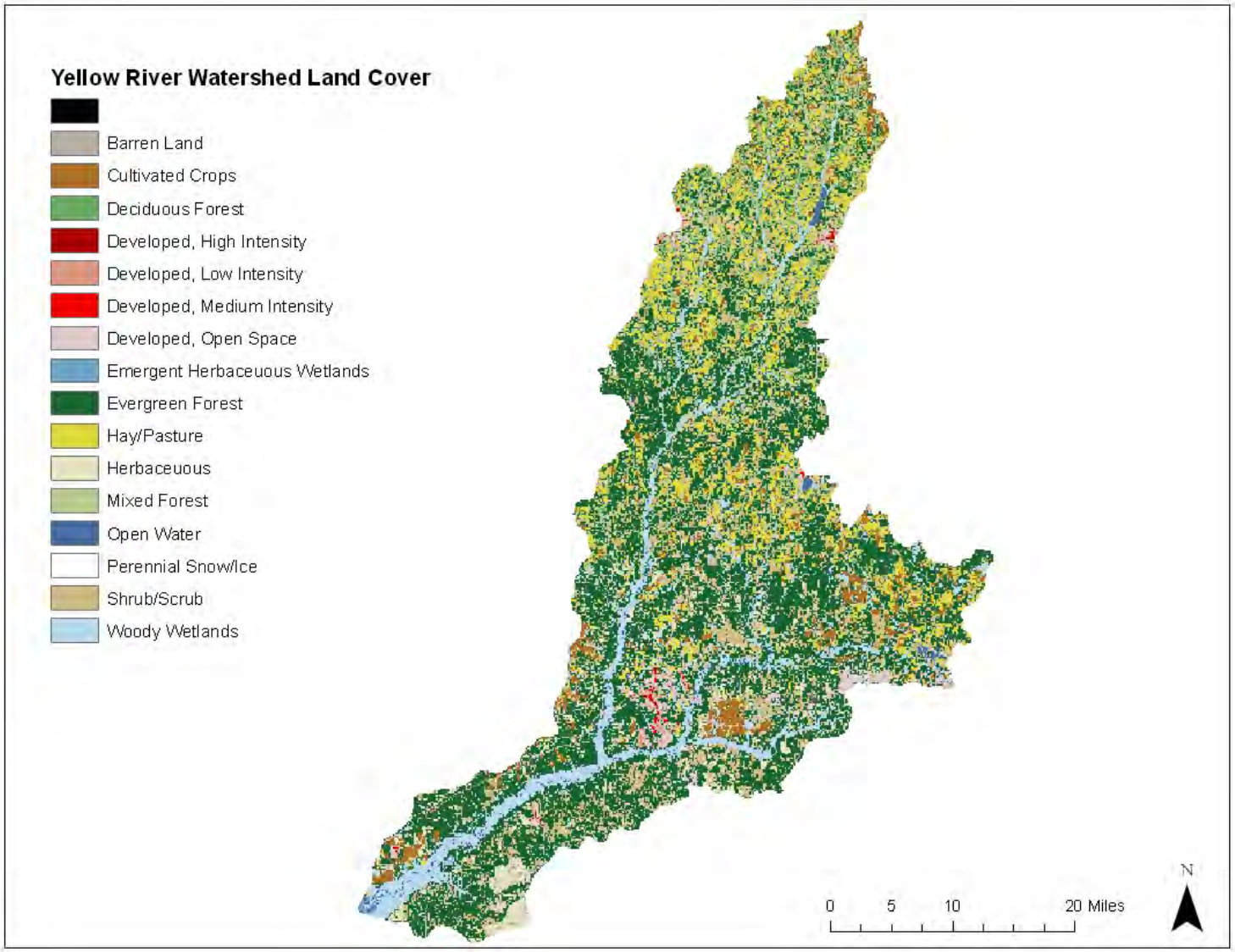


Figure 5. Land use within the Yellow River Basin, Florida. Solid red line indicates northwestern DoD Eglin Air Force Base boundary.

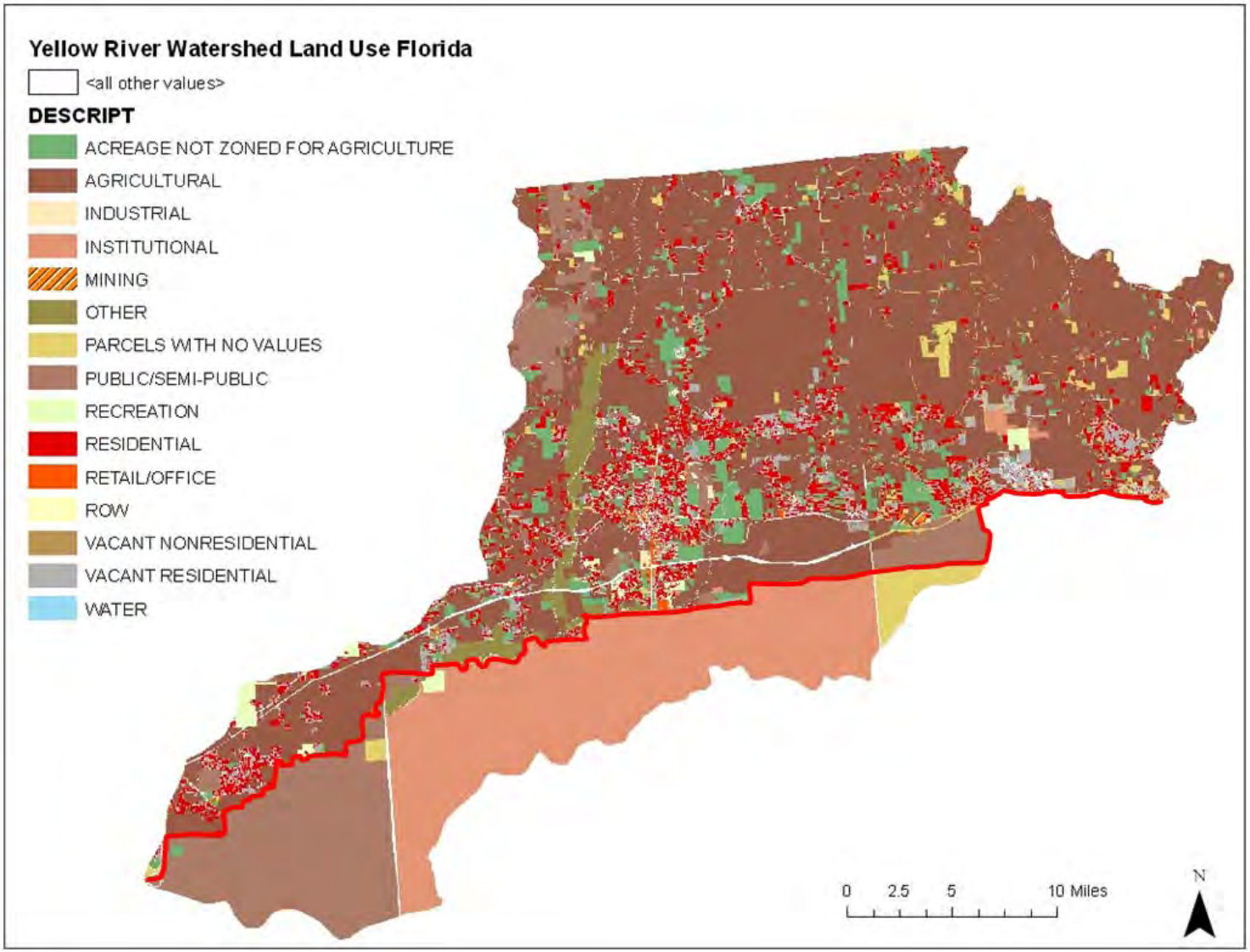


Figure 6. Impoundments in the Yellow River Basin, Alabama and Florida. Black outline indicates DoD Eglin Air Force Base boundary.

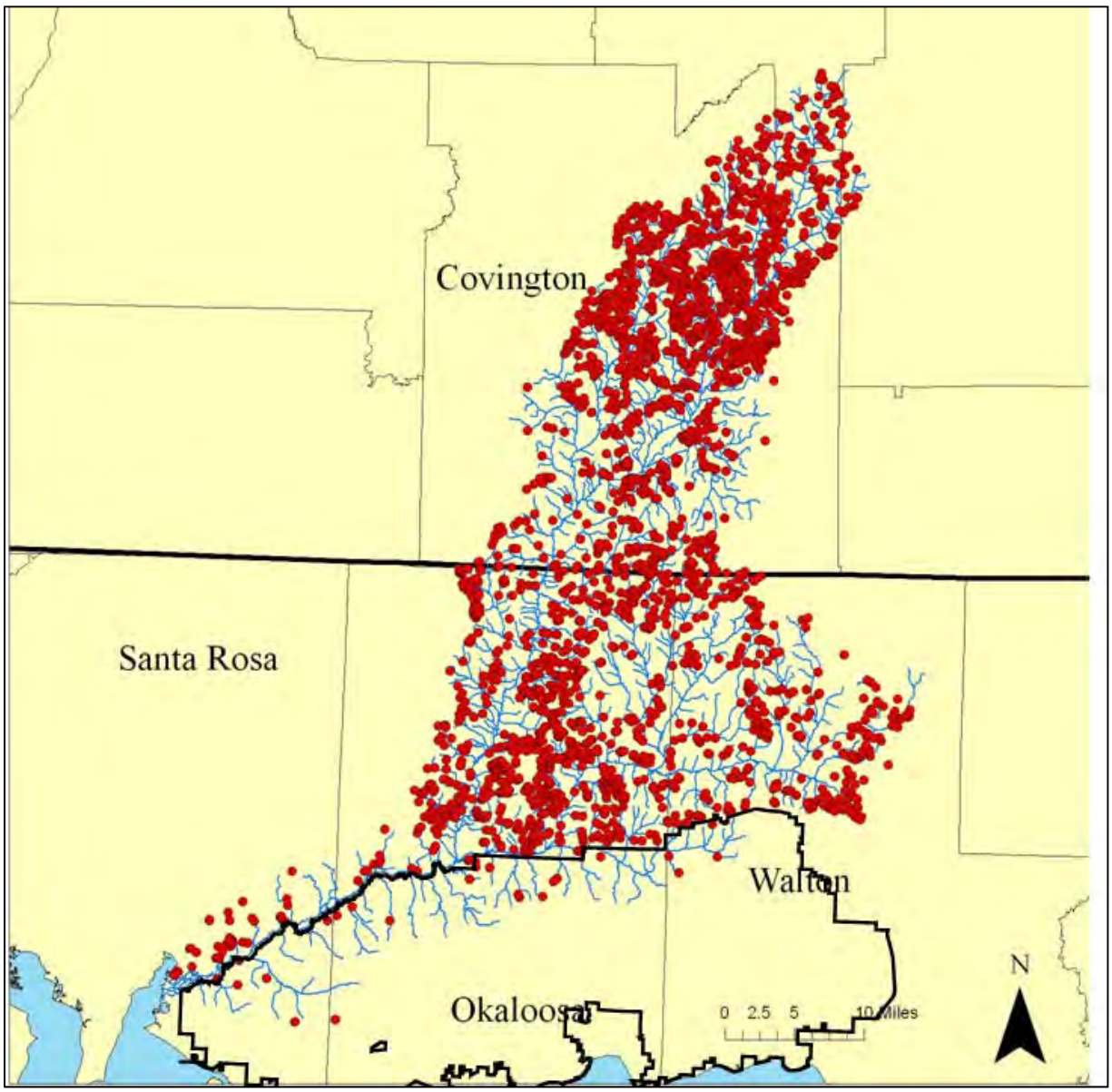


Table 4. River miles assessed in the Yellow River Basin, Alabama and Florida.

Water body	River Miles	Water body	River Miles
Yellow River- AL	35.0	Long Creek	8.0
Yellow River- FL	67.0	Pine Log Creek	6.45
Shoal River	40.0	Dog Creek	0.84
Juniper Creek	1.0	Titi Creek	6.57
Pond Creek	11.6	Boiling Creek	2.57
Five Runs Creek	14.25	Turkey Creek	5.5
Murder Creek	0.35	Gum Creek	4.71
Big Swamp Creek	5.01		
Total:	208.85		

Table 5. Severity score frequencies for river corridor sites in the Yellow River Basin, Alabama and Florida.

Severity Scale	Range	Frequency
Low	0.00 – 4.00	88
Moderate	4.25 – 7.25	43
High	7.50 – 16.5	9
	Total Sites	140

Table 6. Severity score frequencies for river corridor sites in the Yellow River Basin, Florida.

Severity Scale	Range	Frequency
Low	0.00 – 4.00	31
Moderate	4.25 – 7.25	8
High	7.50 – 16.5	0
	Total Sites	39

Table 7. Severity score frequencies for river corridor sites in the Yellow River Basin, Florida.

Severity Scale	Range	Frequency
Low	0.00 – 4.00	57
Moderate	4.25 – 7.25	35
High	7.50 – 16.5	9
	Total Sites	101

Table 8. Sediment Risk Index (SRI) scores for unpaved road crossing sites in the Yellow River Basin, Alabama and Florida.

Sediment Risk Index (SRI)	Range	Frequency
Low	46 – 60	81
Moderate	37 – 45	159
High	12 – 36	99
	Total Sites	339

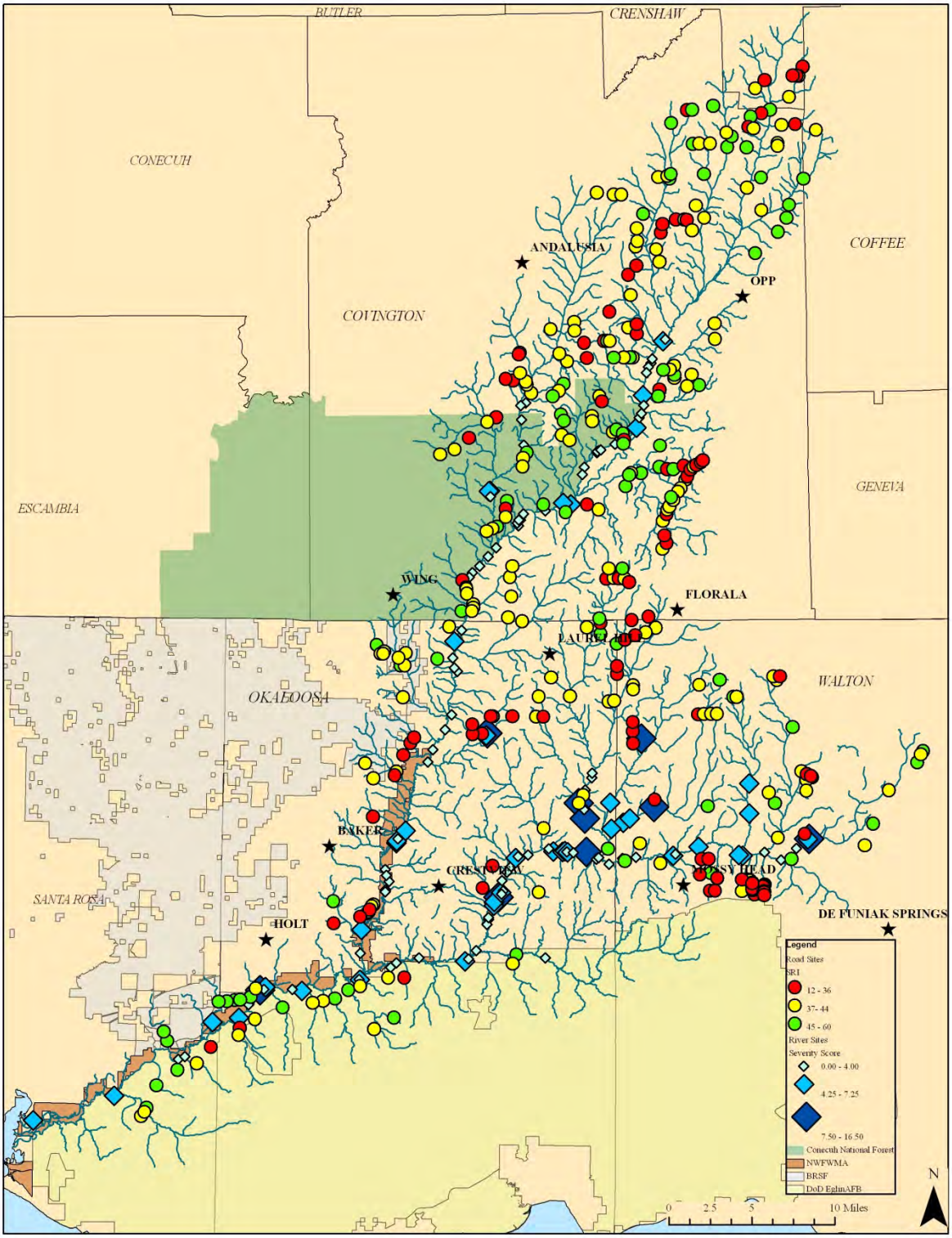
Table 9. Sediment Risk Index (SRI) scores for unpaved road crossing sites in the Yellow River Basin, Alabama.

Sediment Risk Index (SRI)	Range	Frequency
Low	46 – 60	48
Moderate	37 – 45	89
High	12 – 36	47
	Total sites:	184

Table 10. Sediment Risk Index (SRI) scores for unpaved road crossing sites in the Yellow River Basin, Florida.

Sediment Risk Index (SRI)	Range	Frequency
Low	46 – 60	33
Moderate	37 – 45	70
High	12 – 36	52
	Total Sites:	155

Figure 7. Impaired river corridor and unpaved road crossing sites in the Yellow River Basin, Alabama and Florida.



Site Prioritization

Impaired river corridor and unpaved road crossing sites were often located at or near priority ecological resources and designations throughout the basin. Many sites were clustered near each other and were often affected by a common feature such as a road, road crossing, or land use. For example, 35 impaired river corridor and unpaved road sites were found near or at stream crossings of Rattlesnake Road (aka Rattlesnake Bluff Road and Eglin AFB Ranch Road 211) in Okaloosa County, FL. Similar patterns of impairment were apparent throughout the drainage.

We developed two categories for prioritizing sites based on these patterns of impairment location, severity, and potential to affect priority ecological resources and designations: "Focal Areas" and "Areas of Interest". We created these categories to provide a pragmatic restoration approach for maximizing the potential to restore priority ecological resources and designations while minimizing the cost for completing restoration actions (i.e., the "biggest bang for the buck"). All other sites which did not fall within a Focal Area or Area of Interest were considered tertiary places for resource conservation, restoration, and management.

Focal areas are considered primary places for resource conservation, restoration, and management. These areas directly contribute to current degradation in the Yellow River Basin. They also have the greatest potential to positively affect several priority ecological resources and designations because the restoration of one or a few common features could restore numerous sites within the area. Focal Areas were defined as groupings of moderately and highly impaired river and road locations in near proximity to each other which (1) potentially affected several priority ecological resources and/or designations, (2) were within a defined public or private land management area (e.g., a national forest), and/or (3) were typically affected by a common feature.

Areas of Interest are considered secondary places for resource conservation, restoration, and management. These areas also contribute to river and stream degradation, but to a lesser extent than Focal Areas. They also have less restoration potential than Focal Areas because restoration would affect fewer priority ecological resources and designations, though future monitoring of these sites may be necessary if impairments increase within the area. Areas of Interest were defined as groupings of often moderately and highly impaired river and road locations in near proximity to each other which (1) usually affected only one or two priority ecological resources and/or designations, and/or (2) may be affected by a common feature.

We designated seven areas as Focal Areas. The "Clear Creek Watershed", "Conecuh National Forest", and "Five Runs Creek" focal areas are in Alabama. The "Pond Creek Watershed Focal Area" is in both Alabama and Florida. The "Murder Creek", "Rattlesnake Road" (aka Eglin AFB RR 211, see page 46), and "Shoal River at US-90" focal areas are in Florida. Although Five Runs Creek flows through the Conecuh National Forest, we designated it as a separate focal area based on differences in land ownership (and thus potential for enacting restoration) within and outside of the Conecuh National Forest. We designated four areas as Areas of Interest. The "Lightwood Knot" and "Upper Yellow River" areas of interest are in Alabama. The "Oakwood Hills" and "Old River Road" areas of interest are in Florida (Fig. 8).

Focal Areas

Clear Creek Watershed Focal Area.— The Clear Creek Watershed Focal Area consists of the entire Clear Creek watershed, located in south-central Covington County, AL (Fig. 9). We identified a total of 30 impaired unpaved road crossings; no impaired river corridor were identified (Appendix C). Impaired road sites are all privately owned, with 22 of the 30 sites owned by Rayonier Forest Resources LP, of Rayonier, Inc.

Figure 8. Focal Areas and Areas of Interest in the Yellow River Basin, AL and FL. Red outline indicates DoD Eglin Air Force Base boundary.

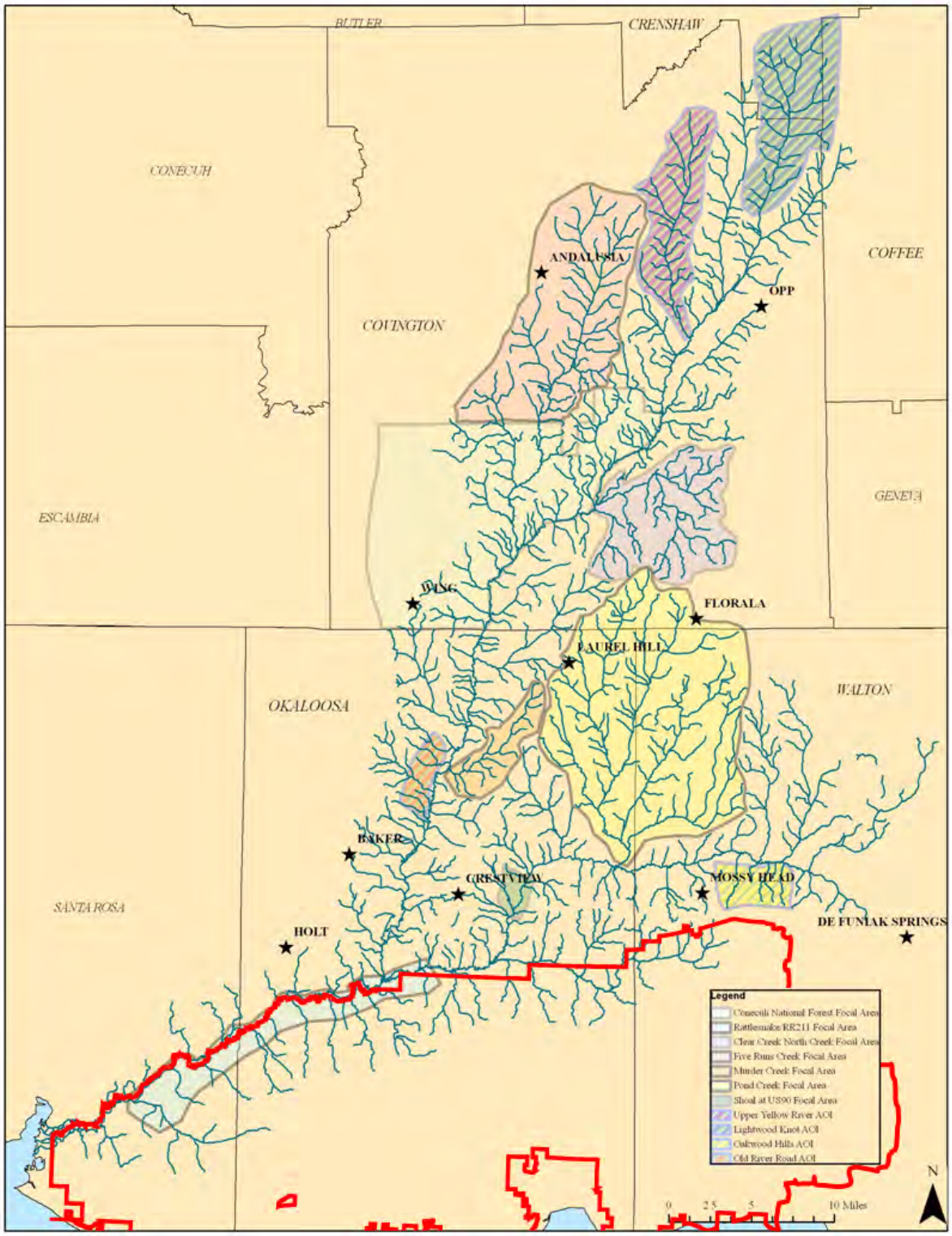
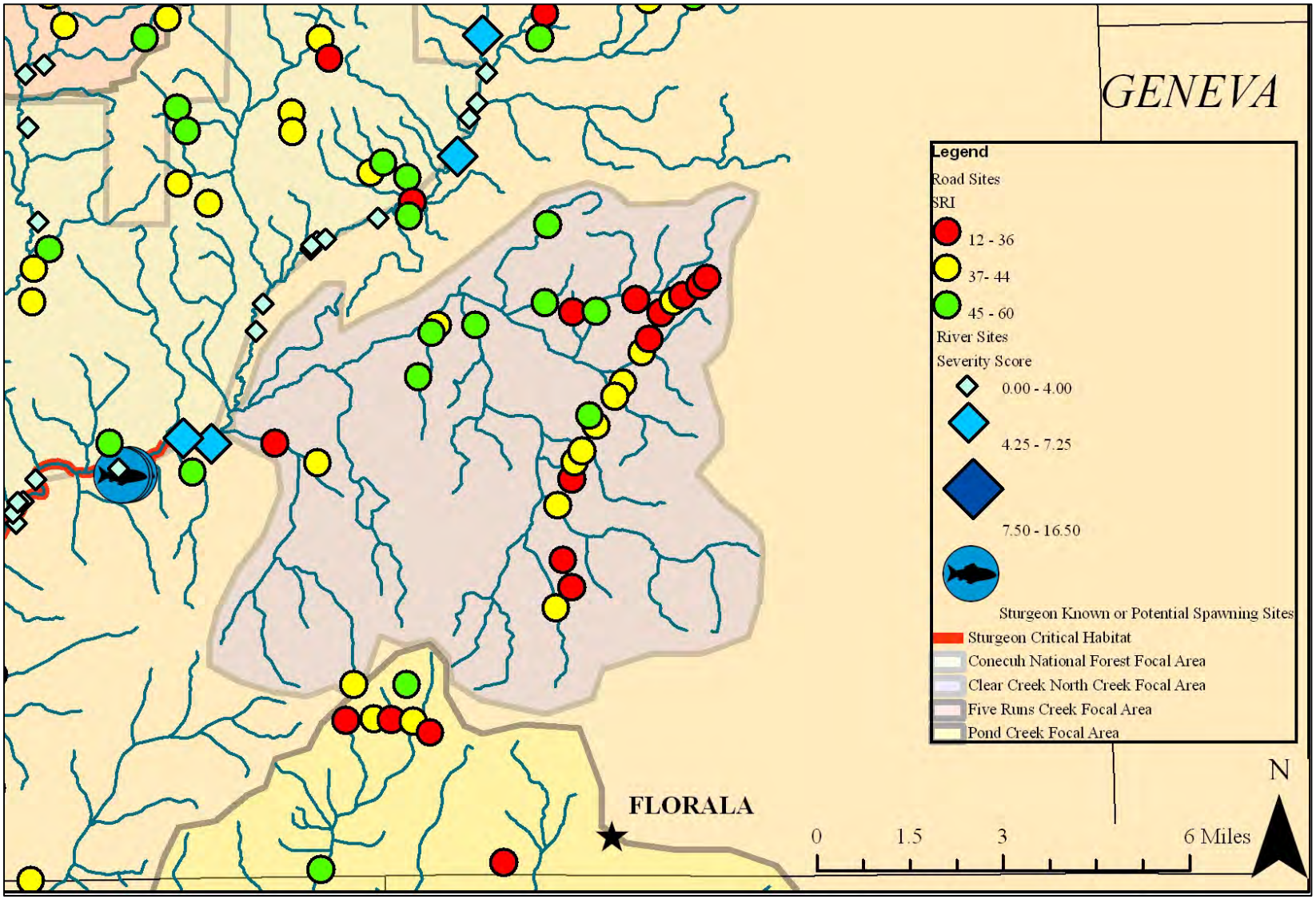


Figure 9. Clear Creek Watershed Focal Area.



Several priority resources and designations are located in or near to the Clear Creek Watershed Focal Area. This focal area directly drains to Gulf sturgeon critical habitat, locations believed to be potential Gulf sturgeon spawning sites, and three collection localities of the candidate mussels Southern sandshell, fuzzy pigtoe (*Pleurobema strodeanum*), and Choctaw bean (*Villosa choctawensis*) in the mainstem of the Yellow River. In addition, this focal area drains to and is located immediately upstream of the 15 river-mile section of the Yellow River that Alabama has designated as impaired under the Clean Water Act Section 303(d) for mercury (Covington Co., AL03140103-0402-100; ADEM 2008).

The 30 impaired unpaved road crossings are comprised of 11 "High", 12 "Moderate", and seven "Low" risk sites. We were unable to survey all of the unpaved roads within this focal area because many were privately owned. However, a majority of impaired sites recorded from this focal area were located along the publically accessible Tram /Johnsons Quarters Road (these roads run together). Tram /Johnsons Quarters Road stream crossings were likely similar to those roads we did not assess based on conditions of nearby roads and confirmation via aerial photography that those roads were similarly unpaved. Thus, the number of impaired unpaved road crossings in the Clear Creek watershed is likely underestimated. Covington County, AL unpaved roads this focal area with impaired sites included Tram /Johnsons Quarters Road (18), Booker Road (3), Swimming Hole Road (3), Laird Road (2), Betty's Road (1), Big Farm Road (1), Buster Aplin Road (1), Camp Eleven Road (1), and New Hope Road (1). These sites crossed Clear Creek and its tributaries.

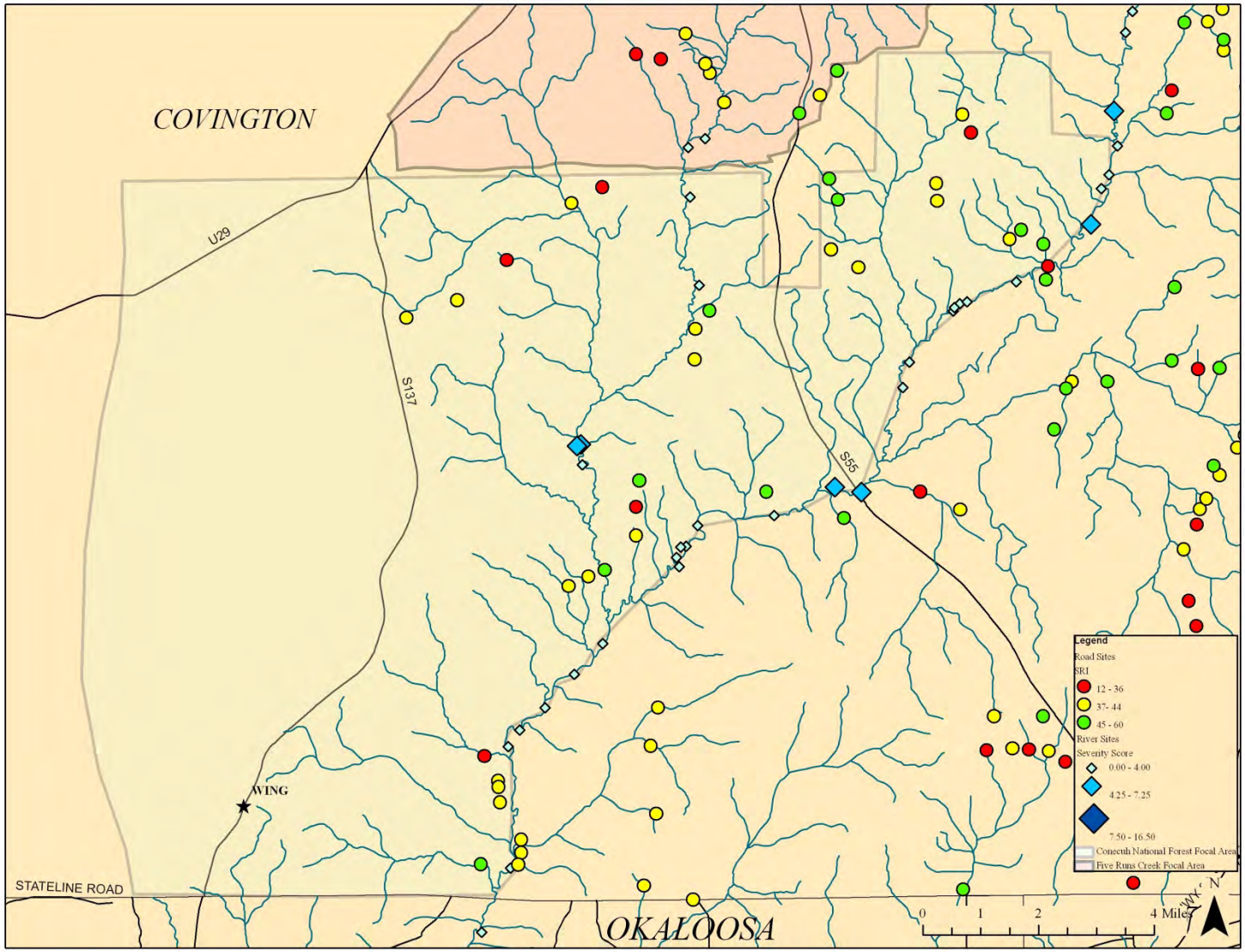
Unpaved road crossings were identified as impaired primarily due to existing or potential for sedimentation resulting from undersized and improperly positioned culverts and bare soils, ditches, and outlets. In addition, much of the watershed appeared to be under silviculture, with

clear cuts and similar land clearings likely contributing to impairment at sites inventoried. Many streams which were at high risk for sedimentation were small tributaries. Sites ranked "High" and "Moderate" were commonly characterized by undersized culverts which were partially blocked, completely blocked, and buried by excessive sediment. This, in combination with high prism fill, resulted in impounded upstream condition and subsequent loss of upstream habitat, fish passage barriers, and loss of downstream habitat heterogeneity due to excessive sedimentation. For example, site co-0820-r-003 (SRI = 28) on Tram Road was characterized by an undersized culvert that was partially buried with sediment and habitat loss was obvious both upstream and downstream of the road crossing. This site, like most of those inventoried, had bare soil ditches and outlets and high prism fill which increased sedimentation risk at those sites. Other sites ranked "Moderate" and "Low" were impaired by similar factors but to a lesser extent than the more impaired sites inventoried.

Conecuh National Forest Focal Area.— The Conecuh National Forest Focal Area consists of the Yellow River and its tributaries within the boundary of the Conecuh National Forest, Covington County, AL (Fig. 10). We identified a total of 52 impaired sites, including 20 impaired sites within the river corridor and 32 impaired unpaved road crossings (Appendix D). Impaired river and road sites are publically (The Conecuh National Forest) and privately owned.

Several priority resources and designations are located in or near to the Conecuh National Forest Focal Area. This focal area is located within or directly drains to Gulf sturgeon critical habitat and locations believed to be potential Gulf sturgeon spawning sites. There are six collection localities of the candidate mussels Southern sandshell, Fuzzy pigtoe, and Choctaw

Figure 10. Conecuh National Forest Focal Area.



bean located in the mainstem of the Yellow River and Five Runs Creek, a large tributary to the Yellow River. Alabama has also designated approximately 15 river-miles upriver from the Alabama-Florida state line in the Conecuh National Forest Focal Area as impaired under the Clean Water Act Section 303(d) for mercury (Covington Co., AL03140103-0402-100; ADEM 2008).

The 20 impaired sites within the river corridor are comprised of five "Moderate" and 15 "Low" risk sites. These sites crossed the Yellow River and Five Runs Creek. River corridor sites identified as impaired for potential bank erosion and sedimentation were predominately due to natural erosive features of the river but nonetheless inventoried during the study. However, there were several sites with impairments likely influenced by proximate land activities. For example, riverbank erosion recorded at site co-0807-009 (severity score = 5) is likely influenced by a land clearing within 30 yards of the riverbank, while impairments recorded at site co-0924-002 (severity score = 4.5) may be influenced by an unpaved road and primitive trail which terminates within yards of the site.

Site co-0610-001 (severity score = 4.25), referred to locally as "Dripping Rock", is characterized by a denuded and breached riverbank and an unpaved road which terminates at the site. Although this site ranks relatively low compared to other impaired river sites, it is directly adjacent to one of five potential Gulf sturgeon spawning sites and is the only site from which sturgeon eggs have been documented in the Yellow River. The "Dripping Rock" site also has substantial public use along its banks adjacent to this spawning area. This site is accessed by the unpaved road, in which persons trespass over private property to reach the river, and vandalization is common. Destruction of the riverbank by trespassers apparently facilitates large amounts of sediment from the unpaved road to enter the river and is believed to smother and

otherwise degrade the natural bedrock and gravel spawning substrate needed by Gulf sturgeon in the Yellow River (FDEP 2002). This site was restored during Phase II of the project (see page 61).

The 32 impaired unpaved road crossings are comprised of six “High”, 17 “Moderate”, and nine “Low” risk sites. Covington County, AL unpaved roads in this focal area with impaired sites included Bass Road (6), Hog Foot Road (4), Sanders Road (4), Shiloh Cemetery Road (3), Braswell Road (2), Bulger Town Road (2), Cravey Bridge Road (2), Nature Road (2), Tim Powell Road (2), Drip Rock Road (1), Groger Road (1), Lamar Lake Road (1), Lake Road (1), and Moores Mill Creek Road (1). These sites crossed small tributaries which drained directly the Yellow River and Five Runs Creek and its tributaries.

Unpaved road crossings were identified as impaired primarily due to existing or potential for sedimentation resulting from undersized and improperly positioned culverts and bare soils, ditches, and outlets. Sites ranked “High” tended to be small tributaries which were impaired primarily due to these factors, with major sources of sediment likely attributed to the unpaved road themselves due to high slope and prism fill. For example, site co-0901-r-018 (SRI = 36) on Cravey Bridge Road is used as a small boat and canoe launch to the Yellow River, and is a collection locality of the candidate mussels Choctaw bean and Southern sandshell. Although the site has a large, properly sized, paved bridge which spans the river channel, bare soil ditches and outlets on all sides of the crossing in combination with high prism fill resulted in a high potential for excessive sedimentation to reach the river unabated, smother in-stream substrates, and generally degraded the river. Sites ranked “High” and “Moderate” were commonly characterized by high prism fill and undersized culverts which were partially blocked, completely blocked, or buried by excessive sediment. This resulted in impounded upstream

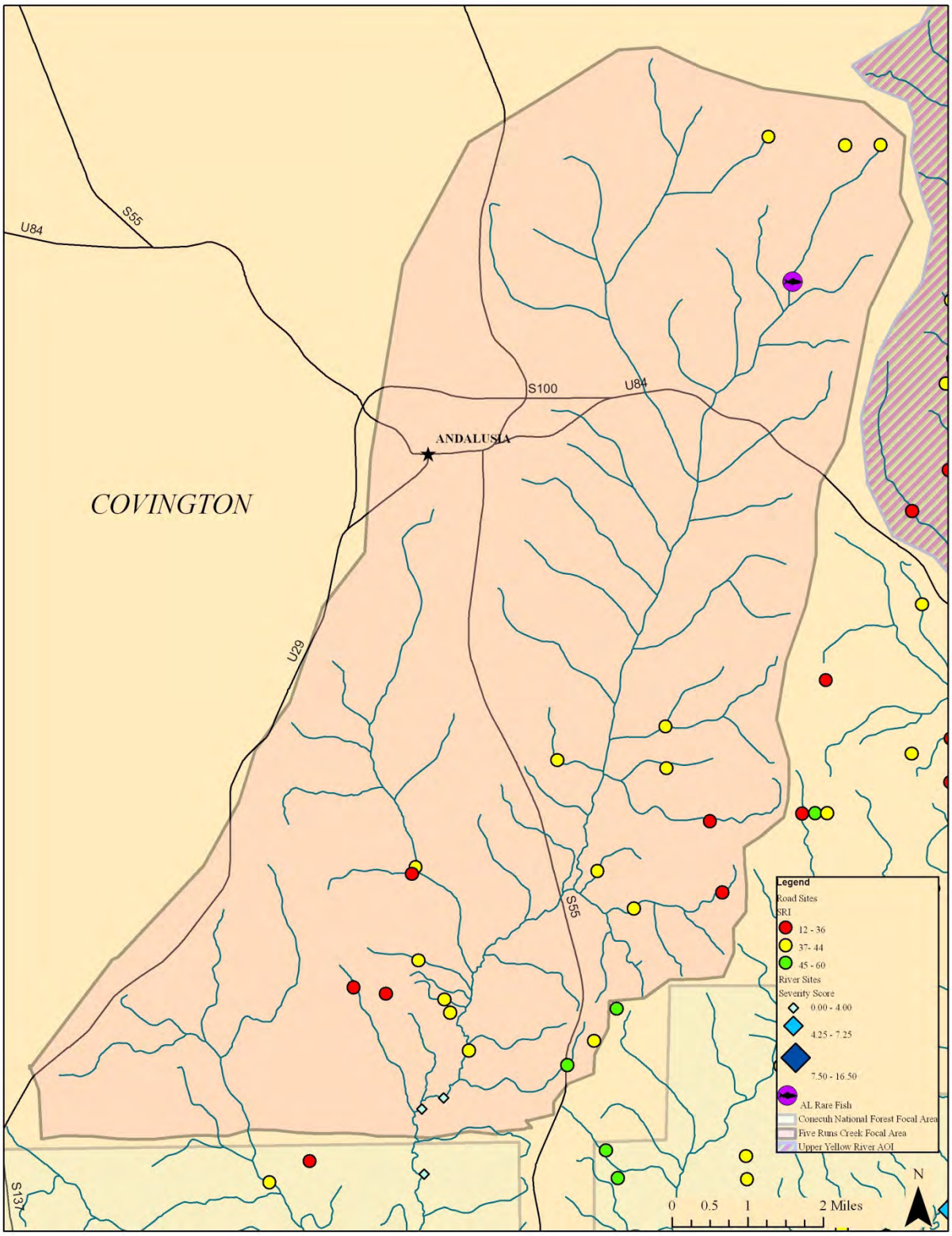
conditions and subsequent loss of upstream habitat, fish passage barriers, and loss of downstream habitat heterogeneity due to excessive sedimentation (e.g., co-0810-r-017 and co-0810-r-011). Cattle access to the stream was also recorded at several sites (e.g., co-0901-r-014 and co-0901-r-010). Other sites ranked "Moderate" and "Low" were also impaired by similar risk factors.

Five Runs Creek Focal Area.— The Five Runs Creek Focal Area consists of the Five Runs Creek watershed north of where it enters the Conecuh National Forest boundary, located in south and central Covington County, AL (Fig. 11). We identified a total of 23 impaired sites, including two impaired sites within the river corridor and 22 impaired unpaved road crossings (Appendix E). All impaired river and road sites are privately owned.

Two priority resources and designations are located in or near to the Five Runs Creek Focal Area. This focal area directly drains to the Conecuh National Forest Focal Area, where three collection locations of the candidate mussels Southern sandshell, fuzzy pigtoe, and Choctaw bean have been recorded from the mainstem of Five Runs Creek. This focal area is also located within the range of one of Alabama's Rare and Imperiled Fishes, the ironcolor shiner (*Notropis chalybaeus*).

The two impaired sites within the river corridor are comprised of one "Moderate" and one "Low" risk site. Both river corridor sites were located in Five Runs Creek. While site co-0923-001 (severity score = 5) was characterized by localized bank erosion likely influenced by an unpaved road leading directly to the edge of the creek, site co-0923-002 (severity score = 2)was likely a natural feature of the river channel. The 22 impaired unpaved road crossings are comprised of five "High", 14 "Moderate", and two "Low" risk sites. Covington County, AL unpaved roads this focal area with impaired sites included Bass Bridge Road (5),

Figure 11. Five Runs Creek Focal Area.



George Mims Road (3), Head Farm Road (3), Eddie Cannon Road (2), Wiggins Farm Road (2), Bay Branch Road (1), Brasville Road (1), Elnor Road (1), Hanegan Road (1), Sammy Brown Road (1), and Stant Wood Road (1). These sites crossed Five Runs Creek and its tributaries.

Unpaved road crossings were identified as impaired primarily due to existing or potential for sedimentation resulting from undersized and improperly positioned culverts and bare soils, ditches, and outlets. Sites ranked "High" tended to be small tributaries which were impaired primarily due to these factors as well as high slope and prism fill. For example, site co-0901-r-012 (SRI = 30) on Sammy Brown Road was characterized by two undersized culverts, high prism fill, and bare soil ditches and outlets. These conditions resulted in excessive sedimentation to the channel, sediment islands and scouring, and loss of habitat both up- and downstream of the road crossing. Localized land clearing within the immediate vicinity of the crossing likely contributed to these impairments. Several "High" and "Moderate" ranked sites were locations where private landowners installed dams at or just upstream of the crossing, creating impoundments, loss of upstream habitat, and complete fish passage barriers (e.g., co-0810-r-015 and co-0810-r-016). Other sites ranked "High" and "Moderate" were characterized by undersized culverts which were partially blocked, completely blocked, or buried by excessive sediment. In combination with high prism fill, this resulted in impounded upstream condition and subsequent loss of upstream habitat, fish passage barriers, and loss of downstream habitat heterogeneity due to excessive sediment. Cattle access to the stream was also recorded at several sites (e.g., co-1029-r-008 and co-1029-r-007). Other sites ranked "Moderate" and "Low" were impaired by similar factors but to a lesser extent than the more impaired sites inventoried.

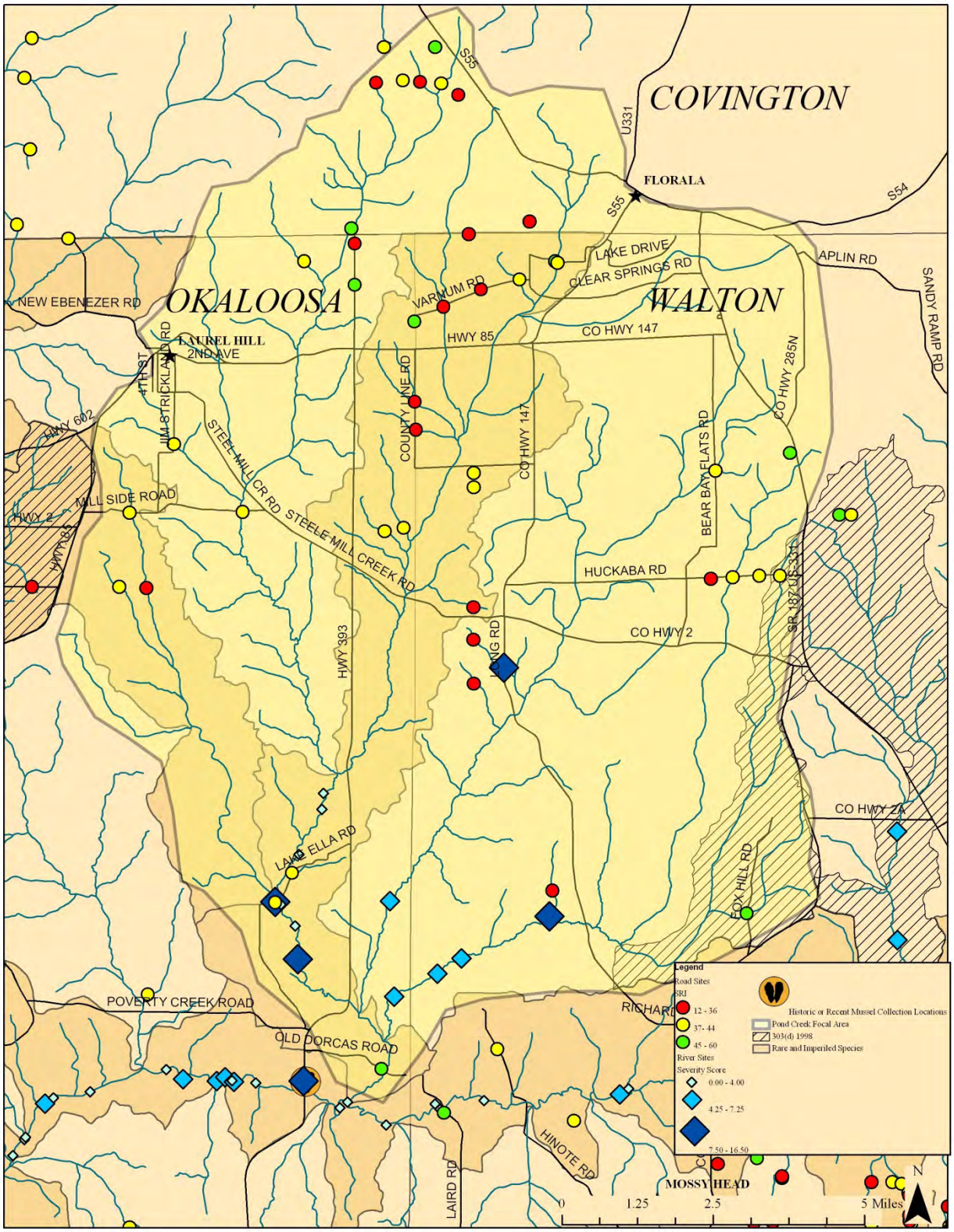
Pond Creek Watershed Focal Area.— The Pond Creek Watershed Focal Area consists of the entire Pond Creek watershed, which drains from the north southward into the middle Shoal

River, located in northeast Okaloosa and northwest Walton counties, FL, and south Andalusia County, AL (Fig. 12). We identified a total of 56 impaired sites, including 13 impaired sites within the river corridor and 43 impaired unpaved road crossings (Appendix F). All impaired river and road sites are privately owned.

Several priority resources and designations are located in or near to the Pond Creek Watershed Focal Area. The mainstems of Pond Creek and Juniper Creek are within the range of two fishes listed among Florida's Rare and Imperiled Species. These fishes include the speckled chub (*Macrhybopsis aestivalis*) and ironcolor shiner. In addition, there is one collection location of a candidate mussel, the Southern sandshell, located at the confluence of Pond Creek and the Shoal River. This focal area overlaps priority wetlands habitat with 1 – 3 focal species in wetland areas in Florida. The confluence of Pond Creek and the Shoal River is within the Outstanding Florida Water designation for the Shoal River. Florida has designated Little Creek as impaired under the Clean Water Act Section 303(d) for fecal coliform (Walton Co., Wbid 144; FDEP 1998). Although Little Creek is not within the focal area, it is located upstream from and drains directly to Long Creek, which is included in the focal area.

The 13 impaired river corridor sites are comprised of four "High", four "Moderate", and five "low" risk sites. These sites were located in Long Creek, Pond Creek, Pine Log Creek, and several unnamed tributaries. River corridor sites were identified as impaired primarily due to existing or potential for riverbank erosion and sedimentation resulting from adjacent unpaved roads and land clearings, intact and abandoned bridges, and powerline crossings. There was also evidence of use of the creeks by trucks and off-road vehicles at two sites on Pond Creek (ok-0922-001 and ok-0928-004).

Figure 12. Pond Creek Watershed Focal Area.



Sites ranked “High” were impaired primarily for different reasons, though the resulting excessive sedimentation, loss of in-stream habitat, and fish passage barriers were similar. Site wa-1007-001 (severity score = 12), an unnamed tributary to Long Creek, was among the highest impaired river sites recorded throughout the study. It was characterized by a complete fish passage barrier due to a concrete dam and resulting upstream impoundment, a completely denuded riparian corridor, and rip-rap which was apparently added to the stream bank but had collapsed into the stream channel. This site is also located downstream of wa-1005-r-005, an unpaved road site ranked “High” for impairments (SRI = 36). These conditions and the resulting sedimentation have resulted in a substantial loss of in-stream habitat heterogeneity for hundreds of yards downstream from the dam and impoundment.

Excessive sedimentation in Pond Creek and its tributary Juniper Creek may be partially responsible for the collapsed bridge and excessive sedimentation present downstream at site ok-0928-001 (severity score = 9.5) . Sources of impairments for other sites ranked “High” included an abandoned powerline crossing with denuded stream banks that allows local access to Pond Creek (ok-0928-004) and stream bank erosion and a failing upstream culvert (wa-1105-004). Sites ranked “Moderate” and “Low” shared similar characteristics as sites ranked “High”, particularly excessive sedimentation and loss of in-stream habitat due to local land use and nearby unpaved roads. Impairments within the this focal area may be affected by current and historical clear cutting forestry practices, particularly in Juniper Creek, a tributary to Pond Creek.

The 43 impaired unpaved road crossings are comprised of 15 “High”, 20 “Moderate”, and eight “Low” risk sites. Covington County, AL unpaved roads this focal area with impaired sites included Union Church Road (5), Chance Road (1), Davis Road (1), and One Bridge Road (1). Okaloosa County, FL unpaved roads with impaired sites include County Line Road (2), East

Plympton Road (2), Lake Ella Road (2), Robinson Road (2), Buck Tyner Road (1), Ludlam Road (1), Millside Road (2), and Pond Creek Road (1) in Okaloosa County. Washington County, FL unpaved roads with impaired sites include Campground Road (4), County Line Road (3), Frost Lane (3), Vamum Road (3), Allen Road (2), Double Bridge Road (2), Bear Bay Road (1), Foxhill Road (1), Franklin Road (1), Jackson Road (1), and Long Road (1). These sites crossed Long Creek, Pond Creek, Pine Log Creek, and several unnamed tributaries.

Unpaved road crossings were identified as impaired primarily due to existing or potential for sedimentation resulting from undersized and improperly positioned culverts and bare soils, ditches, and outlets. In general, sites that ranked "High" were most severely impaired by these factors, resulting in obvious excessive sedimentation and subsequent loss of in-stream habitat as a result. For example, site co-0731-r-008 (SRI = 28) at Horsehead Creek (Pond Creek Drainage) was characterized by two improperly positioned, undersized culverts, resulting in extensive upstream habitat loss due to impounding and loss of downstream habitat due to excessive sedimentation. This condition was common for numerous "High" and "Moderate" ranked unpaved road crossings in this focal area.

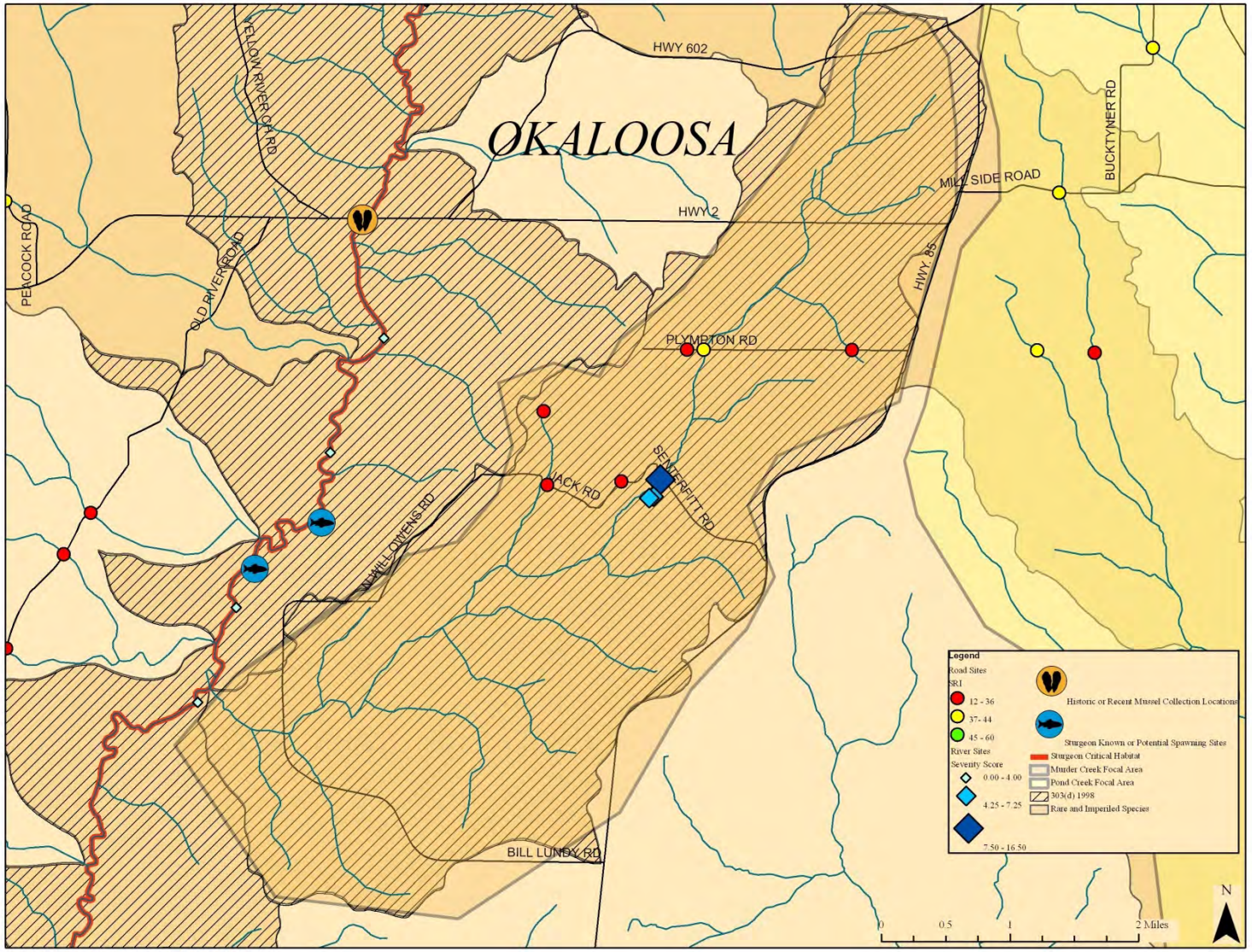
Sites ranked "Moderate" or "Low" were impaired by similar factors but to a lesser extent. Culverts partially blocked, completely blocked, and buried by excessive sediment were not uncommon for sites ranked "High" and "Moderate" (e.g., Wa-0625-r-002 and Wa-0626-r-005). Several sites ranked "High" had complete loss of upstream riverine habitat due to impounded conditions resulting from improperly sized and sediment-blocked culverts, or intentional impounding by private landowners (e.g., Wa-0706-r-003). Cattle access to streams also contributed to impairments at several road crossings. High slopes of unpaved roads in combination with bare soils contributed to impairments at most sites.

Murder Creek Focal Area.— The Murder Creek Focal Area consists of the entire Murder Creek watershed, located in north Okaloosa County, FL (Fig. 13). We identified a total of nine impaired sites, including three impaired sites within the river corridor and six impaired unpaved road crossings (Appendix G). All impaired river and road sites are all privately owned.

Several priority resources and designations are located in or near to the Murder Creek Focal Area. This focal area directly drains to Gulf sturgeon critical habitat. The mainstem of Murder Creek and its tributaries are within the range of two fishes listed among Florida's Rare and Imperiled Species. These fishes include the blacktip shiner (*Lythrurus atrapiculus*) and ironcolor shiner. This focal area overlaps priority wetlands habitat with 1 – 3 focal species in wetland areas in Florida. Florida has designated the Murder Creek Watershed as impaired under the Clean Water Act Section 303(d) for dissolved oxygen and fecal coliform (Okaloosa Co., Wbid 107; FDEP 1998). This focal area also drains directly to a reach of the Yellow River from the Alabama-Florida border downstream to its confluence with the Shoal River that Florida has designated as impaired under the Clean Water Act Section 303(d) for dissolved oxygen, turbidity, and mercury (Okaloosa Co., Wbid 30A; FDEP 1998).

The three impaired sites within the river corridor are comprised of one "High" and two "Moderate" risk sites. All sites were located in Murder Creek. River corridor sites were identified as impaired primarily due to poor bank stability from adjacent land use and conversion, and were highly entrenched. This focal area contained the most highly impaired river corridor site, ok-1105-001 (severity score = 12.5) on Murder Creek. This site is located directly downstream from Senterfitt Road and a private landowner who has extensively cleared land for several acres upstream of the site. There was also large amount of rip-rap present throughout the channel which was presumably used previously for streambank stabilization.

Figure 13. Murder Creek Focal Area.



This has resulted in a loss of in-stream habitat and likely creates a partial fish passage barrier during low flow periods. The other two sites similarly suffer from severe entrenchment and excessive sedimentation, resulting in little in-stream habitat heterogeneity.

The six impaired road crossings are comprised of five "High" and one "Moderate" risk sites. Okaloosa County, FL unpaved roads in this focal area with impaired sites included West Plympton Road (3), Jack Road (2), and Bill Lundy Road/CR-85A (1). These sites crossed Murder Creek, Coon Branch, and several unnamed tributaries. Unpaved road crossings were identified as impaired primarily due undersized and improperly positioned culverts and bare soils, ditches, and outlets. Culverts at all sites were notably undersized, resulting in extensive loss of upstream habitat due to impounding and downstream habitat due to excessive sedimentation. For example, site ok-0429-r-010 (SRI = 26) is characterized by two undersized and perched culverts which completely impound the tributary upstream from the road crossing, resulting in a complete fish passage barrier. This has also resulted in excessive sedimentation and subsequent loss of in-stream habitat downstream from the crossing. Other inventoried sites are similarly impaired by these factors.

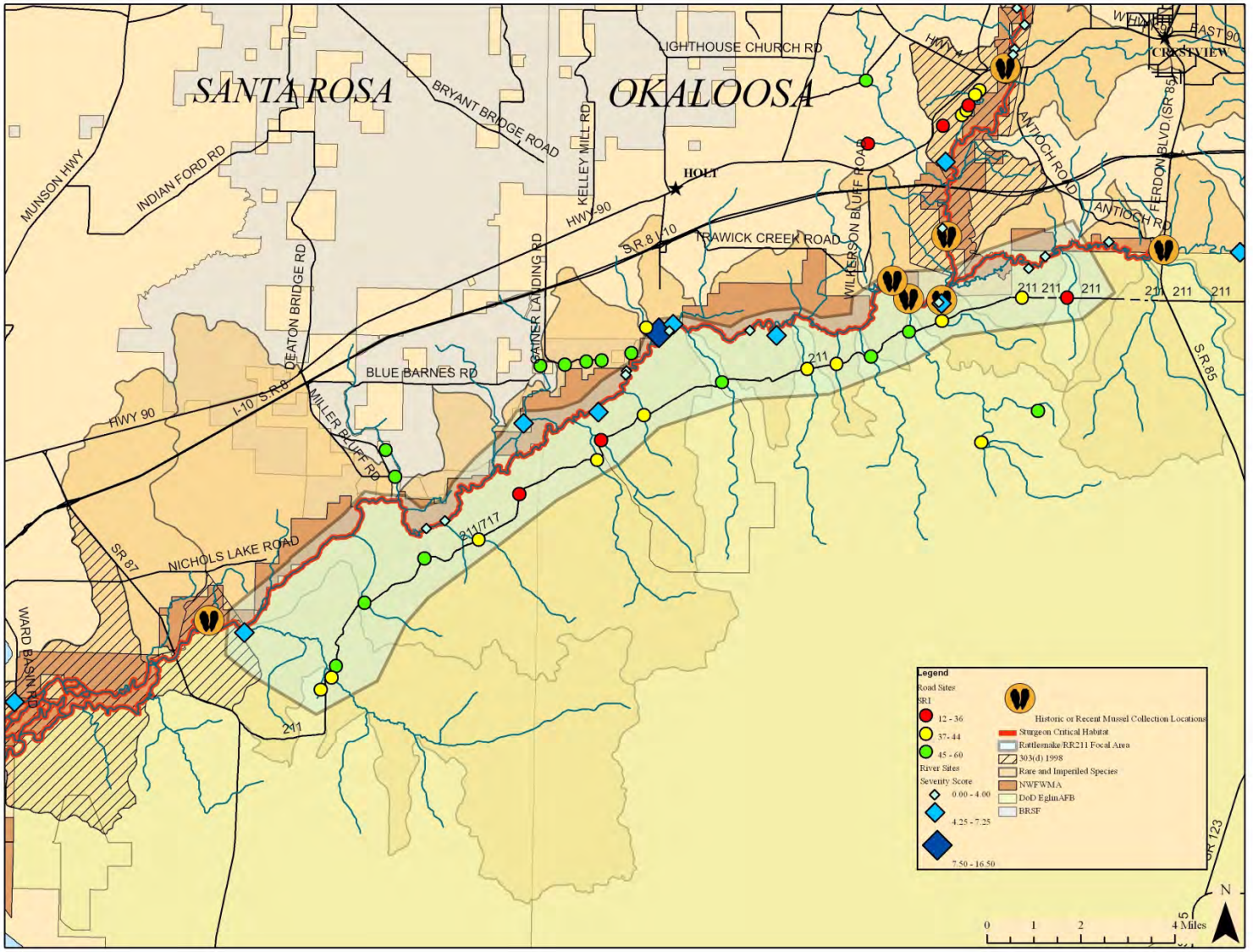
Rattlesnake Road Focal Area.— The Rattlesnake Road Focal Area is located along or near Rattlesnake Road, an unpaved road located in southeast Santa Rosa County and south-southwest Okaloosa County, Florida (Fig. 14). Rattlesnake Road is also known as Rattlesnake Bluff Road and Eglin AFB Ranch Road 211. We identified a total of 35 impaired sites, including 15 impaired sites within the river corridor and 20 impaired unpaved road crossings (Appendix H). Impaired river and road sites are predominately publically owned by the U.S.

Government (Eglin Air Force Base) and the Northwest Florida Water Management District. Other land owners are private entities.

Several priority resources and designations are located in or near to the Rattlesnake Road Focal Area. This focal area is located within or directly drains to Gulf sturgeon critical habitat. The mainstem of the Yellow River as well as all tributaries located within this focal area are within the range of eight fishes listed among Florida's Rare and Imperiled Species. These fishes include the Gulf sturgeon, alligator gar (*Atractosteus spatula*), Alabama shad (*Alosa alabamae*), speckled chub, ironcolor shiner, bluenose shiner (*Pteronotropis welaka*), spotted bullhead (*Ameiurus serracanthus*), and speckled darter (*Etheostoma stigmaeum*). In addition, there are four collection localities candidate mussels within or near to this focal area. These include the narrow pigtoe (*Fusconaia escambia*), Southern sandshell, and Choctaw bean. This focal area overlaps priority wetlands habitat with 1 – 3 focal species in wetland areas in Florida. Florida has designated the lower portion of the Yellow River, which located directly downstream of this focal area, as impaired under the Clean Water Act Section 303(d) for dissolved oxygen, turbidity, and mercury (Santa Rosa Co., Wbid 30A; FDEP 1998).

The 15 impaired river corridor sites are comprised of one "High", six "Moderate", and nine "low" risk sites. These sites were located in the Yellow River, Shoal River, Pitts River, and Boiling Creek. River corridor sites were identified as impaired primarily due to existing or potential for riverbank erosion and sedimentation from adjacent unpaved roads and boat ramps. Site ok-0225-005 (severity score = 8) was impaired due to high potential for riverbank erosion and sedimentation, a pipe discharge, and a collapsed boat ramp originating from a landowner and home positioned near the denuded riverbank. Sites ranked "Moderate" were impaired due to riverbank and boat launch erosion and sedimentation due to public and private land use.

Figure 14. Rattlesnake Road Focal Area.

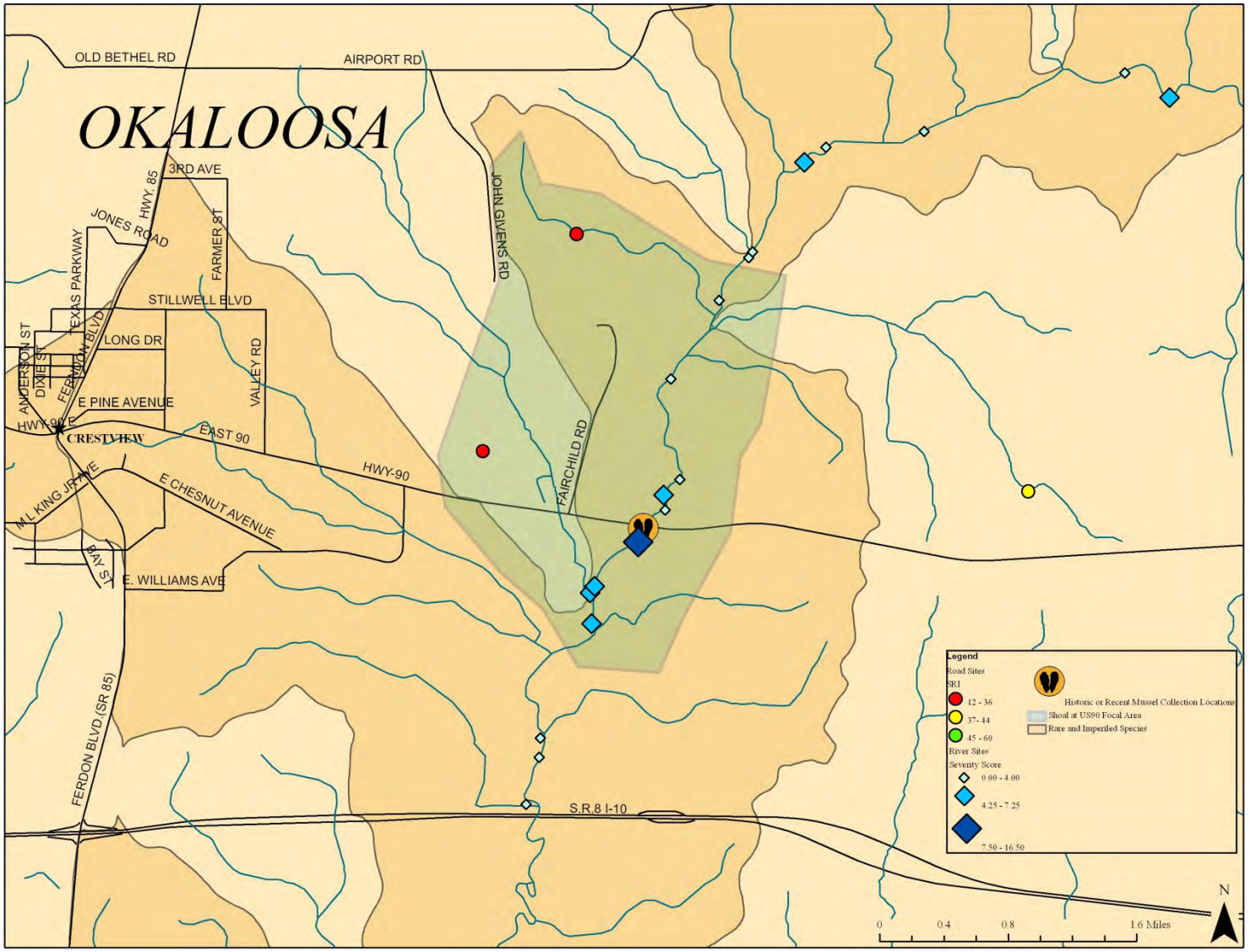


For example, sites used by Eglin AFB for training (ok-0225-001), boat launching (sr-1006-001), and recreation (ok-0319-001, aka “Little Gin Hole”) all had notable sediment risk potential. Private land use such as trailers abutting the river’s edge (sr-0305-001) and designated trailer campgrounds (ok-0225-002) had similar impairments. Sites ranked “Low” had similar potential for sedimentation but were likely due to natural erosive features of the river.

The 20 impaired unpaved road crossings are comprised of three “High”, ten “Moderate”, and seven “Low” risk sites. Rattlesnake Road comprised all impaired unpaved road crossing sites in this focal area. These sites crossed named and unnamed small tributaries which drained directly the Yellow River, Shoal River, and Boiling Creek. Unpaved road crossings were identified as impaired primarily due to undersized and improperly positioned culverts and bare soils, ditches, and outlets. Sites ranked “High” were impaired primarily due to undersized and improperly placed culverts and bare soils. These factors resulted in loss of riverine habitat due to unnaturally ponded upstream condition, loss of downstream habitat diversity due to excessive sedimentation, and fish passage barriers (e.g., ok-0318-r-001). Sites ranked “Moderate” and “Low” were impaired by similar factors but to a lesser extent (e.g., ok-0318-r-006). High slopes of the unpaved road as it approaches these sites in combination with bare soils also contributed to site-specific impairments.

Shoal River at US-90 Focal Area.— The Shoal River at US-90 Focal Area is located approximately 1.5 miles east of the city of Crestview in the immediate vicinity of where US-90 crosses the Yellow River in Okaloosa County, FL (Fig. 15). We identified a total of 11 impaired sites, including nine impaired sites within the river corridor and two impaired unpaved

Figure 15. Shoal River at US-90 Focal Area.



road crossings (Appendix I). Impaired river and road sites are both publicly and privately owned.

Several priority resources and designations are located in or near to the Shoal River at US-90 Focal Area. The mainstem of the Shoal River and its tributaries in this focal area are within the range of three fishes listed among Florida's Rare and Imperiled Species. These fishes include the specked chub, ironcolor shiner, and goldstripe darter (*Etheostoma parvipinne*). There are two collection localities of the candidate mussel Southern sandshell located up- and downstream of where US-90 crosses the Shoal River. This focal area overlaps priority wetlands habitat with 1 – 3 focal species in wetland areas in Florida. It is also within the Outstanding Florida Water designation for the Shoal River.

The nine impaired sites within the river corridor are comprised of one "High", four "Moderate", and four "Low" risk sites. All sites were located in the Shoal River. In general, river corridor sites were impaired primarily due to poor channel stability, recent channel alterations, and mass-wasting banks. Notable are a cluster of four sites, including the site ok-0423-001 (severity score = 11) and four "Moderate" ranked sites, located downstream from US-90. These sites contained large stretches of active mass-wasting banks on both sides of the river, as evidenced by the site condition at the time inventoried, aerial photography, and trees which were likely historically located on the river bank are now positioned in the middle of the channel. Several houses were located directly adjacent to the denuded riverbank approximately 50 yards downstream from US-90. Denuded riverbanks under large powerline crossings (e.g., ok-0616-008) also contributed to poor bank stabilization and high bank erosion potential. In addition, we consistently observed depths of 2-3 ft from bank-to-bank as far as 2.5 river miles downstream from US-90 (approximately to where I-10 crosses the Shoal River). Given the lack of habitat

heterogeneity and sinuosity in this reach, it is likely that the Shoal River has incurred a substantial loss of instream habitat due to excessive sedimentation from these sites. Other sites ranked “Moderate” and “Low” were impaired due to footpaths near to the riverbanks originating from US-90 and natural erosive features.

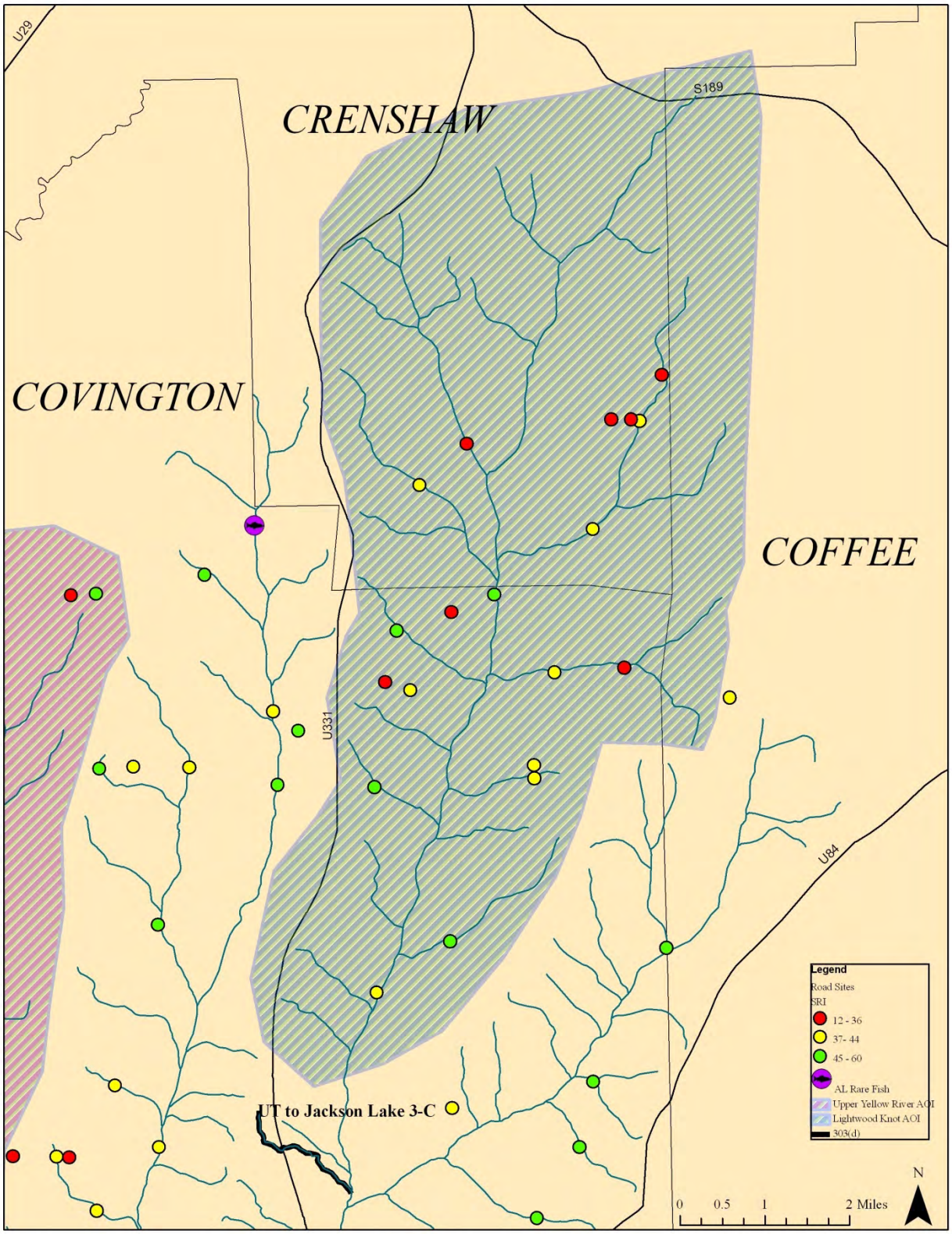
The two impaired unpaved road crossings are comprised of two “High” risk sites. Okaloosa County, FL unpaved roads in this focal area with impaired sites included Fairchild Road (1) and Hare Road (1). These sites crossed two tributaries to the Shoal River. Unpaved road sites were identified as impaired primarily due to existing or potential for sedimentation resulting from undersized and improperly positioned culverts and bare soils, ditches, and outlets. Both were characterized by loss of upstream riverine habitat from impounding due to undersized and improperly positioned culverts and loss of habitat downstream due to excessive sedimentation.

Areas of Interest

Lightwood Knot Area of Interest.— The Lightwood Knot Area of Interest consists of the headwaters of Lightwood Knot Creek, a tributary to the Yellow River located upriver from the Lake Jackson impoundment at the city of Opp, located in northeast Covington, southern Crenshaw, and northwest Coffee counties, AL (Fig. 16). We identified a total of 20 impaired unpaved road crossings; no impaired river corridor sites were identified (Appendix J). All impaired road sites were privately owned. There were no priority resources or designations located in or near to the Lightwood Knot Area of Interest.

The 20 impaired unpaved road crossings are comprised of seven “High”, nine “Moderate”, and four “Low” risk sites. Crenshaw County, AL, unpaved roads in this focal area with impaired sites included Barlow Road (2), Bell Crossing Road (2), Weaver Place Road (2),

Figure 16. Lightwood Knot Area of Interest.



Cauley Road (1), Fox Den Road (1), HDC Road (1), Hudson Road (1), Old Boggy Road (1), and Union Grove Road (1). Covington County, AL unpaved roads in this focal area with impaired sites included Kilcrease Road (3), Community Road (1), Morgan Mill Creek Road (1), Parker Creek Road (1), and Settlement Road (1). These sites crossed Blazer Branch and the mainstem of and small tributaries draining directly to Lightwood Knot Creek.

Unpaved road crossings were identified as impaired primarily due to undersized and improperly positioned culverts and bare soils, ditches, and outlets. Many streams which were at high risk for sedimentation were small tributaries. Sites ranked "High" and "Moderate" were commonly characterized by undersized culverts which were partially blocked, completely blocked, or buried by excessive sediment. In combination with high prism fill at many of these sites, this resulted in impounded upstream condition and subsequent loss of upstream habitat, fish passage barriers, and loss of downstream habitat heterogeneity due to excessive sedimentation. Several privately owned impoundments also impaired several sites in this area.

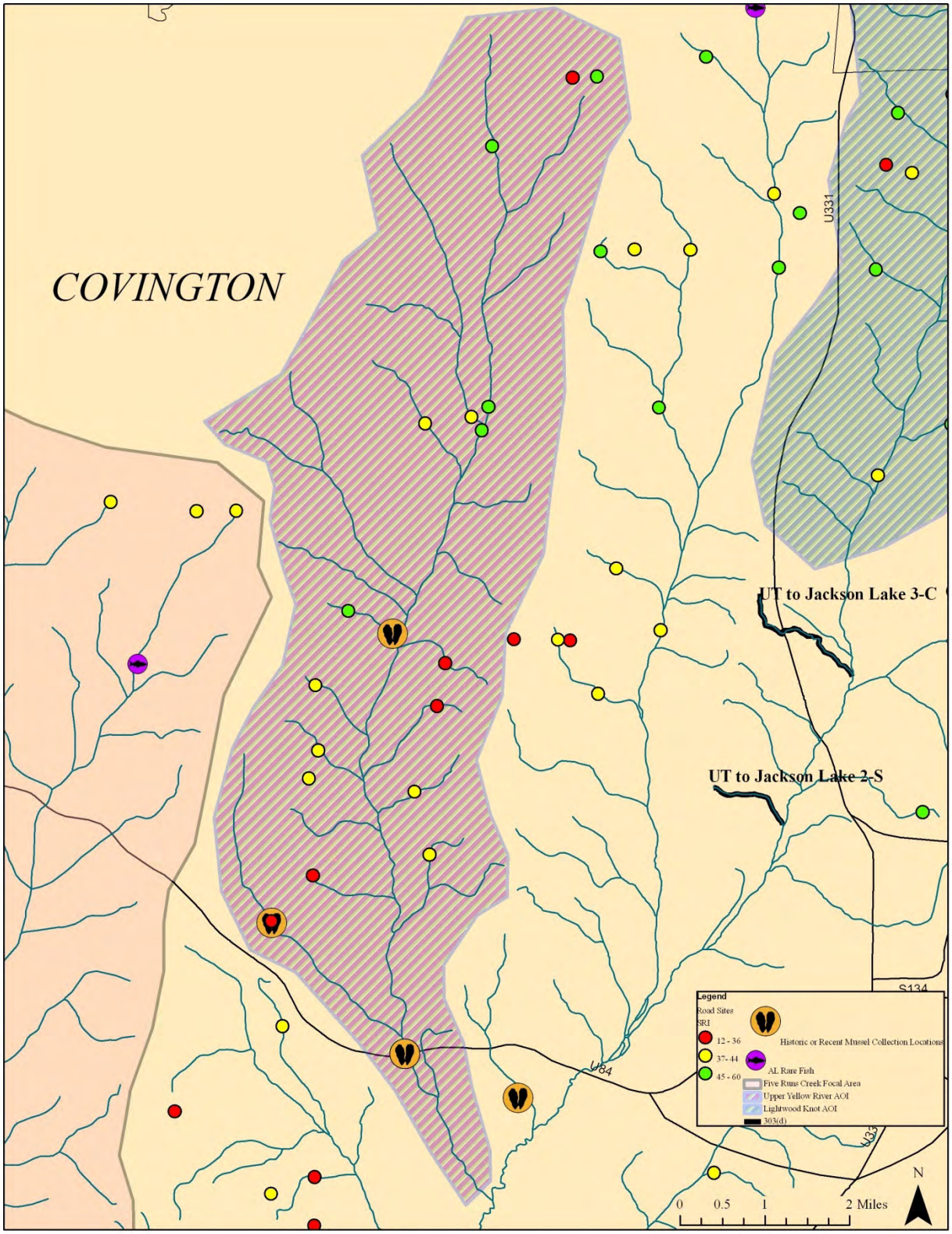
Although numerous sites were impaired, this was not considered a focal area because it lacked the combination priority resources and designations and threat of excessive sedimentation and related impairments compared to focal areas in the Yellow River drainage. There were no priority resources or designations located in or near to this area of interest and all impaired sites flow into Lake Jackson, a man-made impoundment on Lightwood Knot Creek. Sediment and other impairments affecting streams at all impaired sites are deposited in Lake Jackson and thus minimal impairments originating from these sites reaches the Yellow River. However, because this area of interest has been poorly surveyed for fishes and mussels historically, restoration at these road crossings could benefit rare and imperiled species should they be identified in future biological assessments.

Upper Yellow River Area of Interest.— The Upper Yellow River Area of Interest consists of the headwaters of the Yellow River proper, located in north-central Covington County, AL (Fig. 17). We identified a total of 19 impaired unpaved road crossings; no impaired river corridor sites were identified (Appendix K). All impaired road sites were privately owned. Two priority resources and designations are located in or near to the Upper Yellow River Area of Interest. This area of interest is located within the range of one of Alabama's Rare and Imperiled Fishes, the ironcolor shiner. There are also three collection locations of the candidate mussel Southern sandshell in the mainstem of the upper Yellow River within this area of interest.

The 18 impaired unpaved road crossings are comprised of six "High", seven "Moderate", and five "Low" risk sites. Okaloosa County, FL unpaved roads in this area of interest with impaired sites included Old Dragstrip Road (3), Driver Road (2), Horner Smith Road (2), Houston Crossing Road (2), Lord Hill Road (2), Sasser Road (2), Southwind Road (2), E.J. Ready Road (1), Oliver Road (1), and Prestwood Road (1). These sites crossed the mainstem of and small tributaries draining directly to the upper Yellow River.

Unpaved road crossings were identified as impaired primarily due to undersized and improperly positioned culverts and bare soils, ditches, and outlets. Many streams which were at high risk for sedimentation were small tributaries. Sites ranked "High" and "Moderate" were commonly characterized by undersized culverts which were partially blocked, completely blocked, and buried by excessive sediment. In combination with high prism fill at many of these sites, this resulted in impounded upstream condition and subsequent loss of upstream habitat, fish passage barriers, and loss of downstream habitat heterogeneity due to excessive sedimentation. Several privately owned impoundments also impaired several sites in this area of

Figure 17. Upper Yellow River Area of Interest.

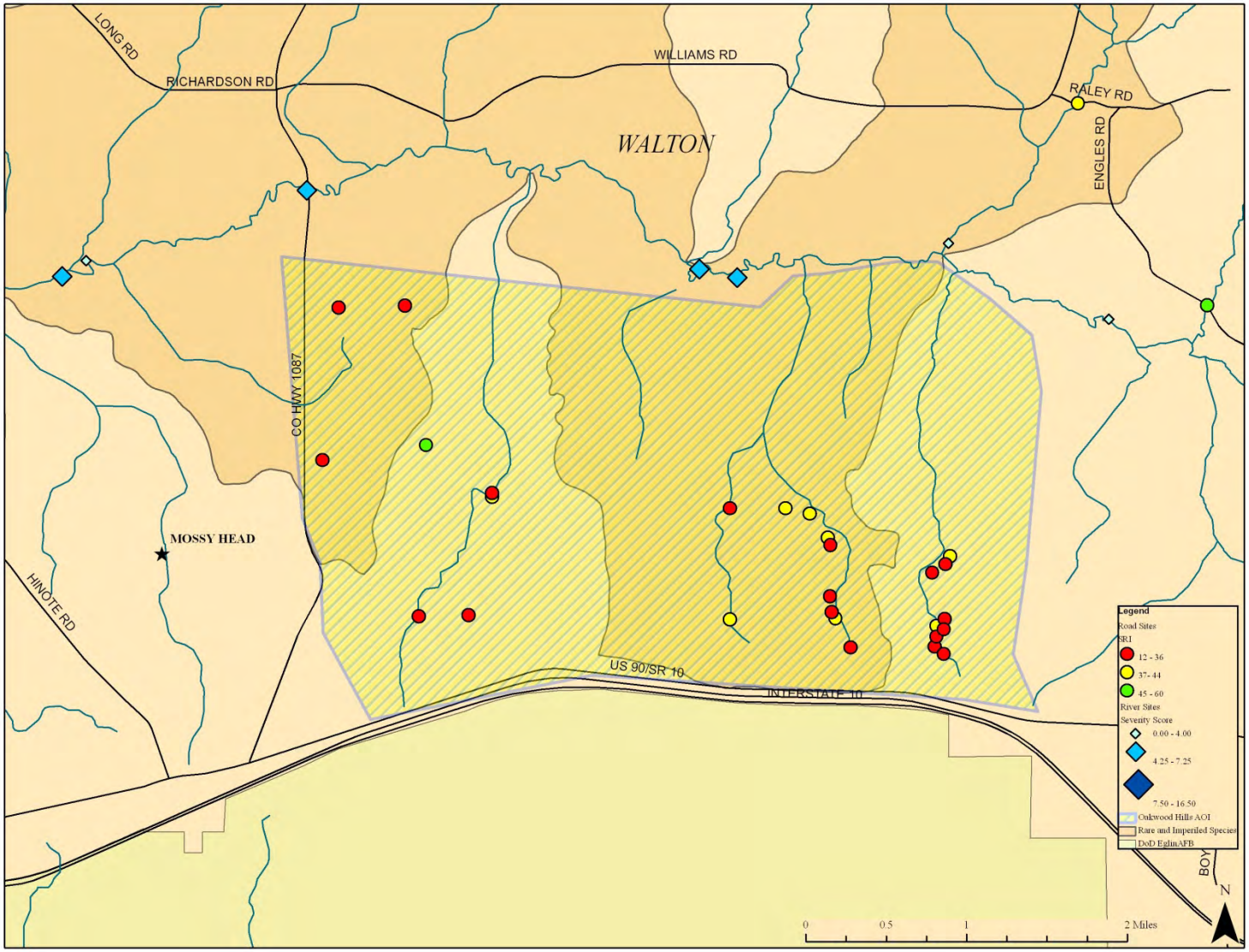


interest. Although numerous sites were impaired, this was not considered a focal area because it lacked the combination priority resources and designations and threat of excessive sedimentation and related impairments compared to designated focal areas in the Yellow River drainage. However, restoration of impaired road sites such as Houston Crossing could improve habitat conditions for the Southern sandshell mussel at the Hollis Creek road crossing collection locality (site co-0907-r-001).

Oakwood Hills Area of Interest.— The Oakwood Hills Area of Interest consists of impaired sites along several creeks and small tributaries draining northward to the upper Shoal River, located in eastern Walton County, FL (Fig. 18). It is named for a housing subdivision located 2.5 miles east of Mossy Head, FL. We identified a total of 30 impaired unpaved road crossings; no impaired river corridor sites were identified (Appendix L). All impaired road sites were privately owned. This area of interest is within the range of three fishes listed among Florida's Rare and Imperiled Species. These fishes include speckled chub, ironcolor shiner, and goldstripe darter. It also overlaps priority wetlands habitat with 1 – 3 focal species in wetland areas in Florida.

The 30 impaired unpaved road crossings are comprised of 11 "High", 12 "Moderate", and seven "Low" risk sites. Okaloosa County, FL unpaved roads in this area of interest with impaired sites included Trout Road (4), Blue Ridge Boulevard (3), Trout Drive (3), Adams Branch Road (2), Blue Ridge Road (2), Unnamed Road off of Squire Way (2), Unnamed Road (2), Amarylis Lane (1), Donna Lane (1), East Dogwood Drive (1), East Lakespur Avenue (1), Hollyhock Place (1), Mill Creek Road (1), Red Oak Road (1), Violet Road (1), and West Dogwood Road (1). These sites crossed Gum Creek, Battle Creek and their tributaries, and

Figure 18. Oakwood Hills Area of Interest.



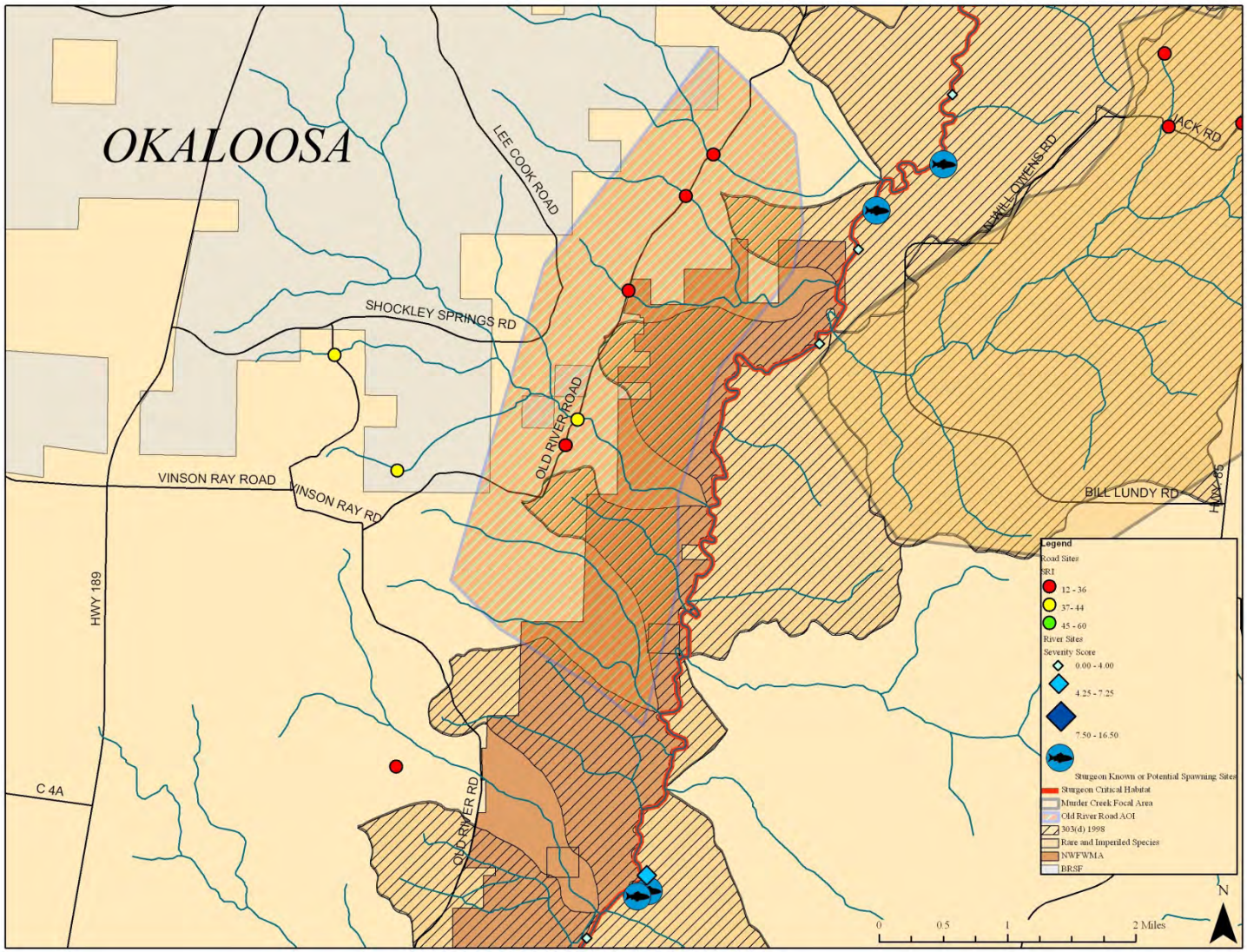
small tributaries to the Shoal River.

Unpaved road crossings were identified as impaired primarily due to undersized and improperly positioned culverts and bare soils, ditches, and outlets. Sites ranked "High" and "Moderate" were commonly characterized by undersized culverts which were partially blocked, completely blocked, or buried by excessive sediment. In combination with high prism fill at many of these sites, this resulted in impounded upstream condition and subsequent loss of upstream habitat, fish passage barriers, and loss of downstream habitat heterogeneity due to excessive sedimentation.

Although numerous sites were highly impaired, this was not considered a focal area because it lacked the combination of priority resources and designations and threat of excessive sedimentation and related impairments compared to designated focal areas in the Yellow River drainage. Nearly all streams at impaired locations flowed into privately owned, man-made impoundments located downstream from their respective impaired site. Aerial photography suggests that these impoundments are regulated by standpipes which drain surface waters to downstream culverts, which is a common water regulation practice for such impoundments in this drainage. Sedimentation entering streams at most locations is likely deposited in these impoundments and thus minimal sediment from these sites reaches the Shoal River. These sites, as well as the confluence of these streams and Shoal River, may need to be assessed in the future as growth in the Oakwood Hills subdivision and this area in general continues.

Old River Road Area of Interest.— The Old River Road Area of Interest is located in north-central Okaloosa, FL, 1.5 miles west of the Murder Creek Focal Area (Fig. 19). It is named for Old River Road, which crosses and impairs several tributaries which drain eastward

Figure 19. Old River Road Area of Interest.



into the Yellow River. We identified a total of five impaired unpaved road crossings; no impaired river corridor sites were identified (Appendix M). All impaired road sites were privately owned.

There are several priority resources and designations located in or near to the Old River Road Area of Interest. This area of interest is located within or directly drains to Gulf sturgeon critical habitat. It is also within the range of three fishes listed among Florida's Rare and Imperiled Species. These fishes include speckled chub, ironcolor shiner, and goldstripe darter. This focal area overlaps priority wetlands habitat with 1 – 3 focal species in wetland areas in Florida. It also drains directly to a stretch of the Yellow River from the Alabama-Florida border downstream to its confluence with the Shoal River which Florida has designated as impaired under the Clean Water Act Section 303(d) for dissolved oxygen, turbidity, and mercury (Okaloosa Co., Wbid 30A; FDEP 1998)

The five impaired unpaved road crossings are comprised of four "High" and one "Moderate" risk sites. Old River Road comprised all impaired unpaved road sites in this area of interest. These sites crossed Bear Branch, Deadfall Creek and one of its tributaries, Polley Creek, and Reedy Creek, which are collectively direct tributaries to the Yellow River. Unpaved road crossings were identified as impaired primarily due to poorly vegetated powerline crossings which runs parallel or near-to two sites, private impoundments which result in fish passage barriers and loss of upstream habitat, and undersized and improperly positioned culverts and bare soils, ditches, and outlets.

Although four of the five sites were highly impaired, this was not considered a focal area for several reasons. First, privately owned impoundments were present at or immediately upstream from three of the five impaired sites. Improvement of road conditions at these sites

would not restore upstream riverine habitat or fish passage unless these landowners would also agree to remove their impoundments and restore each stream channel. Second, sedimentation at these sites ultimately reaches the Yellow River in an area where it has an extensive floodplain. Aerial photography suggests that these confluences are well vegetated and sediment currently reaching this area is likely captured and assimilated before it impacts river directly. However, the proximity of these sites to several priority resources and designations suggests that road improvements and dam removals at these sites could benefit these resources, particularly the speckled chub, ironcolor shiner, and goldstripe darter.

Other sites not categorized as Focal Areas or Areas of Interest are listed in Appendix N.

Site Restoration

Based on the results of Phase I, we identified site number co-0610-001 in the Conecuh National Forest Focal Area as the location for site restoration (Appendix D). This location, known locally as "Dripping Rock", is located on the western bank of the Yellow River approximately two miles downriver of Alabama State Highway 55, in Covington County, AL (Figs. 20 and 21). This location received a severity score of 4.25, resulting in a "Moderate" impairment ranking. Although the site had generally ranked low for most Risk Factors, it had notable impairments for "Bank Erosion" and "Local NPSP (Non-Point Source Pollutants)". Dripping Rock was characterized by a denuded and breached riverbank (Fig. 22) and an unpaved road (Fig. 23) which terminated at the site (Fig. 24). This site was accessible by the unpaved road and had substantial public use, property destruction, and vandalism along its banks from persons who trespassed over private property to reach the river (Fig. 25). Destruction of the riverbank by trespassers facilitated at least 60 tons of excess sediment per year from the unpaved road to

Figure 20. Dripping Rock (site co-0610-001; circled in red), Covington Co., AL. Photo courtesy Topozone.com

Figure 21. Plat map of Dripping Rock site showing property ownership. Green line represents unpaved road which leads from Covington County Road 24 (Open Pond Road) approximately 2,500 ft. south until it terminates at the Yellow River.

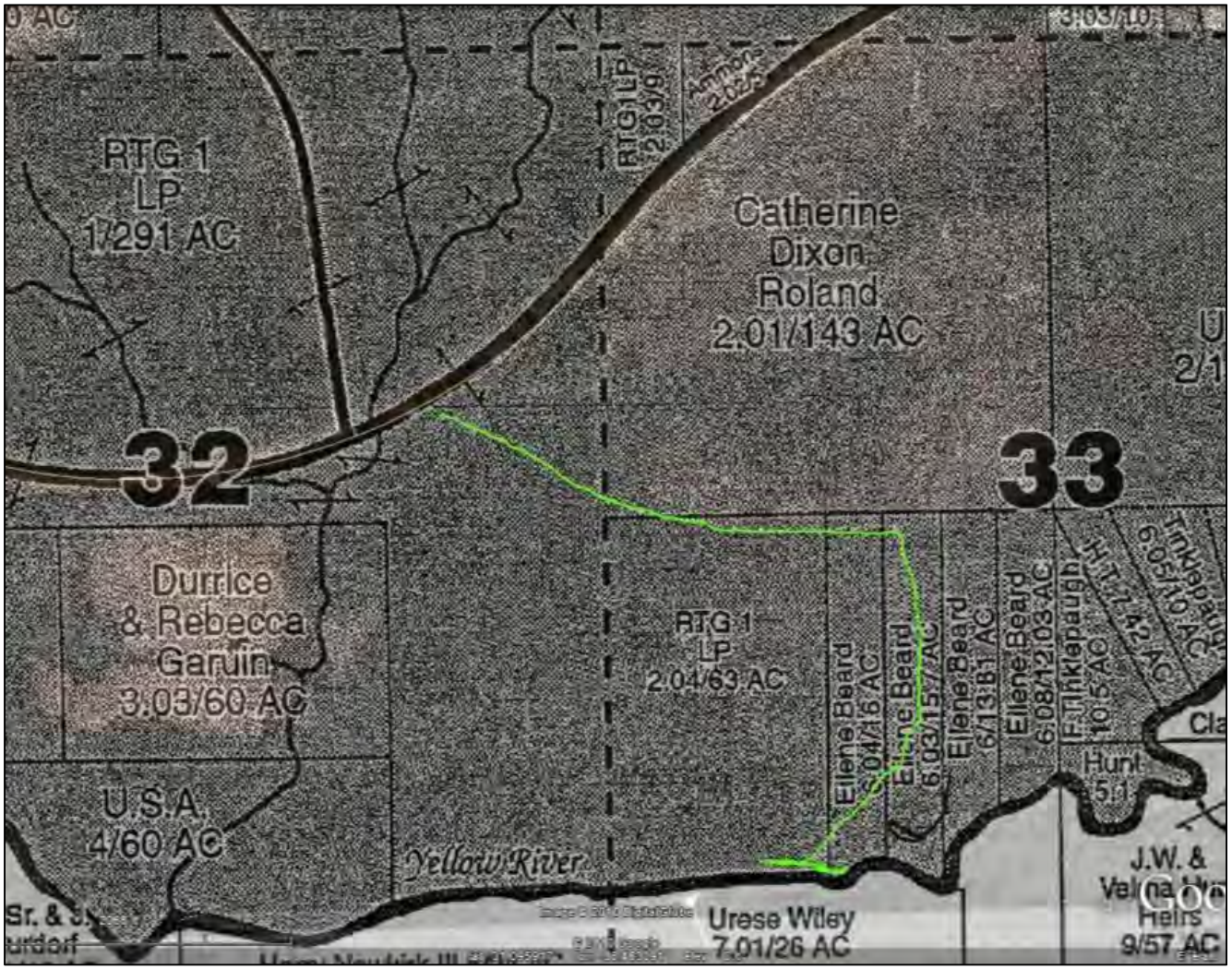


Figure 22. Denuded and breached riverbank at Dripping Rock. Photo credit: The Nature Conservancy.

Figure 23. Unpaved road leading to the Dripping Rock site. Photo credit: The Nature Conservancy.

Figure 24. Unpaved road terminating at the denuded and breached riverbank at Dripping Rock. Photo credit: Eilene Beard.

Figure 25. Degradation from public trespassing at the Dripping Rock site. Photo courtesy of U.S. Fish and Wildlife Service.

directly enter the river (Chris Metcalf, U.S. Fish and Wildlife Service, pers. comm.) (Fig. 26). Sedimentation originating from the unpaved road and denuded riverbank is considered a "High ranking Sources of Stress" to softwater streams, categorized under the heading "roads" in the CWCS (FWC 2005). The State of Florida has previously identified this location as impacting Florida resources and recommended restoration at this site (FDEP 2002).

Dripping Rock is directly adjacent to one of five potential Gulf sturgeon spawning sites and is the only site from which sturgeon eggs have been documented in the Yellow River (USFWS 2001). Excessive sedimentation is believed to smother and degrade the natural limestone hard-bottom substrate – a rare feature in the basin – needed by Gulf sturgeon and likely other species for spawning in the Yellow River (Fig. 27). The U.S. Fish and Wildlife Service also identified the Southern sandshell (*Hamiota australis*) – one of the five mussels which are currently candidates for protection under the Endangered Species Act – at the site in 2011 (Sandy Pursifull, U.S. Fish and Wildlife Service, pers. comm.). The State of Florida has previously identified this location as impacting Florida resources and recommend restoration at this site (FDEP 2002). In addition, the State of Florida has identified this drainage in both Alabama and Florida as an important conservation unit for Gulf sturgeon and recommend habitat restoration for long-term recovery and conservation of its stocks (Wakeford 2001). The cost of restoring this site was estimated as relatively low in comparison to similar river restoration actions (Appendix O). In total, we selected the Dripping Rock site for restoration given the combination of factors above, particularly the potential to optimize benefit to multiple, sensitive species within a rare but ecologically important geologic area of the river which was being directly degraded by a large amount of excess sedimentation.

Figure 26. Breached riverbank showing sediment pollution from the unpaved road directly entering the Yellow River. Photo credit: The Nature Conservancy.

Figure 27. Limestone substrate (shown here exposed due to low river stage) used for spawning by Gulf sturgeon, approximately 0.25 mi. downstream of Dripping Rock. Photo credit: U.S. Fish and Wildlife Service.

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We restored the riverbank as well as the unpaved road leading to the riverbank at Dripping Rock from July 5 – 10, 2011. Although the site is accessible to the public from the Yellow River, we worked with several private landowners to access and stabilize the unpaved road which traversed their properties and was the source of sediment pollution at the site. We used standard unpaved road and river corridor restoration techniques according to restoration designs drafted by the U.S. Fish and Wildlife Service, Panama City Field Office (Appendix O). River corridor was restored by grading, stabilizing & revegetating the breached bank to floodplain level, rather than rebuilding & reconnecting to the adjacent natural levee, in order to help reduce sheer stress from natural rises in river levels thereby reducing chance of failure (Fig. 28). The unpaved road was stabilized by grading, filling, and seeding (Fig. 29). Specifically, we (1) stabilized the length of the impacted streambank and floodplain using natural fiber erosion control cloth; (2) provided native shrub and tree material planting along the stream corridor for future stabilization and habitat recovery; (3) seeded all exposed areas of the road and riverbank with annual and perennial plants; and (4) installed heavy duty gate at road entrance to minimize continued human-induced degradation of the Dripping Rock area (Fig. 30). Materials and supplies for completing the restoration included erosion control fabric for short-term sediment/bank stabilization; stakes for setting the erosion control fabric; trees, shrubs, herbaceous plants, and temporary seed for revegetation and long-term sediment/bank stabilization, and fill dirt for assuring necessary grade; and substrate for long-term revegetation and site stabilization. Figures 31 –36 show pre- and post-restoration photo comparisons at Dripping Rock. See Appendix O for further restoration design and implementation details.

Figure 28. Restored river corridor showing a contoured terrace within the floodplain stabilized with native grasses, shrubs, and trees. Picture taken four days following restoration. Photo credit: U.S. Fish and Wildlife Service.

Figure 29. Unpaved road leading to Dripping Rock was stabilized by grading, filling, and seeding. Photo credit: The Nature Conservancy.

Figure 30. Heavy duty gate installed at entrance to unpaved road from Covington County Road 24 (Open Pond Road) to minimize continued human-induced degradation of the Dripping Rock area. Photo credit: The Nature Conservancy.

Figure 31. Comparison of unpaved road condition before (A) and after (B) restoration at Dripping Rock. Photo credit: The Nature Conservancy.

Figure 32. Comparison of condition of the unpaved road terminus at the breached riverbank, facing north towards the road, before (A) and after (B) restoration at Dripping Rock. Photo credit: The Nature Conservancy.

Figure 33. Comparison of condition of the unpaved road terminus at the breached riverbank, facing west along the riverbank, before (A) and after (B) restoration at Dripping Rock. Photo credit: The Nature Conservancy.

Figure 34. Comparison of condition of the unpaved road terminus at the breached riverbank, facing south towards the Yellow River, before (A) and after (B) restoration at Dripping Rock. Photo credit: Eilene Beard (A) and The Nature Conservancy (B).

Figure 35. Comparison of condition of the breached riverbank before (A) and after (B) restoration at Dripping Rock. Photo credit: The Nature Conservancy.

Figure 36. Comparison of condition of the breached riverbank, looking up-slope from the Yellow River, before (A) and after (B) restoration at Dripping Rock. Phot credit: The Nature Conservancy.

Expected benefits of restoring the Dripping Rock site include: (1) recovery of in-stream habitat for spawning Gulf sturgeon; (2) recovery of native aquatic biota typical to Yellow River stream ecosystems, such as flow-dependent fish and macroinvertebrate species; (3) restoration of natural in-stream water quality and sediment dynamics, which influence the aquatic preserve as described above; (4) increased resilience of aquatic species' populations to population fluctuations; (5) restoration of stream corridor habitat for long-term recovery of the natural riparian vegetation community of this stream system; (6) aesthetic improvement of habitat from degraded to recovered condition; and (7) improvement to condition and management of public resources. The Nature Conservancy and U.S. Fish and Wildlife Service will monitor the restoration success at this site, including future estimates of sedimentation, Gulf sturgeon spawning habitat use, and mussel habitat use.

DISCUSSION

In general, rivers and streams in the Yellow River Basin flow through a relatively undeveloped landscape. However, results of this study suggest that impairments resulting from existing development may be degrading its aquatic resources. Excessive sedimentation was particularly pervasive at the impaired sites identified in the study, which is consistent with threats identified nearby drainages (USFWS 2005a, Witmer et al. 2009). All impaired river corridor sites exhibited similar risk factors regardless of drainage position. Most river corridor sites with a severity ranking of "Moderate" or "High" were impaired primarily due to poor channel stability, recent channel alteration, active or mass-wasting bank erosion, and/or high or extremely high BEHI score (other risk factors such as pipe discharge, water odors, and fish passage barriers were relatively rare). These factors are strongly influenced by geology and underlying bed material, with smaller-sized substrates, such as the sand and clay which typifies the bank and bed

materials of rivers and streams in the Yellow River Basin, at greater risk than larger-sized materials (Rosgen 1996). These sites were commonly near road crossings, land clearings, power lines, and/or similar land use actions which denuded the river banks and further undermined riverbank stability. In contrast, most river corridor sites with a "Low" severity score ranking were typically natural erosion or depositional features of the river or stream. However, the magnitude of these features might be influenced by excessive sedimentation originating from impaired sites upriver. The Shoal River at US-90 focal area exemplified this phenomenon, where several highly impaired sites with long reaches of ongoing mass wasting resulted in the loss of instream habitat and unusually large point-bar development miles downstream from these sites. Considering that river corridor sites with a ranking of "High" were relatively few (6%) and "Low" ranking sites comprised the majority of identified sites (63%), impairments within the river corridor are generally uncommon within the approximately 209 river miles assessed during the study.

Impaired unpaved road crossing sites also exhibited similar risk factors regardless of drainage position. Unpaved roads were more highly impaired than river corridor sites, with SRI rankings of "Moderate" (47%) or "High" (29%) indicating an elevated threat for sedimentation to the streams they crossed. These sites were impaired primarily due to undersized and improperly positioned culverts and bare soils, ditches, and outlets risk factors. These factors commonly resulted in partially or completely blocked culverts, loss of upstream habitat due to subsequent impounding, and loss of downstream habitat heterogeneity due to excessive sedimentation characterized by sediment islands and bank scouring at impaired sites. Fish passage was often noted as limited or prohibited due to these conditions (though this was not calculated in the SRI). Single roads frequently impaired multiple road and occasionally river

corridor sites (e.g., Rattlesnake Road), suggesting that sediment stabilization, paving, and/or similar restoration actions for such roads might have a collective conservation benefit. Although most unpaved roads crossed small tributaries, the cumulative sediment loading across these sites may substantially degrade the tributaries they feed and the Yellow River mainstem. Unpaved roads therefore may present the most widespread, pervasive source of excessive sedimentation in the Yellow River Basin.

Fish passage barriers and loss of in-stream habitat and connectivity may result from the thousands of small impoundments estimated throughout the Yellow River Basin. We acknowledge that our methodology likely misidentifies, mis-categorizes, and/or overlooks potential impoundments. However, we believe this estimation is accurate enough to illustrate the pervasiveness of impoundments caused by (1) unpaved road sites which unintentionally created impounded upstream conditions as observed at numerous field sites, and (2) deliberate construction of private and public impoundments in the basin. Such dams and impoundments pose among the most significant threats to freshwaters, commonly causing substantial changes to riverine habitats and flow patterns with significant losses of biodiversity in affected systems (see Hart and Poff 2002 and references therein). While our estimation may seem large, the National Inventory of Dams has cataloged more than 79,000 dams in the USA, and estimate as many as two million unidentified dams and tens of millions of unidentified culverts resulting in fish passage barriers nationwide (USACE 2005). Populations of biological communities such as fish and mussels – including those prioritized during this study – are likely impacted by these impoundments. Additionally, these impoundments likely exacerbate habitat and ecological degradation already resulting from excessive sedimentation in the basin. Given these resources and the need to restore riverine corridors, habitat, and connectivity under ongoing climate change

(Palmer et al. 2009, Seavy et al. 2009), a more robust analysis of impoundments and their ecological effects in the Yellow River Basin is warranted.

MANAGEMENT RECOMMENDATIONS

General Recommendations

There are 479 impaired river corridor and unpaved road crossing sites in the Yellow River Basin. Excessive sedimentation is the primary cause of impairment at nearly all of these sites, a pattern consistent with recent examinations of rivers and streams in other nearby drainage basins. Focusing future resource conservation, restoration, and management efforts in specific areas can maximize the potential to restore priority ecological resources and designations while minimizing the cost for completing restoration actions (i.e., the "biggest bang for the buck"). As such, we recommend that efforts be concentrated in the seven Focal Areas identified in this study. Focal areas with a large proportion of public ownership, such as the Rattlesnake Road and the Conecuh National Forest focal areas, may present the most immediate and viable opportunities for restoration. This is because (1) public funding is more readily available in greater amounts for restoration actions on public lands and sovereign resources, (2) state and federal agencies managing these areas generally have greater restoration experience than private landowners, and (3) the number of parties needed to approve restoration at multiple sites is significantly reduced under one or a few public managing agencies responsible for those areas. It should be noted, however, that while private entities may own the lands abutting river corridor sites and unpaved road crossings, the counties, states, and federal government usually have ownership and/or jurisdiction over sovereign river resources and the unpaved road crossings themselves. An exception to this may be the Clear Creek Watershed Focal Area, where one

private entity – Rayonier Forest Resources LP, of Rayonier, Inc. – owns most impaired sites in that area. Restoration in this focal area may be therefore more similar to areas which are publically owned for the reasons stated above.

We strongly encourage restoration at multiple sites under one project as stated above. Unpaved roads, which contribute to the greatest and most severe number of impairments, may be the best targets for restoration. We recommend targeting unpaved roads which affect multiple sites to provide maximum reduction in excessive sedimentation and benefit to priority ecological resources and designations. High-priority roads include:

- Rattlesnake/Rattlesnake Bluff/Eglin AFB Ranch Road 211 (Rattlesnake Road Focal Area)
- Bass, Hogsfoot, and Sanders roads (Conecuh National Forest Focal Area)
- Tram /Johnsons Quarters Road (Clear Creek Watershed Focal Area)
- Bass Bridge Road (Five Runs Creek Focal Area)
- Union Church Road (Pond Creek Watershed Focal Area).

We also recommend initiating improvements at highly impaired river corridor sites. Although these sites tend to contribute excessive sediment to a lesser degree than unpaved road sites, stabilization can provide substantial conservation benefit, especially when completed in tandem with nearby unpaved road sites. The Phase II restoration of site co-0610-001 ("Dripping Rock") in the Conecuh National Forest Focal Area is an excellent example of such targeted, high-leverage restoration actions. Other high priority sites include:

- All river corridor sites ranked "High" and "Moderate" in the Rattlesnake Road Focal Area (especially if combined with unpaved road restoration)

- All river corridor sites ranked “High” and “Moderate” in the Shoal River at US-90 Focal Area.

Focal areas may provide heretofore unrecognized mitigation potential for future public and private construction, roads, and related projects. Few mitigation sites have been identified in the Yellow River Basin (see Yellow River Ranch Mitigation Area located 1.5 mi. downstream of the Rattlesnake Road Focal Area in Santa Rosa County, FL for an exception). This study provides hundreds of localities where impairments to rivers, streams, and wetlands have been assessed and prioritized using standard methods. These sites can be used to further develop mitigation credits and plans in both Alabama and Florida. We recommend that any future mitigation investigation be focused within the focal areas identified herein.

Eglin Air Force Base Recommendations

This study identified the Rattlesnake Road Focal Area containing among the highest priority sites recommended for restoration. This was the only focal area that directly affects Eglin AFB. To summarize, a total of 35 impaired sites, including 15 impaired sites within the river corridor and 20 impaired unpaved road crossings, were identified. These sites are predominately publically owned by the Eglin AFB and the Northwest Florida Water Management District. River corridor sites were impaired primarily due to existing or potential for riverbank erosion and sedimentation from adjacent unpaved roads and boat ramps. Unpaved road crossings were impaired primarily due to undersized and improperly positioned culverts and bare soils, ditches, and outlets. Several priority resources and designations are located in or near to the Rattlesnake Road Focal Area, notably the federally threatened Gulf sturgeon and candidate mussels the narrow pigtoe, Southern sandshell, and Choctaw bean. Rattlesnake/Rattlesnake Bluff/Eglin AFB Ranch Road 211 within this focal area was specifically identified as among the

highest priority unpaved roads for restoration. This road is maintained by both the Eglin AFB and Okaloosa County. This road also provides access to several impaired river corridor sites owned/used by Eglin AFB for training (ok-0225-001), boat launching (sr-1006-001), and recreation (ok-0319-001, aka "Little Gin Hole"; Appendix H)

Eglin AFB and the USFWS recognize that the unpaved roads of Eglin AFB range road system are experiencing accelerated rates of erosion resulting in excessive sedimentation and habitat loss that adversely impacts the environment and road system management (Rainer 2001; USFWS 2007). This is exemplified at Rattlesnake/Rattlesnake Bluff/Eglin AFB Ranch Road 211, which is a significant source of excessive sedimentation from multiple sites to Yellow River tributaries, contains many inadequate culverts, is prone to frequent wash-outs, and is an access road which contributes to the impairment of several river corridor sites. As with our General Recommendations, we strongly encourage Eglin AFB to stabilize/restore the unpaved Rattlesnake/Rattlesnake Bluff/Eglin AFB Ranch Road 211 as a primary action within the Rattlesnake Road Focal Area.

Restoration of Rattlesnake/Rattlesnake Bluff/Eglin AFB Ranch Road 211can provide multiple benefits to military and natural resource stewardship missions. First, stabilization and sediment control measures can help reduce excessive sedimentation originating from the bare-soil road, ditches, and ditch outlets to better maintain road conditions as a consistent and reliable throughway. Second, stabilization measures can dramatically reduce the amount of fill needed to maintain road grade, with a direct and often substantial cost savings in equipment, supplies, materials, operation hours, administrative, and related costs to Eglin AFB (USFWS 2005b). Third, road stabilization combined with restoration of certain impaired river corridor areas can improve the quality of Eglin AFB training sites, including sites sr-1006-001 (Severity Score =

4.25) and ok-0225-001 (Severity Score = 5.75; Appendix X). Both sites are unimproved and characterized by unpaved roads and unimproved boat ramps with moderate to high bank erosion potential. Stabilization of the riverbanks and road and hardening of the boat ramp can reduce sedimentation, improve long-term reliable access, quality of use, and site condition for training exercises. Fourth, similar restorative actions can provide improved, high-quality recreation areas for Eglin AFB personnel, such as the training sites above as well as ok-0319-002 (Gin Hole Landing; Severity Score = 3.75) and ok-0319-001 (Little Gin Hole Landing; Severity Score = 5.25).

Finally, restoration of Rattlesnake/Rattlesnake Bluff/Eglin AFB Ranch Road 211 can substantially reduce sedimentation and related water quality and habitat impacts to federally protected or incipient protected species and their designated/proposed critical habitats. Federally protected or candidate species found adjacent to or within the focal area include Gulf sturgeon and the narrow pigtoe, Southern sandshell, and Choctaw bean mussels (Fed. Reg. 2003; Fed Reg. 2011). The Eglin AFB owns land adjacent to the critical habitat designated or proposed for these species, with no portions of stream or river channels occurring within the boundary of the military reservation, and are therefore not exempted or proposed for exemption for critical habitat under the Endangered Species Act (Fed. Reg. 2003; Fed Reg. 2011). Eglin AFB must therefore consult with the USFWS on any action that may affect these species' populations and their respective critical habitats. In addition, managing the impacts from excessive sedimentation is a designated "primary constituent element" that may destroy or adversely modify these species' critical habitats and is considered essential to their conservation (Fed. Reg. 2003; Fed Reg. 2011). This road accounted for all 20 impaired road crossings, which crossed 16 different tributaries that drained directly (or within one stream order) to the Yellow River within

these species' critical habitats, with 13 of these crossings constituting a "High" or "Moderate" risk primarily from excessive sedimentation.

The Eglin AFB is currently consulting with the USFWS to assure that the current range road maintenance program consultation does not destroy or adversely modify critical habitats for these species (K. Herrington, U.S. Fish and Wildlife Service, pers. comm). We recommend that the Eglin AFB employ similar unpaved road stabilization/restoration and culvert modification/replacement techniques as used to aid the recovery of Okaloosa darter within Eglin AFB lands (Fed. Reg. 2010). We expect this will benefit the Eglin AFB by similarly reducing its regulatory burden and aid in the recovery of several species which are federally protected or proposed for protection that are likely impacted by the current condition of Rattlesnake/Rattlesnake Bluff/Eglin AFB Ranch Road 211.

In March 2011, we provided a draft copy of the final version of this report for review and comment from Stephen Seiber, Chief of the Natural Resource Management Section of Eglin AFB. Mr. Seiber informed us that the draft was acceptable and that he concurred with Rattlesnake/Rattlesnake Bluff/Eglin AFB Ranch Road 211 restoration recommendation. In the subsequent months, Eglin AFB has implemented sediment control measures at sites ok-0407-r-005 (Metts Creek; SRI = 50), ok-0407-r-004 (Malone Creek; SRI = 44), ok-0318-r-004 (Turkey Gobbler Creek; SRI = 46). Sediment control measures included construction of earthen berms in ditch outlets, seeding and planting to stabilize berms, and use of temporary sediment controls such as silt fencing and hay bales to reduce sediment runoff originating from the road, ditches, and ditch outlets at the sites. The Eglin AFB has also begun closing access to site ok-0319-002 (Gin Hole Landing; Severity Score = 3.75), while providing sediment control measures and Geoweb ® sediment stabilization and slope protection at the unpaved road boat ramp at site ok-

0319-001 (Little Gin Hole Landing; Severity Score = 5.25). Mr. Seiber also stated that Eglin AFB is currently developing sediment control measure plans for at least five additional sites located on Rattlesnake/Rattlesnake Bluff/Eglin AFB Ranch Road 211 and at other training sites identified within the Rattlesnake Road Focal Area. We encourage Eglin AFB to continue to these measures as well as explore options internally and with partners for restoration actions that further reduce excessive sedimentation originating from this road and focal area.

Restoration Guidelines

Specific restoration recommendations for each impaired site are beyond the scope of this project. However, the development of explicit, detailed, engineering-level stream restoration designs will be necessary to once sites are actively targeted for restoration. Fortunately, there are numerous, high-quality guides to enacting riverine and road restoration actions that can ameliorate the threats identified in this study. Rosgen (1996) provides excellent foundational information on patterns and influence of environmental and anthropogenic factors in river channel development, degradation, and restoration. The Natural Resources Conservation Service has developed specific guidelines for all aspects of stream and stream corridor restoration, from identification to assessment to implementation (FISRWG 1998). The North Carolina State Stream Restoration Institute also provides similar guidelines with examples of restoration techniques which are applicable to impaired sites within the Yellow River Basin (Doll et al. 2003). Other state and federal agencies such as the U.S. Forest Service and the U. S. Fish and Wildlife Service also provide techniques for designing and implementing river and road crossing restoration to improve bank stability, decrease erosion, and improve in-stream connectivity at sites. USFWS (2005b) is an excellent resource specifically written to address and fix the problems of excessive sedimentation at these crossings in northwest Florida. This manual details

methods for stabilizing soils, managing runoff and sedimentation, constructing properly sized and positioned bridges and culverts, and restoration designs for reducing excessive sedimentation, increase in-stream habitat diversity. These resources were used in combination for the Phase II restoration during this project. We strongly encourage resource managers to consult these references when considering restoration practices aimed at reducing the threats that impact the Yellow River and its tributaries.

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