U.S. Fish & Wildlife Service

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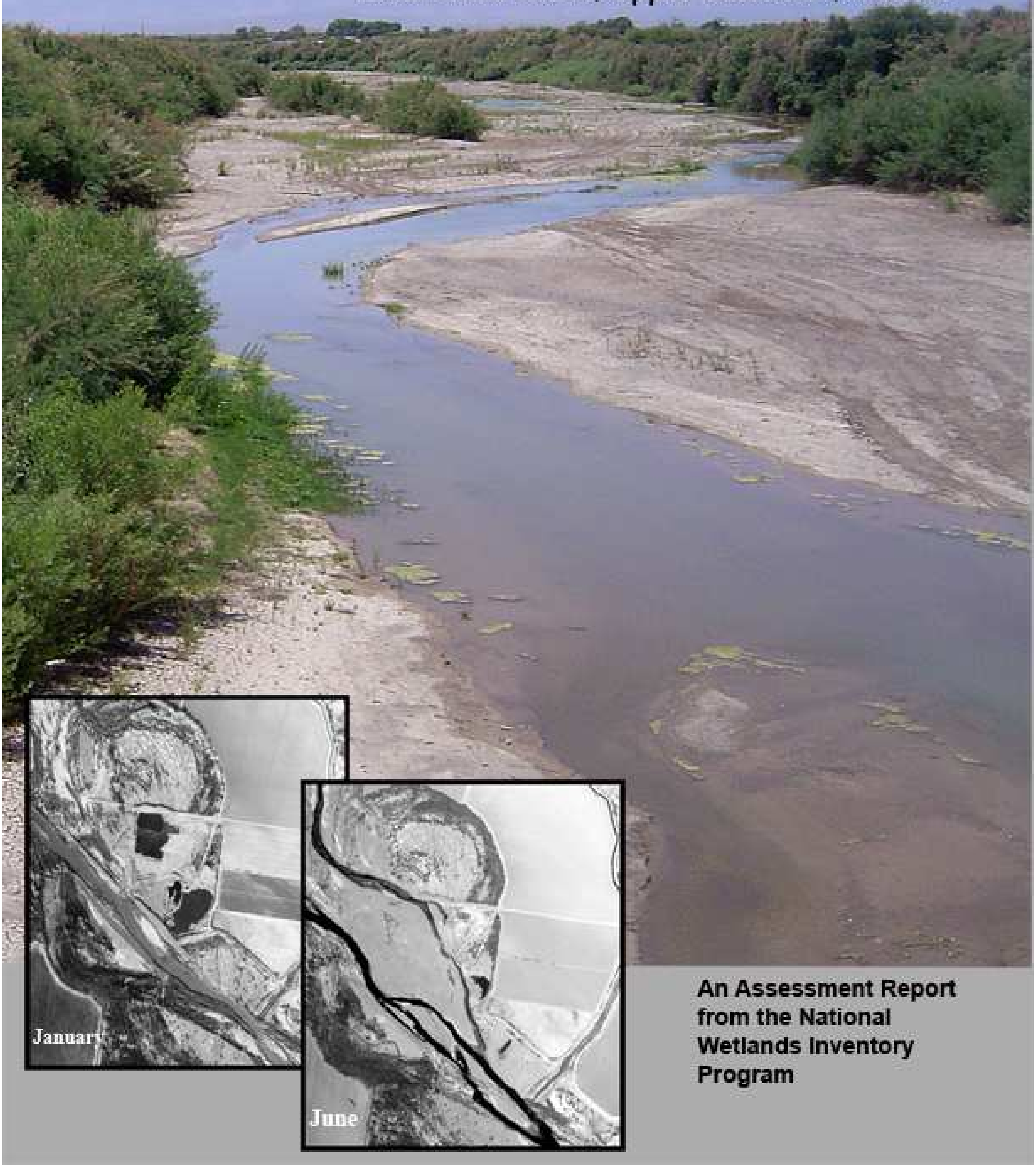

An Assessment Report from the National Wetlands Inventory Program

Monitoring Changes to Wetland and Riparian Vegetation Resulting from the February 13th, 2005 Flood Event, Upper Gila River, Arizona

By

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U.S. Fish and Wildlife Service
National Wetlands Inventory Program

An Assessment Report from
The U.S. Fish and Wildlife Service's National Wetlands Inventory Program

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Acknowledgments

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Preface

Since the mid-1970's the U.S. Fish and Wildlife Service's National Wetlands Inventory (NWI) has been providing the nation with wetland maps and information, as well as conducting assessments of wetland status and trends. Various products from this program include wetland /riparian digital data, hardcopy maps, mapping reports, and wetland /riparian vegetation species documentation. This information is available online at: http://www.wetlands.fws.gov, or by contacting a Regional Wetlands Coordinator.

In 2002, the U.S. Fish and Wildlife Service (Service) produced a new strategy for the National Wetlands Inventory Program. The new strategy emphasized three goals: ***1) strategic mapping, 2) wetland trend and change analysis, and 3) identifying and assessing threats to aquatic habitats at risk.*** This strategy has been "stepped down" to the Regional level to provide localized, detailed wetland and riparian data and information. In the southwest, especially Arizona and New Mexico, wetland systems are not abundant, and the results from the national wetlands trends study do not reflect local conditions in many areas of this region. Moreover, riparian habitats-vital habitats for many Threatened and Endangered species and important for maintaining water quality-are not included in these national studies. Local wetland/riparian trend assessments will provide more meaningful data to aid in management and policy analysis. This study will fill such a roll.

Contents

List of Figures

List of Tables

Introduction

The importance of riverine wetland/riparian habitats in the southwestern U.S. is well documented. The Arizona Riparian Council stated that 60 - 75 percent of Arizona's resident wildlife species depend on riparian areas to sustain their populations, yet these areas occupy less than 0.5 percent of the state's land area (USFWS 1997). In recent years, riparian habitats have been one of the focal points of the U.S. Fish and Wildlife Service's National Wetlands Inventory, Southwest Region, with increased efforts to produce updated digital data for the Region.

In February of 2005, heavy rainfall melted snowpacks in the mountainous headwaters of the Upper Gila River Basin causing extensive flooding in southwestern New Mexico and southeastern Arizona. Remotely located, with limited water control facilities, the Upper Gila River is prone to seasonal flooding from summer thunderstorms, spring storms and snowmelt. Geomorphic studies on the Upper Gila produced by the Bureau of Reclamation indicate tendencies for changes to the alluvial channel through avulsion and lateral migration during flood events (Klawon, 2001). These flood dynamics can have erosive effects wetland/riparian vegetation and encroaching upland landuse.

In January of 2005, the Service acquired aerial photography for the riparian corridors of the Upper Gila, San Francisco, and Tularosa River corridors for a digital mapping project. In March of 2005, field investigations along the Upper Gila River near Safford, detected significant changes in the alluvial channel and wetland/riparian vegetation communities when compared with the January photography. These changes were attributed to the February flood event. To document the specific changes, the Service acquired new imagery for this area later in May 2005 to record any alterations to the wetland/riparian vegetative community caused by the recent flooding.

The wetland/riparian communities in the study area, (Figure 1.) are considered important potential breeding habitat areas for the southwestern willow flycatcher (*E. traillii extimus*; USFWS 2005), as well as potentially providing habitat for as many as thirteen other federally listed species (USFWS 2005).

The purpose of this report is to document the changes to wetland and riparian vegetation along a specific stretch of the Upper Gila River resulting from the February 2005 flood event. Changes due to other human impacts will be identified but separated from the flood impact data. Using the latest GIS technologies and NWI digital change detection techniques, this study will emphasize quantitative changes (i.e., changes in extent/acreage) to wetland/riparian communities. The study is not a qualitative assessment, though does provide some generalized data on wetland/riparian vegetation that appears to be damaged from the flood.

<u>Study Area</u>

The study area for this project is along a section of the Upper Gila River in southeastern Arizona, from where the Bylas Bridge (U.S. Hwy 70) crosses the river, east of San Carlos Reservoir upstream to the confluence with the San Francisco River south of Clifton, Arizona (Figure 1.). The largest urban center in the area is the city of Safford, Arizona. The specific study area includes the Upper Gila River and its adjacent wetland/riparian communities and neighboring upland areas eroded or damaged by the flood. Major tributaries were identified to the extent of the aerial photography.

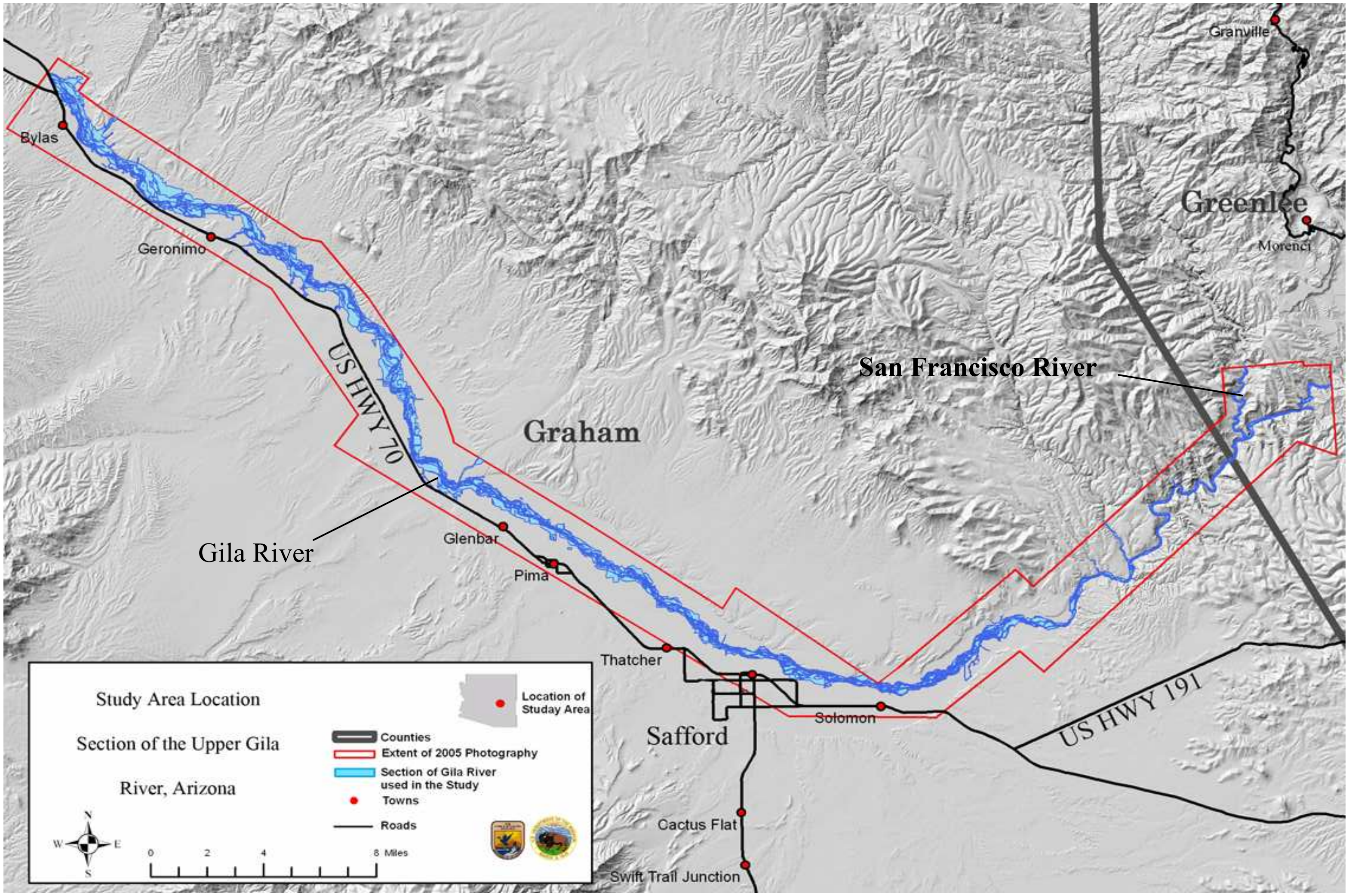


Figure1. Study area from Bylas bridge (Hwy 70) on the western extent to the Upper Glia River confluence with the San Francisco River.

Study Design and Procedures

Study Objectives

This study was designed to provide current, scientifically valid wetland/riparian data and information on areas of concern, within the Southwest Region regardless of ownership and measure change of those resources over time.

Types and Dates of Imagery

In this study, two eras of aerial color infrared photography were analyzed to capture the wetland and riparian vegetation changes resulting from the February 2005 flood event. The original (Time 1) wetland/riparian digital delineations were created using Color Infrared (CIR) photographs flown in January 18^{th} and 19^{th} of 2005 at a scale of 1:15,840. Time 2 delineations were based on interpretation of May 19, 2005 CIR photography (1:15,840 scale) that was acquired by the Service specifically for this study.

Wetland and riparian habitats were identified and classified following the Service's definitions and classification systems for these habitats.

Wetland Definition and Classification

The Service uses the Cowardin *et al.* (1979) definition of a wetland. This definition is the Service's official standard for classifying and mapping wetlands. It has also been adapted as the national standard for wetland mapping, monitoring and data reporting as determined by the Federal Geographic Data Committee. It is a two-part definition as indicated below:

> *Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water.*
>
> *For purposes of this classification wetlands must have one or more of the following three attributes: 1) at least periodically, the land supports predominantly hydrophytes; 2) the substrate is predominantly undrained hydric soil; and 3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year.*

For this study, tidal (salt water) wetlands, non-riverine deepwater habitats (lakes), ephemeral waters and "farmed wetlands" were not examined, and all deepwater riverine classes (open water, shore) are treated as one type. No differentiation was made between riverine water or shore classes within the active alluvial channel. Loss/gain of vegetation or upland acreage to or from the riverine system was identified (Table 1.).

Riparian Definition and Classification

The term *"riparian"* may be viewed from different perspectives, and has many definitions. In 1997, the western Regions of the Service developed a classification system to identify riparian areas that fell outside of the Cowardin *et al.* (1979) system. Since that time, "A System for Mapping Riparian Areas In The Western United States" (USFWS 1997) has also been adopted by the Service and is a national standard for riparian mapping, monitoring and data reporting as determined by the Federal Geographic Data Committee. The definition is indicated below:

> *Riparian areas are plant communities contiguous to and affected by surface and subsurface hydrologic features of perennial or intermittent lotic and lentic water bodies (rivers, streams, lakes, or drainage ways). Riparian areas have one or both of the following characteristics: 1) distinctly different vegetative species than adjacent areas, and 2) species similar to adjacent areas but exhibiting more vigorous or robust growth forms. Riparian areas are usually transitional between wetland and upland.*

This definition and the accompanying classification system were used to identify and map riparian habitats in the study area (Table1.).

Classification of Upland Land Uses

For a few areas not altered from the flood, but by human activities, landuse had to be determined. We developed an abbreviated upland classification system patterned after the U.S. Geological Survey land classification system (Anderson *et al.* 1976). Three generalized categories were used to describe conversion of wetland/riparian communities to upland (Table1.). Upland areas eroded by river channel changes and uplands visibly damaged by flood flows were identified and their acreages were calculated.

Table 1. Description of wetland, deepwater, riparian, and upland categories used in this study:

Wetland Type	Common Description
Palustrine Emergent	Marshes, wet meadows
Palustrine Shrub*, broad-leaved deciduous	Shrub wetlands (e.g., *Salix spp*.)
Palustrine Shrub, needle-leaved deciduous	Shrub wetlands (i.e., *Tamarix spp*.)
Palustrine Forested**	Forested swamps
Palustrine Emergent, Shrub mix	Mixed marsh and shrub wetlands
Palustrine Shrub, deciduous mix	Mixed shrub wetlands (e.g., *Salix/Tamarix*)
Palustrine Forested, shrub mix	Mixed forest and shrub wetlands
Palustrine Nonvegetated wetlands	Open water, exposed substrate
Riverine wetlands (deep water)	River systems

Riparian Type	Common Description
Emergent	Grasses, sedges
Emergent, Shrub* mix	Herbaceous mix, no dominant species
Shrub Cottonwood	Cottonwood
Shrub Salt Cedar	Salt Cedar
Shrub Mesquite	Mesquite
Shrub Willow	Willow
Shrub Salt Cedar, Mesquite mix	Salt Cedar, Mesquite mix
Shrub mixed deciduous	Mixed shrubs, more than two/no dominant
Forested** Cottonwood	Cottonwood
Forested mixed deciduous	Mixed forest, more than two/no dominant
Forested Cottonwood, shrub Salt Cedar mix	Forested Cottonwood, shrub Salt Cedar mix

Upland Type	Common Description
Agriculture	Cropland, pasture, managed rangeland
Rural Development	Non-urban developments and infrastructure
Other Uplands	Uplands not in other categories, barren land

* By Cowardin and Service Riparian definition, shrub communities are less than 6 meters.
** By Cowardin and Service Riparian definition, forest communities are 6 meters or greater.

Methods of Data Collection and Imagery Analysis

Technical advances in the quality of remotely sensed imagery, computerized mapping techniques, and modern data management systems greatly improved the ability to capture more detailed and timely amount of information in this study. The data modernization processes involved the use of customized software tools to execute tasks specific to wetland and riparian attribution, providing logic checking functions and verification of the digital vegetation data.

The delineation of wetland and riparian habitats through image analysis forms the foundation for all subsequent products and results of this study. A great deal of emphasis has been placed on the quality of the image interpretation. The Service made no attempt to adapt or apply these products to regulatory wetland boundary determinations or to jurisdiction or land ownership. Rather the information was used solely to assist in detecting change with in the study area.

Wetland and riparian areas were identified based on vegetation, visible hydrology and geography. Delineations reflected changes in vegetation and hydrology, caused by the February 2005 flooding event, which were identifiable from the aerial photography. The delineations were made using the Optem Digital Transfer stereoscope, "heads up" digitizing of rectified photography for both eras of imagery.

Wetland/Riparian Vegetation Change Detection

Aerial photography was the primary source data for detecting changes in wetland and riparian vegetation. It was used in conjunction with reliable collateral data such as topographic maps and soils information. Interpreted data were field verified to answer questions regarding image interpretation, land use and attributions of wetland-riparian vegetation changes.

For the change analysis/detection, the interpreter used a geographic information system (GIS) to place the previously completed January delineation data (Time 1) over the May imagery (Time 2) then used photo interpretation techniques to classify the vegetation change. Such changes were grouped into three categories; wetland/riparian vegetation loss, wetland/riparian damage (canopy/cover reduction and thinning), and upland overbank flow. (For definitions of these categories, see Appendix A).

Field Verification

Access for field work was limited due to the amount of private property in the area. Two field verification trips were used to correlate the imagery to the vegetation types present in the study area. The first field observation trip was in March 2005, the second May 2006. Primary access to the Upper Gila River corridor was public road crossings. Binoculars and spotting scopes were also used in an attempt to view more distant vegetation.

Quality Control

To ensure the reliability of wetland/riparian change detection data, the Service adhered to established quality assurance and quality control measures for data collection, analysis, verification and reporting. All interpreted imagery was reviewed by a technical expert in ecological change detection. All polygons with in the study area were reviewed and the analyst adhered to all standards, quality requirements and technical specification. All digital files were subjected to rigorous quality control inspections. A customized software package was used to insure digital data quality and mapping accuracy.

Study Limitations

- There was a small imagery holiday (missing data) near Pueblo Viejo, Arizona. A small area of the river channel and vegetated corridor was not covered by either era of aerial photography. This was due to a change in flight line orientation. This small area was excluded from the study.

- Field verification access was extremely limited because of its proximity to privately owned land. Access was achievable at public road bridge crossings.

- The leaf-off January 2005 CIR imagery made identification of dominant riparian species types highly difficult.

Results and Discussion

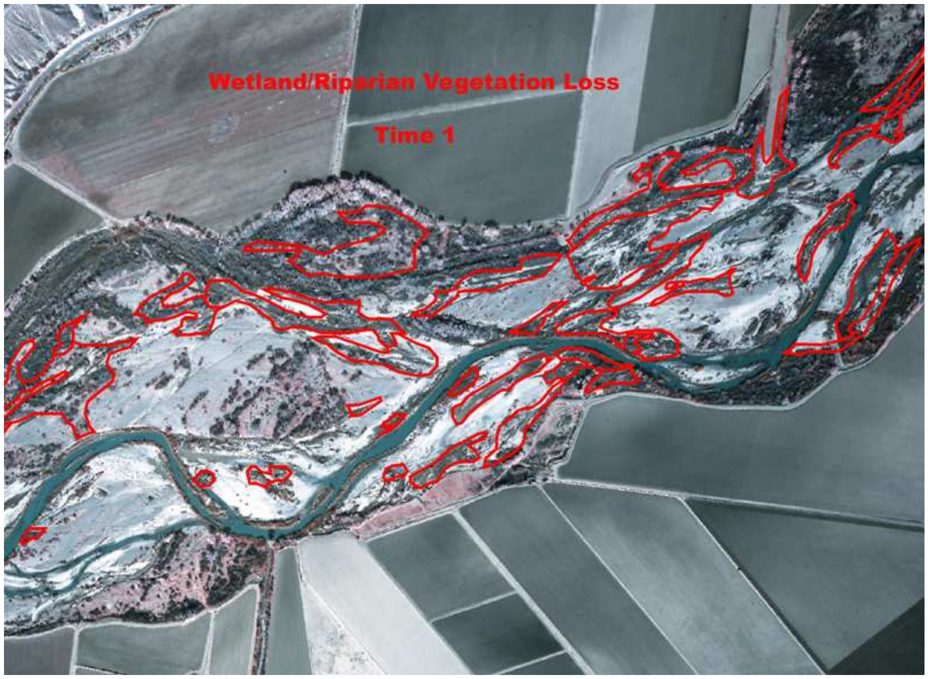
Assessment of Flooding Effects to Wetland and Riparian Vegetation (vegetation loss)

In January 2005, there were 11,249.3 acres of wetland and riparian vegetation identified. By June 2005, 10,499.3 acres of wetland and riparian vegetation remained. The flood caused a loss of 750 acres of wetland and riparian vegetation. These areas were converted to riverine or nonvegetated wetlands. Emergent wetlands experienced the greatest change, declining by 56% (Table 2.). Emergent/shrub mixed wetlands followed with 49% loss, but these wetland actually lost more acreage (159.3) compared to the emergent type. From an acreage standpoint, broad-leaved deciduous shrub wetlands received the most damage, losing nearly 186 acres (17% of the January total). Overall, wetlands sustained more damage than riparian habitats (706.1 acres lost vs. 43.9 acres lost, respectively). This is not surprising given wetlands usually reside lower on the landscape and therefore, more prone to receive stronger erosive forces from significant flood events.

Table 2. Wetland and riparian vegetation, by category, lost/converted to riverine or nonvegetated wetlands, from February 2005 flood.

	Jan. 05 Acreage	June 05 Acreage	Change (acres)	Change (% lost)
Wetland Category				
Emergent	247.3	108.1	(139.2)	(56%)
Shrub, broad-leaved deciduous	1085.7	900	(185.7)	(17%)
Shrub, needle-leaved deciduous	1378.4	1376.5	(1.9)	(1%)
Forested	36.7	36.7	0	0%
Emergent/Shrub mix	323	163.7	(159.3)	(49%)
Shrub, deciduous mixed	2899.2	2679.2	(220)	(8%)
Forested/Shrub mix	290.1	290.1	0	0%
Total	6260.4	5554.3	(706.1)	(11%)
Riparian Category				
Emergent	249.8	245.1	(4.7)	(2%)
Emergent, Shrub	156.5	139.4	(17.1)	(11%)
Shrub Cottonwood	21.3	21.3	0	0%
Shrub Salt Cedar	3732.9	3718.9	(14)	0%
Shrub Mesquite	32.2	32.2	0	0%
Shrub Willow	1.2	1.2	0	0%
Shrub Salt Cedar, Mesquite	370	370	0	0%
Shrub mixed deciduous	375.6	367.5	(8.1)	(2%)
Forested Cottonwood	34.8	34.8	0	0%
Forested mixed deciduous	8.9	8.9	0	0%
Forested Cottonwood, shrub Salt Cedar	5.7	5.7	0	0%
Total	4988.9	4945	(43.9)	(1%)
Total wetland/riparian vegetation change	11249.3	10499.3	(750)	(7%)

According to streamflow data there has not been a flood of this magnitude (February 2005 flood) since January 1995 (Appendix B.). This process has allowed the robust establishment of emergent and shrub wetland vegetation in/along the river channel and within older river channel scars. The imagery shows that these communities exhibited more of an impact from the flood waters (Figure 2.).



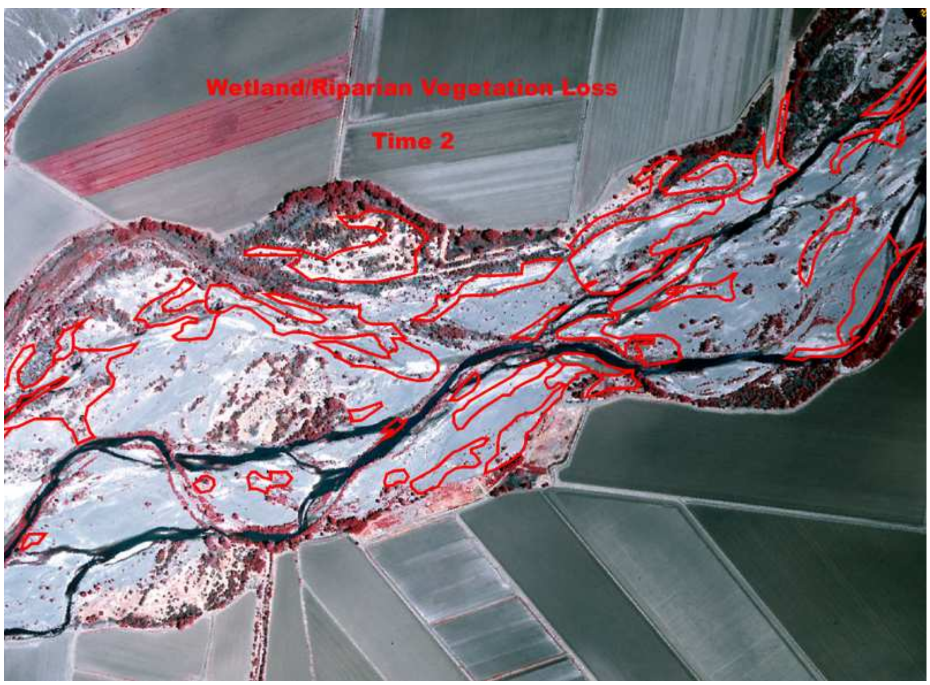


Figure 2. Upper Gila River floodplain, near Solomon, AZ, before (above) and after (below) the February 2005 flood. The areas outlined in red show the condition of the habitat at Time 1 for the areas altered by flooding prior to Time 2; the red areas on the lower photo show the absence of vegetation in these areas at Time 2. CIR aerial photography, 1:15,840 scale, January 18, 2005 (upper), May 19, 2005 (lower).

The highest frequency of vegetation loss occurred just down stream from water diversion structures. This coincides with recent BOR fluvial geomorphology studies (Wittler. Klawon, 2004) that showed a greater tendency for flood damage downstream of these structures due to the build up of floodwaters prior to a breech or overflow, when much more energy is released. (Appendix C).

Flood Damage to Wetland Communities

A total of 454.5 acres of vegetated wetlands were damaged by the severe flooding. This constituted 7.3% of the total wetland acrege. Mixed wetland shrub/emergent communities that lost the emergent understory totaled 229.5 acres (Figure 3.). Mixed wetland shrub/emergent communities that lost the shrub overstory totaled 29.3 acres.

Many wetland communities maintained their cover types but were "thinned out" due to the flooding. These damaged communities totaled 195.7 acres (Table 3.). From a mapping standpoint, there was no change in acreage for these communities. This was not considered a loss of habitat, since the canopy/cover density, though reduced, is still met or exceeded the Cowardin *et.al.* (1979) definition of 30 percent vegetative coverage.

Table 3. Summary of damaged wetland communities with canopy/cover reduction

Wetland Type	Acres with Reduced Canopy/Cover Density
Emergent	6.5
Emergent, shrub mix	7.0
Shrub, broad-leaved deciduous	52.0
Shrub, deciduous mix	130.2
Total	195.7

Breeding sites for the southwestern willow flycatcher may be adversely affected by such reductions. One of the primary constituent elements for potential habitat states that breeding sites contain dense tree/shrub canopy, with densities ranging from 50% to 100% as measured from the ground (USFWS 2005). So even though the vegetative cover was not removed from these nearly 200 acres, the overall quality of the community may be degraded. Since it is beyond the scope of this study to calculate exact canopy density changes (only to indicate that it has occurred), further studies are be required to evaluate this condition.

Flood Damage to Riparian Communities

A total of 175 acres of riparian vegetation were damaged due to flood flows. Mixed riparian shrub/emergent communities that lost the emergent understory totaled 72 acres (Figure 3.). Mixed riparian shrub/emergent communities that lost the shrub overstory totaled 20 acres.

Many riparian communities maintained their cover types but were "thinned out" due to the flooding. These damaged communities totaled 83 acres (Table 4.). Like the above assessment for the wetland communities, this was not considered a loss of habitat, since the canopy/cover density, though reduced, is still meets or exceeds the Riparian. (USFWS 1997) definition of 30 percent vegetative coverage.

Table 4. Summary of damaged riparian communities with canopy/cover reduction

Riparian Type	Acres with Reduced Canopy/Cover Density
Shrub Salt Cedar	60.3
Emergent, shrub mix	22.7
Total	83.0

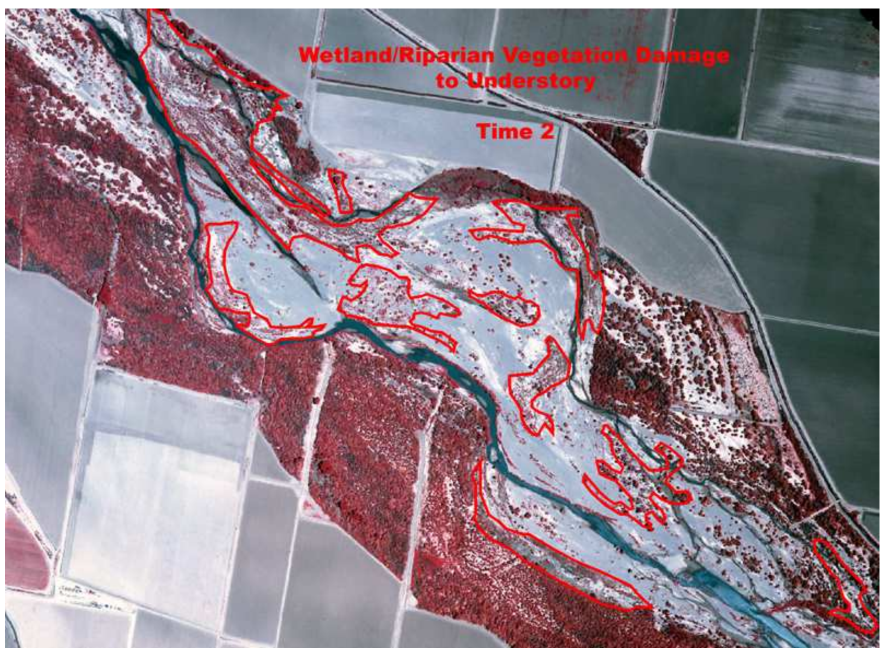


Figure 3. Upper Gila River floodplain, near Thatcher, AZ. highlighting areas where wetland and/or riparian vegetation have been damaged (emergent understory removed, shrubs remain) due to flooding. Upper photo shows areas prior to flood damage, while lower photo shows the condition of these areas after the flood. Note that there was also vegetation loss which was not indicated in this example. CIR aerial photography, 1:15,840 scale, January 18, 2005 (upper), May 19, 2005 (lower).

Upland Erosional Damage and Loss

A total of 326.2 acres of upland were damaged or lost to erosion by the flood event.

Uplands considered damaged exhibited evidence of scouring from overbank flows totaled 238.6 acres. Potential topsoil erosion or loss of upland vegetation could have occurred.

There were two major areas of extensive erosional loss of uplands to riverine or unvegetated wetlands totaling 87.6 acres. Major losses occurred near Sanchez, Arizona (Figure 4.) and at a gravel mine within the floodplain, near Thatcher, Arizona, where tailings areas, levees and unpaved roads were washed away.

Table 5. Summary of upland losses due to flood erosion

Upland Type	Acres Lost
Agriculture	52.6
Rural Development	21.0
Other/barren land	14.0
Total	87.6

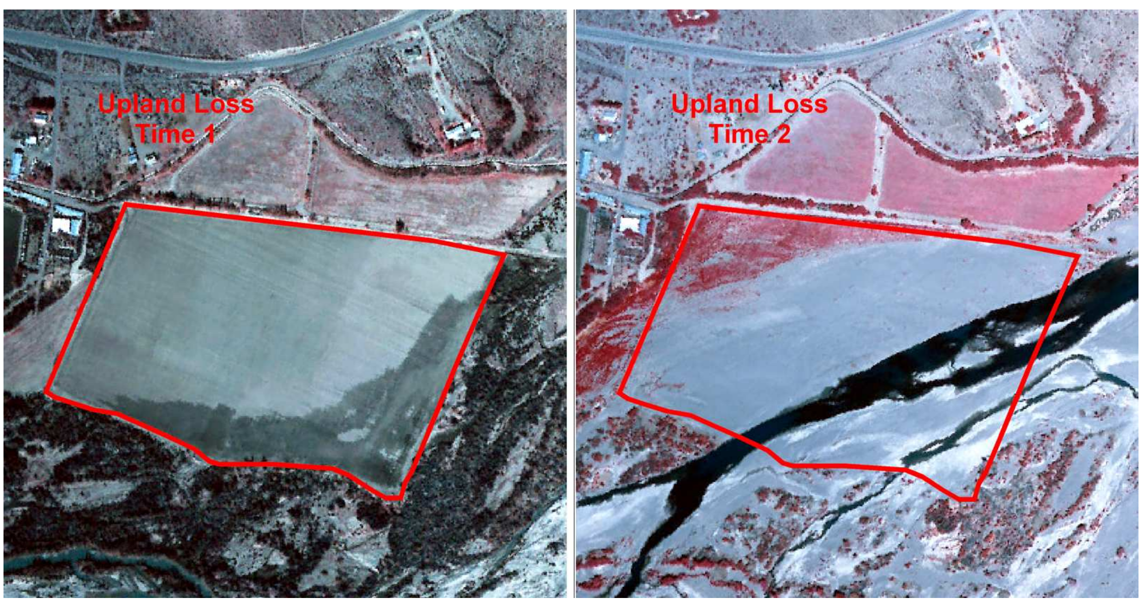


Figure 4. Upper Gila River floodplain, near Sanchez, AZ. Example of upland agriculture lost to channel change, as a result of the flood. CIR aerial photography, 1:15,840 scale, January 18, 2005 (left), May 19, 2005 (right).

Loss of Wetland and Riparian Vegetation Not Related to the Flood Event

There were small losses, or conversions, of wetland and riparian vegetative communities to upland, due to various human activities. Most of this involved clearing of vegetation for agriculture or other undetermined activites.

Table 6. Wetland/Riparian Vegetation Loss to Human Activities

Vegetation Type Lost	New Landuse	Acreage
Palustrine shrub wetlands	Agriculture	1.8
Palustrine shrub wetlands	Other	0.6
Riparian shrub Salt Cedar	Agriculture	5.0
Riparian shrub Salt Cedar	Other	20.0

Summary

Looking at historical flood data and photographic records, the Upper Gila River has been prone to dramatic changes from major flood events (Wittler/Klawon, 2004). And though the loss of and damage to wetland and riparian vegetation, from this event, was not catastrophic, the potential does exist for greater loss or damage to this ecologically important river system.

Monitoring efforts can provide information as to the changing nature of the Upper Gila River. Updated National Wetlands Inventory digital map data, along with other data sources, can assist by providing information on; potential threatened and endangered species habitat, invasive vegetative species, and potential areas for vegetation restoration. These data also create a basis for long-term monitoring and trends work.

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Appendix A. Definitions of Change Categories

1. Wetland/Riparian Vegetation Loss:

From visual inspection of the aerial photography, at least 70% of the wetland and/or riparian vegetation was removed by flooding.

2. Wetland Riparian Vegetation Damage (canopy/cover reduction and thinning):
Wetland/riparian vegetation that was damaged by flood waters were identified as follows;

a. Mixed vegetative communities, usually shrub and emergent, had more than 70% of one of the cover types removed by flooding. *Example; An area identified as a palustrine shrub/emergent wetland community in Time 1, is identified as a palustrine shrub community, only, in Time 2.*
b. Canopy/cover of vegetative community was reduced due to flooding, but still remained above 30% coverage for the given area. Acreage loss was not calculated for these areas.

3. Upland Overbank Flow:
Upland (non-wetland/riparian) areas that were damaged/eroded by flood waters were identified as follows;

a. Damage includes scouring of upland vegetation cover (crops/pasture/range) and/or topsoil, damage to roads, levees, excavations, etc… These areas were not converted to wetlands.
b. Upland areas that were totally eroded and exhibiting riverine or wetland characteristics were considered erosional loss. These upland areas were converted to wetland or riverine habitats.

Appendix B. Historical Peak Flows, Gila River, Solomon, AZ

Table 7. USGS Gage Station 09448500: Gila River at head of Safford Valley, near Solomon, AZ; February 1980-February 2005 (USGS 2006)

Date	Gage Height	Stream flow (cfs)	
Feb. 16, 1980	8.95	25,300	
Jul. 12, 1981	10.55	7,000	
Oct. 03, 1981	10.15	5,240	
Mar. 25, 1983	12.1	11,300	
Oct. 02, 1983	20.8	132,000	Largest recorded cfs.
Dec. 29, 1984	16.95	60,200	
Oct. 17, 1985	10.98	7,690	
Nov. 03, 1986	9.1	3,020	
Sep. 23, 1988	11.02	7,820	
Oct. 15, 1988	7.18	891	
Aug. 16, 1990	8.52	2,240	
Mar. 02, 1991	14.38	26,200	
Feb. 14, 1992	13.42	17,900	
Jan. 19, 1993	18.56	86,200	
Sep. 04, 1994	7.01	1,760	
Jan. 05, 1995	17.5	62,400	Last event w/ higher cfs.
Aug. 10, 1996	13.29	7,470	
Sep. 22, 1997	14.23	16,900	
Jul. 23, 1998	10.11	4,950	
Aug. 05, 1999	11.46	8,240	
Aug. 29, 2000	6.36	506	
Oct. 23, 2000	15.16	24,600	
Sep. 12, 2002	10.76	4,740	
Oct. 08, 2002	9.77	2,780	
Nov. 13, 2003	9.17	2,520	
Feb. 13, 2005	18.44	39,000	Study flood event.

cfs = cubic feet per second

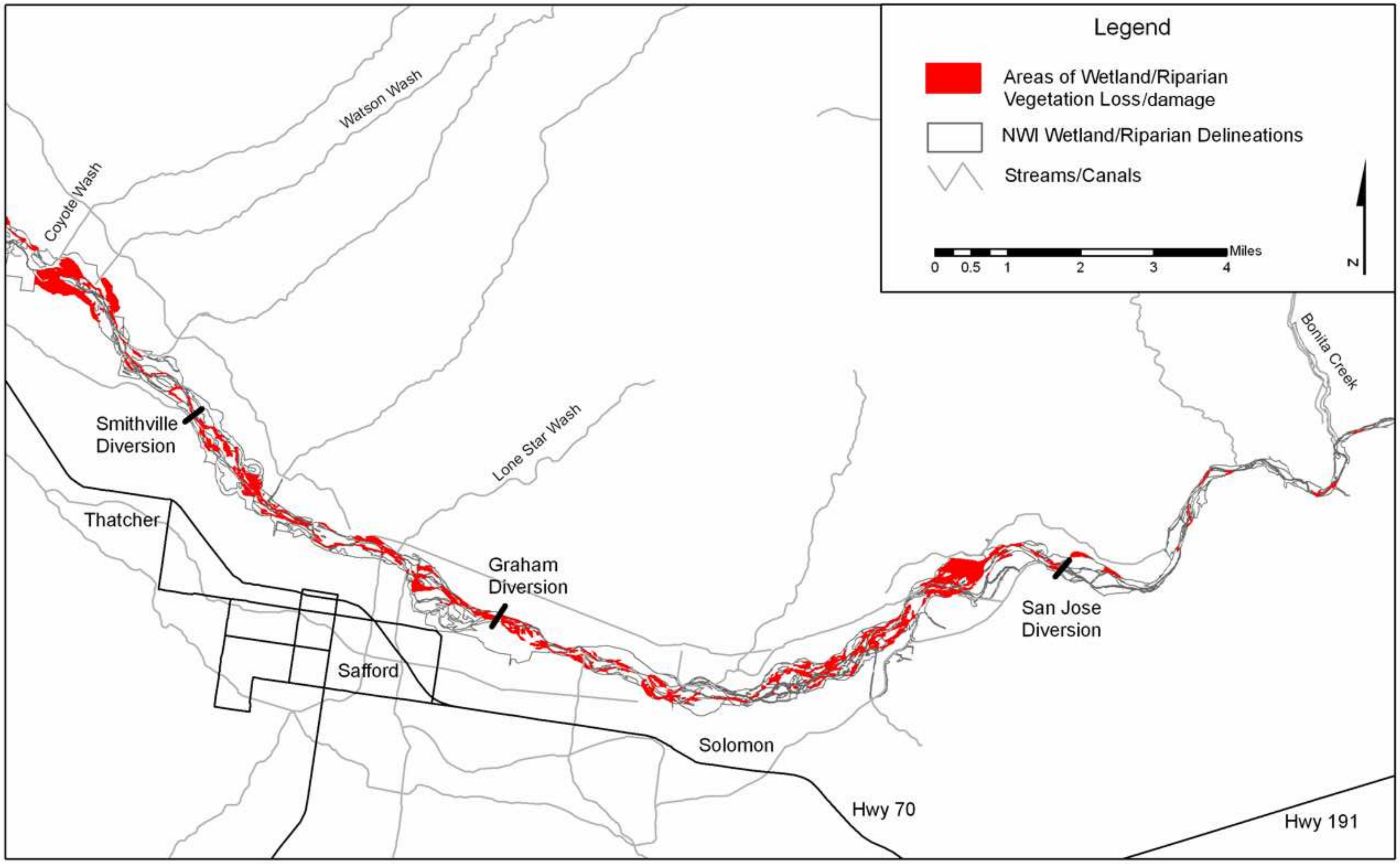

Figure 5a. Areas of wetland and riparian vegetation loss and damage, relative to diversion structures on the Upper Gila River. Note the lack of loss/damage upstream (to the right) of the San Jose Diversion. Map data compiled 2005 & 2006.

Appendix C (cont.). General Locations of Vegetation Loss and Damage Relative to Diversion Structures

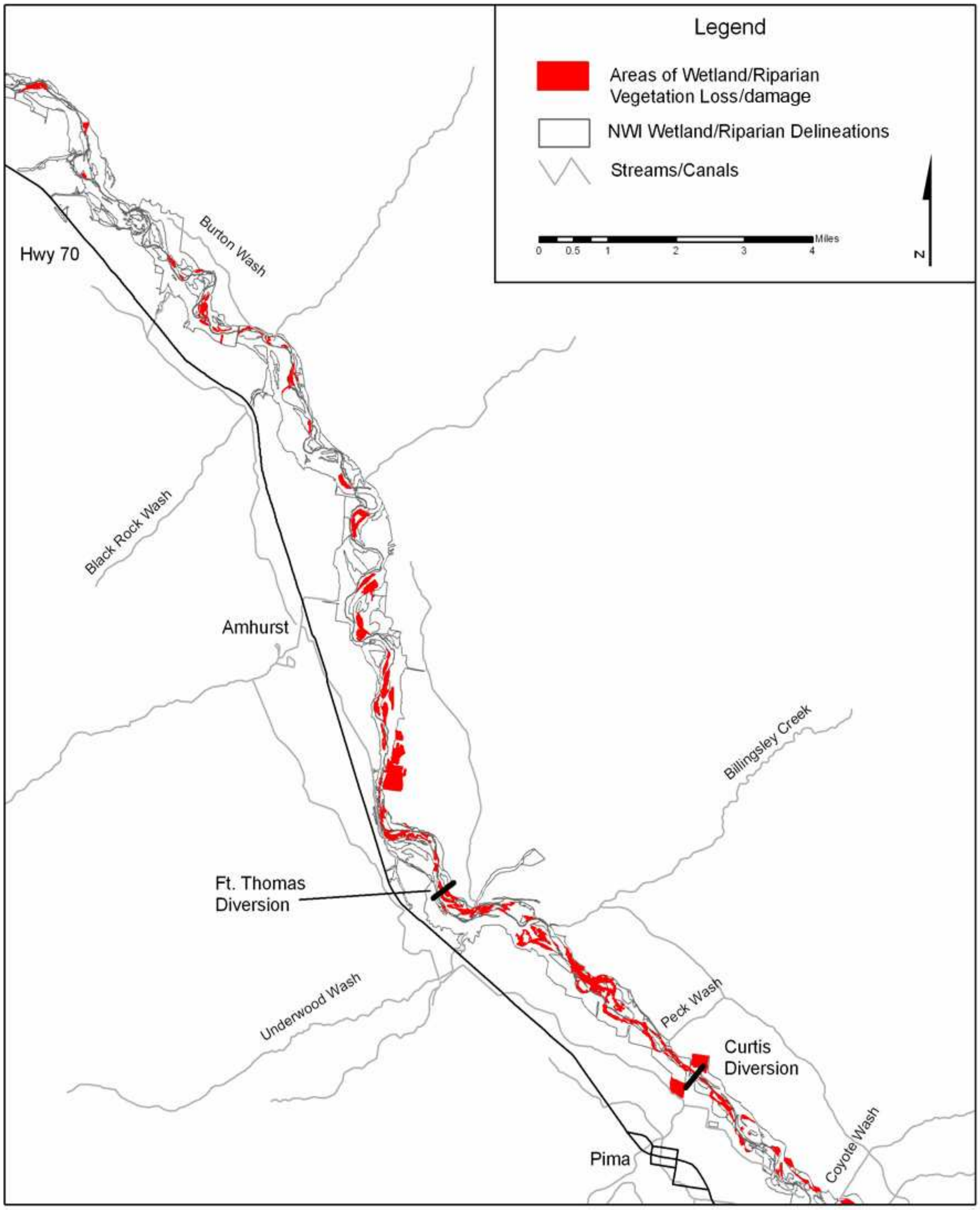

Figure 5b. Areas of wetland and riparian vegetation loss and damage, relative to diversion structures on the Upper Gila River. Note the frequency of loss/damage decreases as the distance from the Ft. Thomas Diversion increases (to the left). Map data compiled 2005 & 2006.