

# *A System for Mapping Riparian Areas in the Western United States*

U.S. Fish and Wildlife Service  
National Wetlands Inventory

## **Contents**

Introduction . . . . .	1
Concept of Riparian . . . . .	2
Riparian Definition . . . . .	3
Mapping Conventions . . . . .	4
Riparian Mapping System . . . . .	5
Photointerpretation . . . . .	7
Digitization and Area Measurement . . . . .	7
Cartography . . . . .	9
Definitions . . . . .	11
Relationship to Other Programs . . . . .	12
Chronology of Definition and System Development . . . . .	13
Acknowledgments . . . . .	15
Literature Cited . . . . .	15
List of Figures	
Figure 1. Area of Applicability . . . . .	2
Figure 2a. NWI Standard Wetland-Riparian Map. . . . .	4
Figure 2b. NWI Color-Coded Wetland-Riparian Map . . . . .	4
Figure 3. Riparian Classification System . . . . .	6
Figure 4. Color Infrared Photograph . . . . .	7
Figure 5. Wetland-Riparian Reference Diagram . . . . .	10

*December 1997*

## ***Introduction***

The U.S. Fish and Wildlife Service (Service), through the National Wetlands Inventory (NWI), is Congressionally mandated to identify, classify and digitize all wetlands and deepwater habitats in the United States. The NWI has extensive mapping expertise and knowledge involving wetland identification and classification, photointerpretation, and digital data capabilities. Reflecting this expertise, the NWI is regularly asked to provide resource mapping guidance, and with increasing frequency, is requested to map riparian areas of the western United States.

Riparian habitats are among the most important vegetative communities for western wildlife species. Chaney, et al (1990) observed that greater than 75 percent of terrestrial wildlife species in the Great Basin region of eastern Oregon, as well as in southeastern Wyoming, are dependent on riparian habitats.

In Arizona and New Mexico, 80 percent of all vertebrates use riparian areas for at least half their life cycles; more than half of these are totally dependent on riparian areas. Similarly, 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. Aquatic and fish productivity are directly related to a properly functioning and healthy riparian habitat (Washington Dept. Fish and Wildlife 1995).

The Fish and Wildlife Act of 1956 authorizes the Service to map habitats used by fish and wildlife resources. However, the Service has never formally adopted a standardized riparian definition or developed conventions to guide the mapping of riparian areas. This paper fills that void.



**Cottonwoods (forested, deciduous) occurring on the second terrace adjacent to emergent wetland along Arikaree Creek, Colorado.**

# Concept of Riparian

Riparian is viewed from many perspectives. Older and more classical riparian interpretations identify primarily woody vegetation associated only with lotic systems. Recent interpretations include a broader view involving both lotic and lentic systems, surface and subsurface water influences, and natural forces and human-induced activities that affect the woody and emergent vegetation. Although riparian areas are closely associated with water and topographic relief, they are mapped independently from either wetland or upland. Riparian areas lack the amount or duration of water usually present in wetlands, yet are "wetter" than adjacent uplands.

Riparian plant species may be on the National wetland plant list (Reed 1988) or be true upland species expressing greater vigor due to increased water compared to upland situations.

Lists of plants and soils associated with riparian areas have not been developed across the area of applicability. The unavailability of these lists does not preclude subsequent development of area wide or site specific plant and soils lists as regional requirements dictate. Although some riparian plant species are included in Reed (1988), as individuals they do not all function as hydrophytes.

The definition and conventions that follow apply primarily to areas of the western United States where mean annual evaporation exceeds mean annual precipitation (Figure 1). This focus does not diminish the equivalent values of similar streamside or riverside communities throughout the country that are important fish and wildlife habitats.

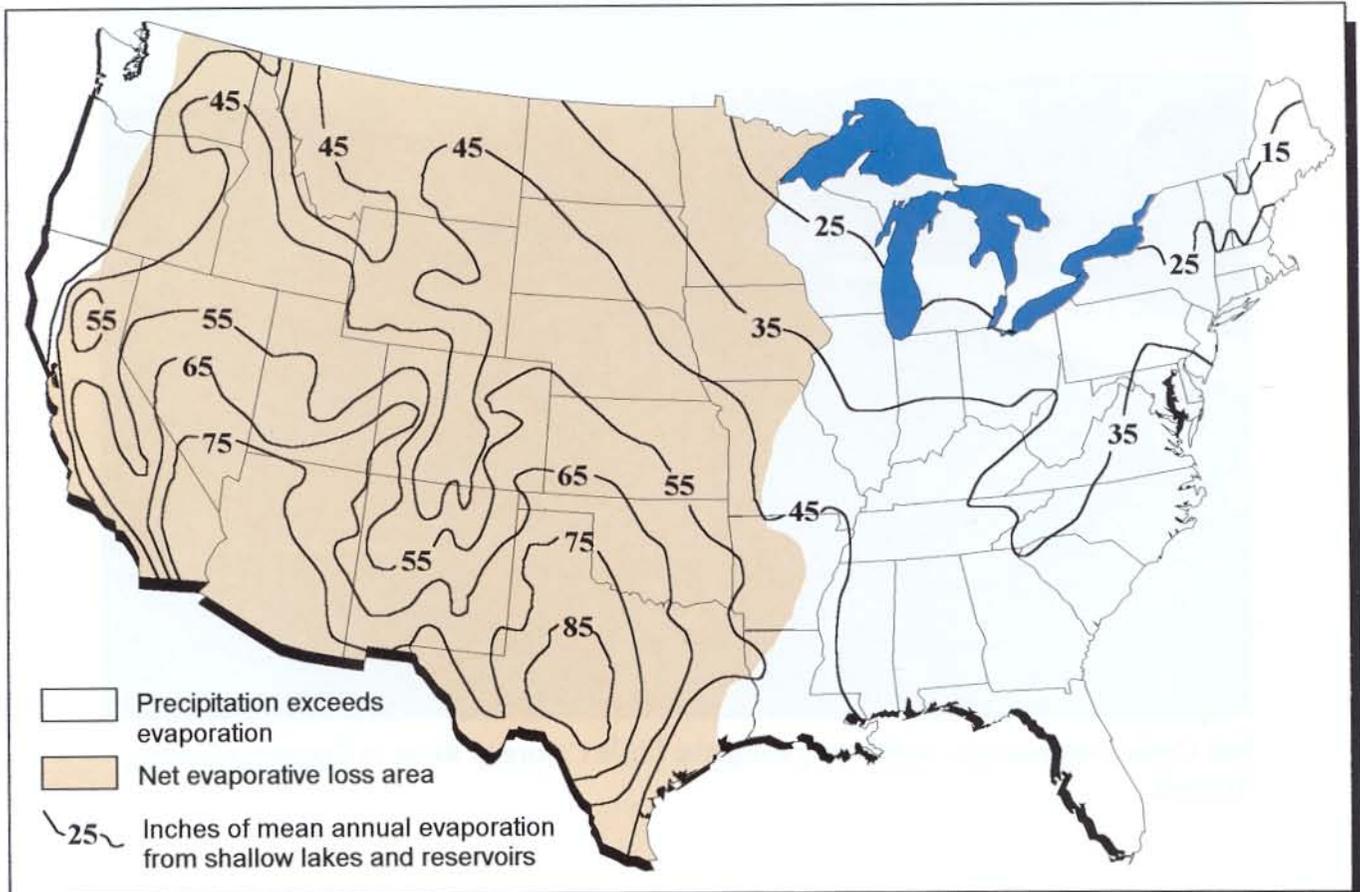


Figure 1. The area of applicability for the Fish and Wildlife Service's riparian definition and mapping conventions is shaded. In this broad region, mean annual evaporation exceeds mean annual precipitation. From U.S. Department of Agriculture (1981).

## ***Riparian Definition***

There are many riparian definitions used by government agencies and the private sector. Riparian initiatives often concentrate on either functionality or land use applications where an exact definition is not required. However, a riparian definition is essential for consistent and uniform identification and mapping. For these purposes, in the area of applicability:

**"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) distinctively 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."**



Salt Cedar (scrub-shrub, deciduous) along the Little Colorado River in Coconino County, Arizona.

## Mapping Conventions

Conventions are necessary to ensure consistency in riparian mapping efforts throughout the western United States. The present conventions were developed by the Service to be used for the preparation of riparian maps. These conventions provide specific instructions for application of the riparian mapping system and are in concert with the Cowardin et al. (1979) classification system used for wetland mapping. Wetland mapping, based on the Cowardin et al. system, uses detailed photointerpretation conventions (USFWS 1995), cartographic conventions (USFWS 1994a), and digitizing conventions (USFWS 1994b). The Cowardin et al. system is the Federal standard for wetlands mapping.

Riparian delineation using remotely-sensed data involves limitations such as scale and date of the imagery, and hydrologic conditions. As with wetlands, the identification of riparian areas from aerial photographs is best accomplished with ground truthing on a project-specific basis.

Riparian maps are 1:24,000-scale and based usually on the same photography used for production of NWI wetlands maps (Figure 2a).

NWI maps are based primarily on 1:58,000-scale, color infrared emulsion. Riparian areas, as in the identification of wetlands, are subject to errors of omission and commission consistent with data collected through remotely sensed technologies. Riparian maps have no effect on existing NWI wetlands maps. The final riparian product will be a wetland-riparian map. Once digitized, wetland-riparian maps can be provided in a variety of formats including color-coded maps (Figure 2b).

Minimum mapping units will be established for specific projects based on funding, scale and quality of aerial photographs, and agency needs. Photointerpreters will make every effort to identify all observable riparian areas, if not by polygon, then by either point or single line features.

Woody riparian areas associated with lotic systems (perennial or intermittent) are the predominant features of the mapping effort. This is consistent with the classical concept of riparian areas, facilitates a high degree of map accuracy, and identifies most of the riparian areas in the western United States. However, emergent cover and/or lentic riparian areas may be mapped if the imagery allows identification of these features.

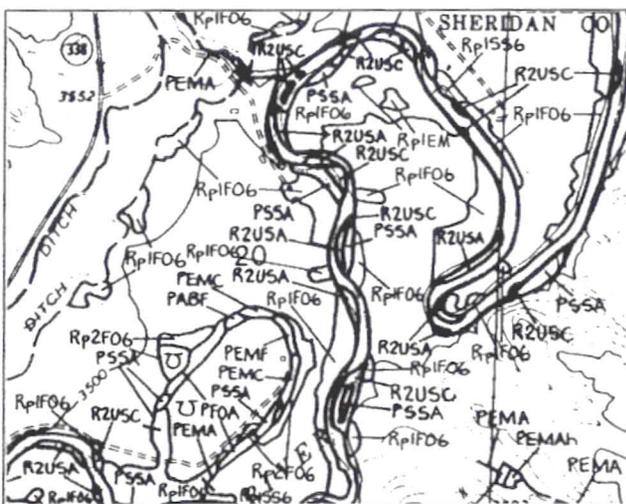


Figure 2a. Portion of standard NWI map showing wetland and riparian classifications along the Tongue River, Wyoming.

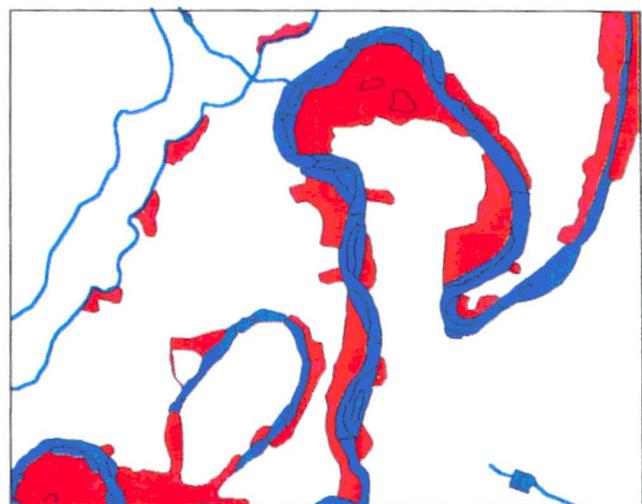


Figure 2b. Digitized and color coded NWI map (wetland is blue; riparian is red) of the same area shown on the left.

## Riparian Mapping System

Aerial photographs are the primary data source for riparian mapping. Field reviews, soil surveys, topographic maps, and local inventories are used as collateral data. The riparian mapping system (Figure 3) is hierarchical, open ended, and uses System, Subsystem, Class, Subclass and Dominance Types.\*

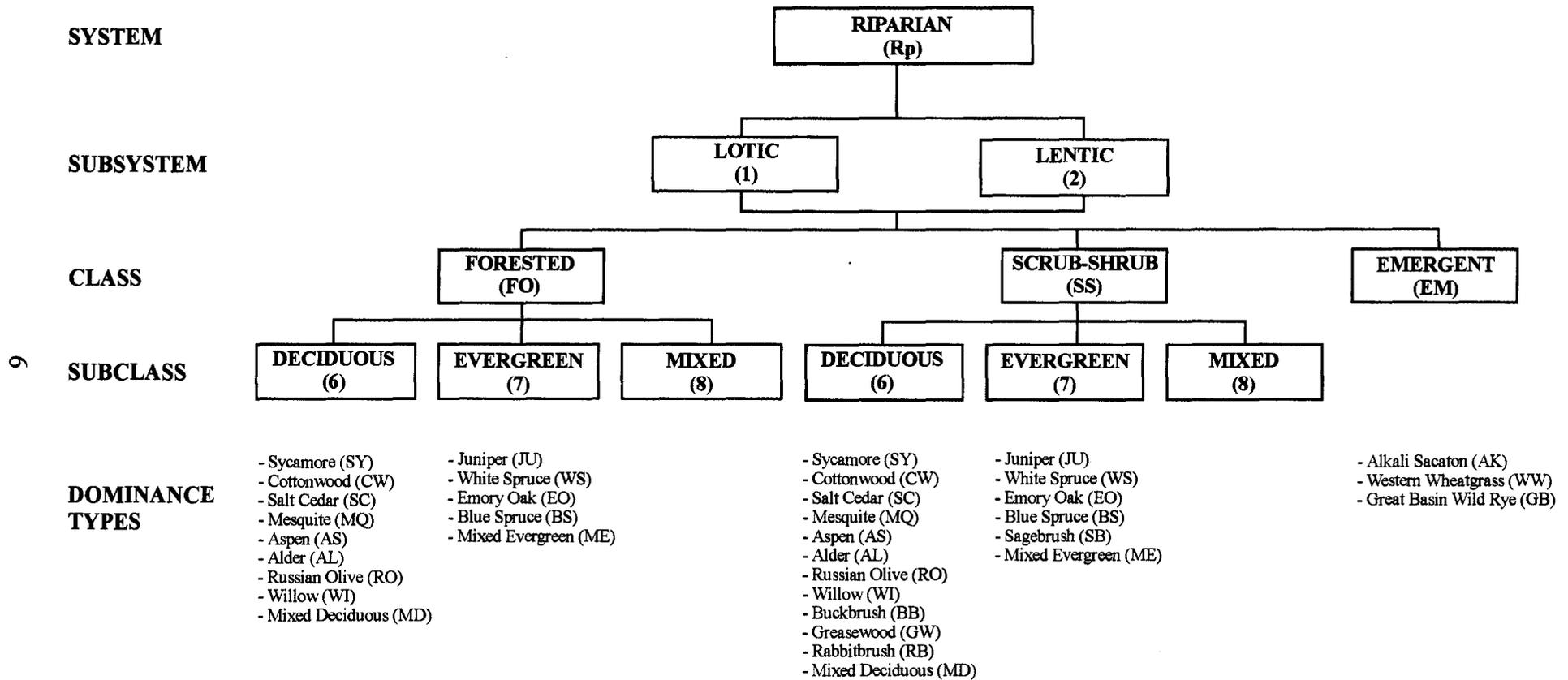
The level of mapping detail is determined by user needs. Special modifiers similar to those in the Service's wetland classification system may be appropriate in site-specific situations.

- **System** is a single unit category - riparian vegetation (Rp).
- **Subsystem** defines two categories reflecting the water source for the riparian area - lotic (1) and lentic (2).
- **Class** describes the dominant nonhydrophytic life form of riparian vegetation. For these conventions, classes are: forested (FO) woody vegetation usually greater than 6 m. in height; scrub/shrub (SS) woody vegetation usually less than 6 m. in height; and emergent (EM) erect, rooted vegetation with herbaceous stems.
- **Subclass** further describes the Class as either deciduous (6), evergreen (7), or mixed deciduous/evergreen (8).
- **Dominance Type** refers to vegetative species within the mapping unit, e.g. cottonwood (CW), alder (AL). Dominance types vary throughout the country. Therefore, the hierarchy in Figure 3 is open-ended and may be added to as needs arise. Necessary additions will be coordinated by the Cartographic Supervisor at the National Wetlands Inventory Center in St. Petersburg, Florida.

\*For instance, **Rp1FO6CW** is interpreted as:

System:	<b>Rp</b>	- Riparian
Subsystem:	<b>1</b>	- Lotic
Class:	<b>FO</b>	- Forested
Subclass:	<b>6</b>	- Deciduous
Dominance Types:	<b>CW</b>	- Cottonwood

Although specific vegetation types are identified (Figure 3), these species are presented only as examples. A single dominant type (e.g., cottonwood) often infers or may be interpreted as representing a plant community of several species such as an indicator species does for a guild.



**Figure 3. Hierarchical riparian mapping and classification system.**

## Photointerpretation

Riparian photointerpretation follows established Service procedures and protocols. Most riparian signatures are transitional between wetland and upland signatures and are recognizable from aerial photographs (Figure 4). Riparian signatures may also exist independent from wetlands.

The conventions that follow are designed specifically for riparian mapping done in conjunction with standardized Service wetland and deepwater habitat mapping.

1. The tallest life form, making up at least 30% cover, defines the class.
2. The mixed subclass (8) is a mix of woody evergreen and deciduous vegetation. Each must comprise at least 30% of the vegetative cover.
3. Other than number 2 above, the only mixing permitted is of dominance types (each at least 30%). No more than two dominance types can be mixed.
4. Tilled fields used for grain production will not be mapped as riparian.
5. A linear showing wetland and riparian codes is used when both wetland and riparian units make up an area that is less than a pen width. This applies where the wetland and riparian areas are so narrow that they prevent mapping as a distinct polygon. Therefore, labels for both are applied to a single linear feature.

## Digitization and Area Measurement

Data collected with these conventions are readily incorporated into a Geographic Information System. Area measurements for polygons are made from the delineations. Point data can be displayed as the number of points or given an average areal figure. Linear features can be displayed as a distance figure, or given an average areal figure.

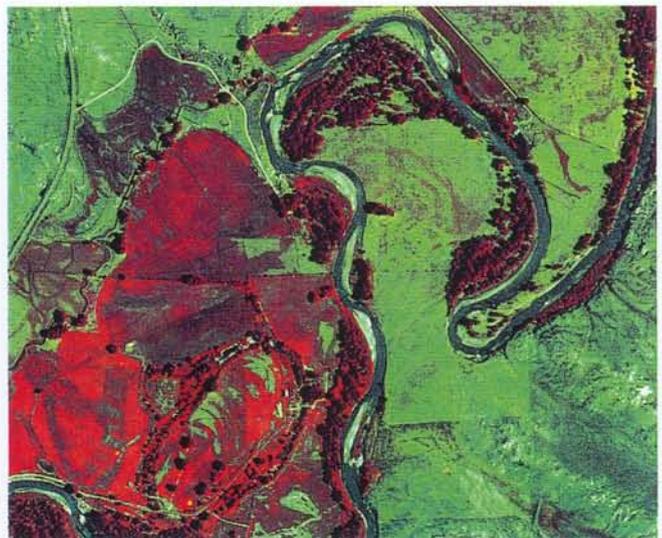
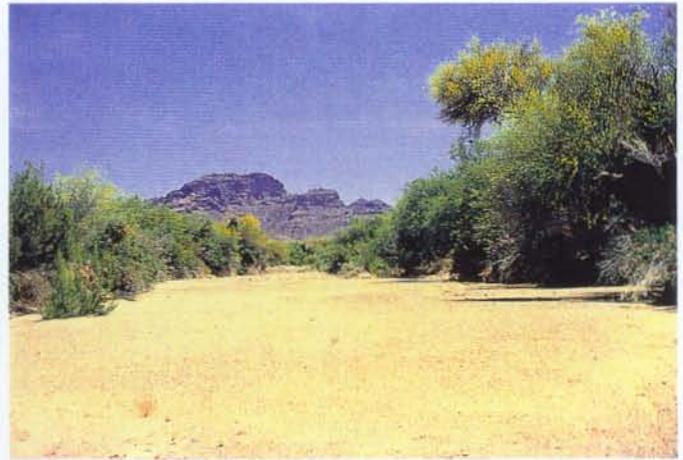


Figure 4. Color infrared photograph of the Tongue River, Wyoming area shown in Figures 2a and 2b (National High Altitude Program).

Riparian areas support an array of habitats ranging from emergent, herbaceous species to broadleaf deciduous shrubs and trees to forested evergreens. Most often, these vegetative components and associated dynamic hydrological settings are evident as shown in the following pictures from four vastly different locales.



**Western Wheatgrass (emergent) located along the Snake River, Nebraska (Rp1EMWW).**



**Palo Verde/mesquite (scrub-shrub, mixed deciduous) along Growler Wash, Arizona in Organ Pipe Cactus National Monument (Rp1SS6MD).**



**Forested, mixed deciduous species existing adjacent to the Gila River, New Mexico (Rp1FO6).**



**Spruce (forested, evergreen) adjacent to a lentic system in Utah (Rp2FO7).**

## Cartography

Riparian and wetland classification boundaries along a linear feature are shown as one of the following:

- [ ] - riparian classification within brackets
- I - boundary between riparian classifications
- | - boundary between wetland and/or deepwater classifications

The following numbered paragraphs, when referenced with Figure 5, serve as cartographic examples for mapping riparian in conjunction with standard NWI maps:

1. R2UBH deepwater habitat polygon with adjacent polygons of PSSA wetland and riparian vegetation (Rp1FO6AS and Rp1SS6MD).
2. R2UBH deepwater habitat linear without adjacent wetland or riparian vegetation.
3. Wetland change from R2UBH to R4SBC. Note the single dash "break" | showing the wetland classification boundary which extends to 6 when the wetland classification changes to R4SBA.
4. R4SBC wetland with riparian vegetation (Rp1FO6). When both units form a single linear delineation the wetland code is separated from the riparian code by a hyphen (-), R4-Rp1FO6.
5. No wetland change. Riparian forested (Rp1FO6) has changed to riparian shrubs (Rp1SS6). Note the "I" riparian "break" which denotes the boundary between riparian types.
6. End of riparian vegetation and change in wetland from R4SBC to R4SBA, indicated by a riparian "end bracket" ( ] ) and wetland dash "break" |.
7. Intersection of R4SBA and R4SBJ wetlands with a narrow band of riparian vegetation. Thus the delineation R4SBJ-Rp1SS6MD. Refer to #4.
8. Continuation of R4SBA wetland with a polygon of PFOA wetland and riparian polygons of Rp1FO7, Rp1SS7, and Rp1SS6MD.
9. "Isolated" riparian unit connected by subsurface water to adjacent wetland (Rp2SS7SB).
10. Continuation of R4SBA wetland with a PSSJ wetland polygon and a Rp1EM riparian polygon.
11. Continuation of R4SBA wetland with a narrow band of riparian vegetation Rp1SS6AS.
12. Non-wetland riparian linear (Rp1SS7) intersecting a wetland linear (note riparian "break").
13. PEMFh wetland bordered along one side by riparian vegetation Rp2SS6CW. The linear riparian unit forming the edge of a mapped wetland is delineated as a dashed line with appropriate riparian code and "breaks" [ ].
14. A linear R4SBA wetland bordered by a PFOA wetland polygon and a riparian vegetated polygon of Rp1FO6SC/WI. Note: A forward slash in the riparian code indicates a mixed dominant type classification.
15. Change from R4SBA wetland to a PEMA linear wetland bordered by a narrow band of riparian shrubs, thus PEMA-Rp1SS6MD. Refer to note #4.
16. Continuation of PEMA linear wetland with a change in the riparian vegetation, thus PEMA-Rp1FO6MD.
17. Change of PEMA linear wetland to PFOA linear wetland and the riparian from forested to shrubs, thus PFOA-Rp1SS6MD.
18. Continuation of PFOA linear wetland now bordered by riparian forested, thus PFOA-Rp1FO6.
19. Polygons of PEMA and PFOA wetlands separated by a dashed linear of riparian vegetation (Rp1SS6). The extent of the riparian vegetation is indicated by "end brackets."

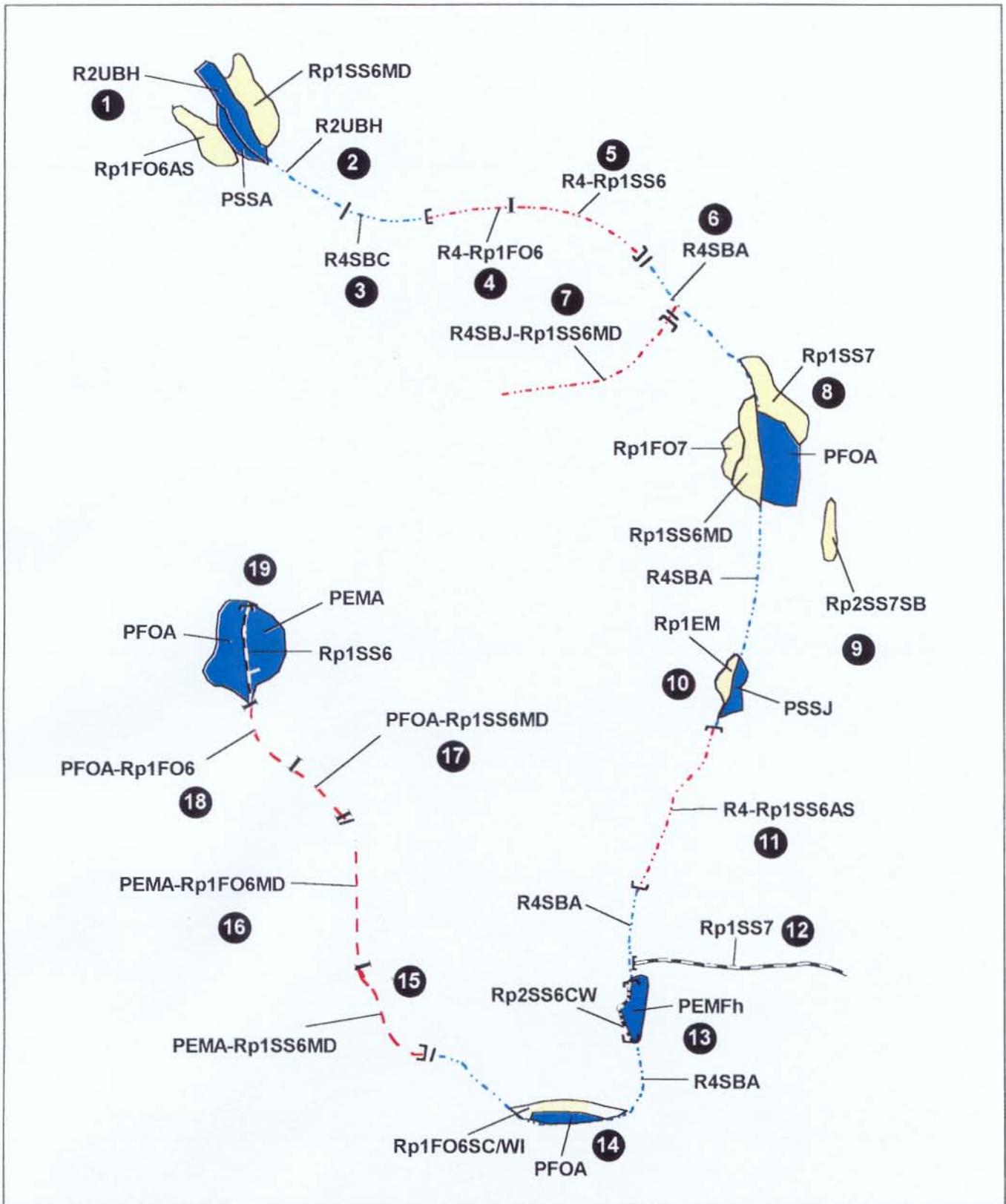


Figure 5. Reference diagram of mapped wetland and riparian areas. Wetlands are blue, riparian areas are beige, wetland-riparian areas are red.

# *Definitions*

The following definitions were developed specifically for these riparian mapping conventions.

<b>Dominant</b>	The vegetative species or life form either controlling or most prevalent in the immediate environment. For these conventions, considered to be at least 30 percent vegetative cover.
<b>Emergent</b>	A species that is erect and rooted with an herbaceous stem.
<b>Forested</b>	Woody vegetation greater than 6 meters in height.
<b>Growth form</b>	Generally related to vigorous health, compactness, crowding, and/or numbers of individuals.
<b>Intermittent</b>	A stream that flows only at certain times of the year or an area where the substrate is usually exposed, but surface water is present for variable periods without a detectable seasonal pattern.
<b>Lentic</b>	Related to or living in standing water.
<b>Lotic</b>	Related to or living in flowing water.
<b>Perennial</b>	A stream that flows continuously or an area where water covers the land surface throughout the year in all years.
<b>Scrub/Shrub</b>	Woody vegetation less than 6 meters in height.
<b>Wetland</b>	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.

## ***Relationship to Other Programs***

Although not technical criteria or procedures, this section briefly addresses some policy and application concerns presented by cooperating agencies.

### **Wetland Regulatory Programs**

The procedures described in this document are for mapping riparian areas for resource inventory purposes only, and have no relationship to any wetland regulatory program. These mapping conventions do not supplant the procedures for identifying wetlands subject to U.S. Army Corps of Engineers regulation under Section 404 of the Clean Water Act, as described in the 1987 Wetland Delineation Manual (Corps of Engineers 1987) or other Federal, State, or local wetland programs.

### **Federal Geographic Data Committee Vegetation Standard**

A Vegetation Classification Standard was recently adopted by the Federal Geographic Data Committee (FGDC). That standard was established to "enable Federal agencies to collect vegetation information in a standard format and apply a standard classification system to vegetation in reports and on maps. This uniform National Vegetation Classification Standard (NVCS) should complement regional or local classifications that are designed to meet more specific objectives."

The Riparian definition and mapping conventions contained in the present report were likewise developed to provide uniformity, but more importantly to be consistent with the Wetlands Standard adopted by the FGDC in December 1996. The Wetlands Standard (Cowardin et al. 1979) is the basis for all wetlands maps prepared by the NWI. Because all riparian mapping to be accomplished by the Service will be done in concert with NWI wetland maps, the riparian mapping conventions were prepared to be synchronous with the existing wetland standard.

Although the FGDC vegetation standard contains associations of vegetative communities that would fit the riparian definition, in reality those communities can be both riparian and upland. This makes them incompatible with the present mapping system. Users of the Service's riparian classification system should be able to convert most of the riparian data to fit the NVCS vegetative standard.

### **Riparian Mapping Direction**

The Service will conduct riparian mapping in response to requests from cooperating agencies rather than as part of a comprehensive effort to map all riparian areas in the western United States. Therefore, riparian mapping will be done only to meet the requirements of cooperating agencies and offices. Updating riparian maps will occur only when funding is available from the cooperating agencies.

# *Chronology of Definition and System Development*

The Service completed riparian mapping projects for several agencies in Arizona in the early 1990's. Additional projects were conducted for the National Park Service in Nevada, and the Bureau of Land Management in Wyoming. Each project included a variety of definitions, classifications, and mapping conventions. The Service was regularly asked to map riparian areas in the western United States, but lacked a standard definition and conventions to guide the mapping.

Riparian was an important discussion topic at the National Wetlands Inventory Regional Coordinators' Meeting in Tucson, Arizona, in January 1997. A commitment was made at the meeting to assemble a National Wetlands Inventory committee of habitat and cartographic specialists to develop the Service's riparian definition and mapping conventions.

A group of Service employees met in March, 1997, and produced a draft riparian document which contained a definition, a classification system, and mapping conventions. The group included NWI Coordinators and Assistant Coordinators from the western states; Washington Office staff; and a cartographic specialist from the National Wetlands Inventory Center in St. Petersburg, Florida. Service support staff from Regional and Field Offices provided additional input.

The draft document was then reviewed by NWI staff in all of the Regions, in Washington, and the National Wetlands Inventory Center in St. Petersburg, Florida. Following that review, the revision was sent for review to all Service Divisions and Field Offices with a request for a critical review. During this time, the draft procedures were used by the Service for wetland and riparian mapping in Great Basin National Park, Nevada, as part of an interagency agreement with the National Park Service.

Subsequent to the Service review and further updating of the draft document, seven Service employees met in Great Basin National Park, Nevada, during late May, 1997, to field test the definition and conventions and to evaluate their effectiveness in a field situation. As part of the draft map review process, Park Service personnel field-checked over 700 sites mapped as riparian to validate the procedures. Field checking revealed that the draft procedures were used successfully to identify and map riparian areas using aerial photographs. Field checking also revealed that some changes in the draft document should be considered.

Paramount among these was the fact that the microclimatic conditions that are responsible for riparian area formation and identification in Alaska are vastly different compared to those in the lower 48 states. Subsequently, the draft was refocused to apply only to areas of the arid west where mean annual evaporation exceeds mean annual precipitation. The Alaska Regional Wetlands Coordinator concurred with this decision.

Another consideration from the Nevada field work was the necessity to change the focus of the definition from one based on the species make up and physiognomy of woody vegetation on the ground, to one based on the signature of vegetation observable from remotely-sensed data. This issue was addressed in the subsequent revision of the draft.

An "Operational Draft" document was prepared in July 1997 which considered input from the Service and the experiences in Great Basin National Park. This document was called an Operational Draft to symbolize the fact that the Service was satisfied with what had been produced, and would use the definition and conventions for mapping purposes, but was still receptive to improvement if additional information or experience indicated that changes were needed.

On July 23, 1997, the Acting Director of the Service distributed a "Dear Colleague" letter that transmitted the Operational Draft to the Directors of 10 Federal agencies having a direct or peripheral interest in riparian areas. The same letter was sent to the Directors of the State resource agency in each of the 22 states in the riparian definition's "Area of Applicability". This transmittal letter requested that a critical review be conducted by each agency or state before the Service formally adopted the definition and conventions. The Service made it clear in the cover letter that the agency was pleased with the

current product, but was willing to consider changes based on the input of others. The Western Regional Offices provided the Acting Director's July 23, 1997 letter and copies of the Operational Draft to additional State and Federal Agencies and non-governmental entities to achieve the most comprehensive review possible.

Input from this review was considered by the Service during a final review of the document in early November, 1997. Those agencies that provided input are included in the Acknowledgments section.



Forested, mixed deciduous species along the Sheyenne River, North Dakota.

## *Acknowledgements*

The principal authors of this document were David Dall, Chuck Elliott, and Dennis Peters; NWI Regional Wetland Coordinators in the Western United States. Craig Faanes was the principal facilitator throughout the completion of this publication. Several early drafts of this document were reviewed by staff of the National Wetlands Inventory in each of the 7 Service Regions. Subsequent review was provided by Field Offices of the Divisions of Ecological Services and Refuges. Valuable review and criticism of the draft was provided by the following outside agencies and organizations as the draft approached the final version: Arizona Game and Fish Department, California Department of Fish and Game, Iowa Department of Natural Resources, Kansas Department of Wildlife and Parks, Louisiana Department of

Wildlife and Fisheries, Nebraska Game and Parks Commission, Nevada Division of Wildlife, Texas Parks and Wildlife Department, Utah Division of Wildlife Resources, Wyoming Game and Fish Department, U.S. Army Corps of Engineers, U.S. Bureau of Land Management, U.S. Bureau of Reclamation, U.S. Environmental Protection Agency, U.S. Geological Survey, U.S. National Park Service, U.S. Natural Resources Conservation Service, U.S. Office of Surface Mining, University of Montana (School of Forest Resources), Western Working Group - Partners in Flight, Wyoming Natural Diversity Database, and Donn Kesselheim. Special appreciation is extended to Candy Reckling for her guidance and expertise in the publication of this document. All photographs taken by U.S. Fish and Wildlife Service personnel.

## *Literature Cited*

Arizona Riparian Council. No Date. Fact Sheet #1. Arizona State University. Center for Environmental Studies. Tempe, AZ. 4 pp.

Chaney, E., W. Elmore, and W.S. Platts. 1990. Livestock grazing on western riparian areas. Northwest Resource Information Center, Inc. Eagle, Idaho. 45 pp.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service, Washington, DC. FWS/OBS 79-31. 103 pp.

Reed, P.B. Jr. 1988. National list of plant species that occur in wetlands: 1988 National summary. U.S. Fish and Wildlife Service. Biological Report 88(24). 244 pp.

U.S. Army Corps of Engineers. 1987. Wetland delineation manual - Technical Report Y-87-1. U.S. Army Engineers Waterways Experiment Station, Vicksburg, MS.

U.S. Department of Agriculture. 1981. 1980 appraisal, part 1. Soil, water, and related resources in the United States; status, condition, and trends. USDA. Washington, DC.

U.S. Fish and Wildlife Service. 1994a. Cartographic conventions for the National Wetlands Inventory. U.S. Fish and Wildlife Service, St. Petersburg, FL. 71 pp.

U.S. Fish and Wildlife Service. 1994b. Digitizing conventions for the National Wetlands Inventory. U.S. Fish and Wildlife Service, St. Petersburg, FL. 21 pp.

U.S. Fish and Wildlife Service. 1995. Photointerpretation conventions for the National Wetlands Inventory. U.S. Fish and Wildlife Service, St. Petersburg, FL. 60 pp.

Washington Department of Fish and Wildlife. 1995. Priority habitat management recommendations: riparian. Priority Habitats and Species Division. Olympia, WA.