APPENDIX G: Photo Interpretation and Visual Key to Vegetation Mapping Units.

Ouray National Wildlife Refuge
Vernal, Utah

2000-2001

Introduction

This document is a photo interpretation and visual key to map units for the Ouray National Wildlife Refuge Vegetation Mapping Project. Its purpose is to:

Provide a ground photo image for each map unit;
Provide visual examples of each map unit with aerial photographs and delineated overlays;
Provide descriptions for the visual examples;

This key does not attempt to show an exhaustive representation for all variations within each map unit; only the most common or significant representations are included herein. These should be sufficient to give the user a feel for the imagery and an understanding of the relationships between classification and mapping.

Organization to the Photo Interpretation Visual Key

This key presents descriptions and illustrations for every vegetation map unit used in the Ouray National Wildlife Refuge Vegetation Mapping Project. Each map unit is presented on one page. The images that follow are scanned portions of the 2000 color infrared (CIR) aerial photograph prints with the matching transparent interpreted overlays. These images are of the same scale (1:12,000) as the aerial photographs. Each image reveals the photo interpreter's drawn polygon outlines. A current map code is included in yellow and represents the vegetation map class. With map class, a short explanation describes the location of the map unit in relation to the project and a how it generally appeared on the aerial photos. Other information about the map unit or the polygon is also presented if it adds to better understanding or recognition of that particular map unit.

The map units are arranged according to physgnomic groups and land-use (*e.g.* agricultural lands). Three physgnomic groups were used to organize the types at Ouray, Herbaceous, Shrub, and Wooded Vegetation. These groups highlight the ecological diversity found on the refuge and are linked by common ecological processes.

Aerial Photographs

Horizons, Inc (3600 Jet Drive P.O. Box 3134 Rapid City, SD 57709-3134) collected aerial photographs for Ouray on July 5, 2000. The photos were taken at a flight altitude of 6,000 feet above sea level using Kodak Aerochrome Infrared 2443 film. The photo mission was designed to take photos with about 30% side lap (between each flight line) and 60% overlap (along each flight line). The scale of the CIR 9 x 9-inch photos is 1:12,000 (approximately 1 inch = 1000 ft.). Two sets of contact prints were produced and used for stereoscopic interpretation. A total of 52 frames taken over 6 flightlines were used to cover the project area. (See Figure 5. for flightline and photo locations).

Color Infrared Film (CIR)

CIR film was chosen as the format for Ouray NWR vegetation project based on its ability to highlight subtle changes in deciduous and wetland vegetation. CIR film presents a "false color" picture that combines infrared reflectance with green and red visible bands. These differences in reflectance create differences in color that can be easily distinguished and delineated as different plant species and vegetation communities. Reflectance is influenced by structure of the canopy, the orientation of the plants and their leaves, and the thickness and pigment content of leaves.

Texture is also important to the photo interpreter for identification. For trees, texture is influenced by type and orientation of leaves, crown size and shape, and branch structure. An uneven canopy height will appear more broken than an even canopy. Similarly, trees having small crowns will appear a finer texture than trees that have large crowns. Depending on the tree species, the texture can be rough or smooth, fine, lacy, billowy, compact, or any number of other descriptors. These are imprecise terms, but nonetheless important visual elements of the imagery. In contrast, herbaceous vegetation, including wetland and upland communities, generally tend to appear much smoother in texture than forests or woodlands (Hershey and Befort 1995).

CIR photography is not consistent enough to allow a species or type to be described precisely. Film batch, printing process, sun angle, light intensity, shadow, and exposure can all affect the appearance of CIR photography (Hershey and Befort 1995). For accurate mapping at Ouray, ground verification by both the photo interpreter and the refuge staff was very important for successful interpretation of types with confusing or similar signatures.

Please refer back to Ouray National Wildlife Refuge Vegetation Mapping Final Report Section 6 for a complete list of map units and their relationship to USNVC plant associations.

<u>Literature Cited:</u>

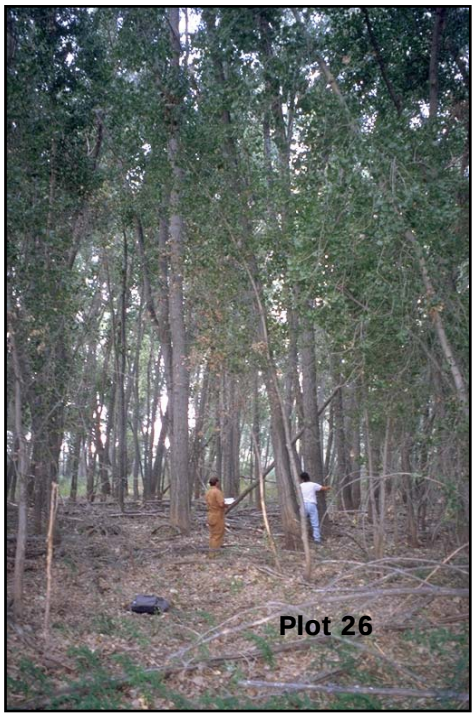
Hershey, R. and W. Befort. Aerial photo guide to New England forest cover types. Radnor, PA: USDA Forest Service ; 1995; NE Forest Experiment Station General Technical Report NE-195.

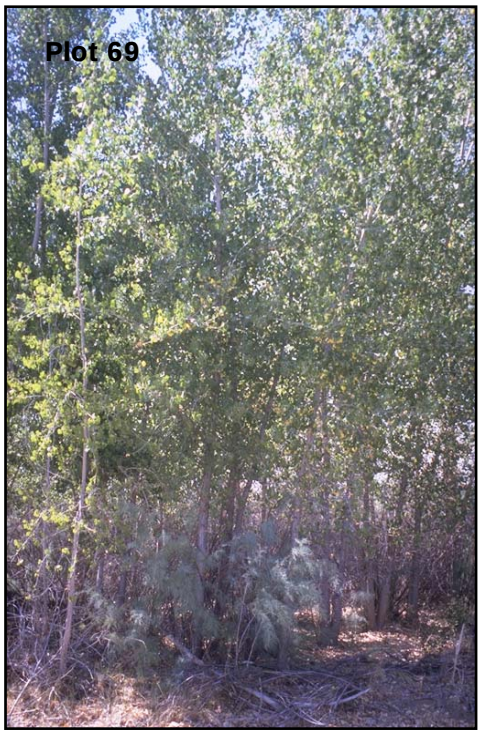
WOODED VEGETATION

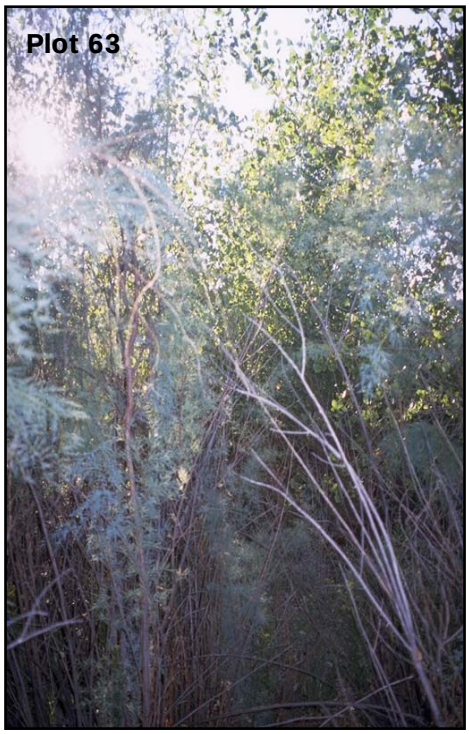
(includes Tall Shrublands, Woodlands and Forests)

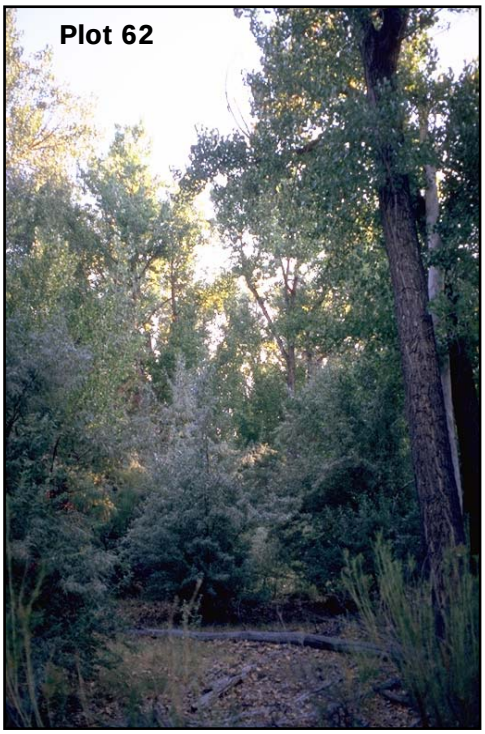
Fremont Cottonwood Temporarily Flooded Forest Alliance (Map Code 1)

Location: The Fremont Cottonwood Temporarily Flooded Forest Alliance type lines the Green River banks, point bars, side channels, and grows on islands within the river. It is the common forest type within the Refuge.

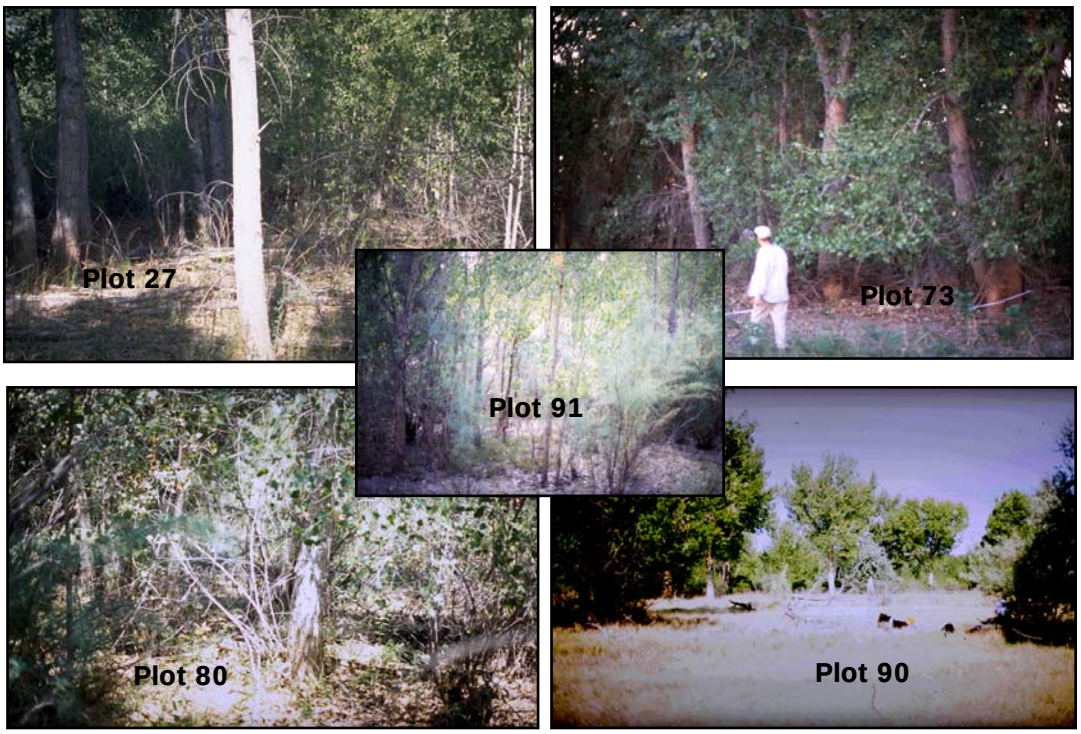




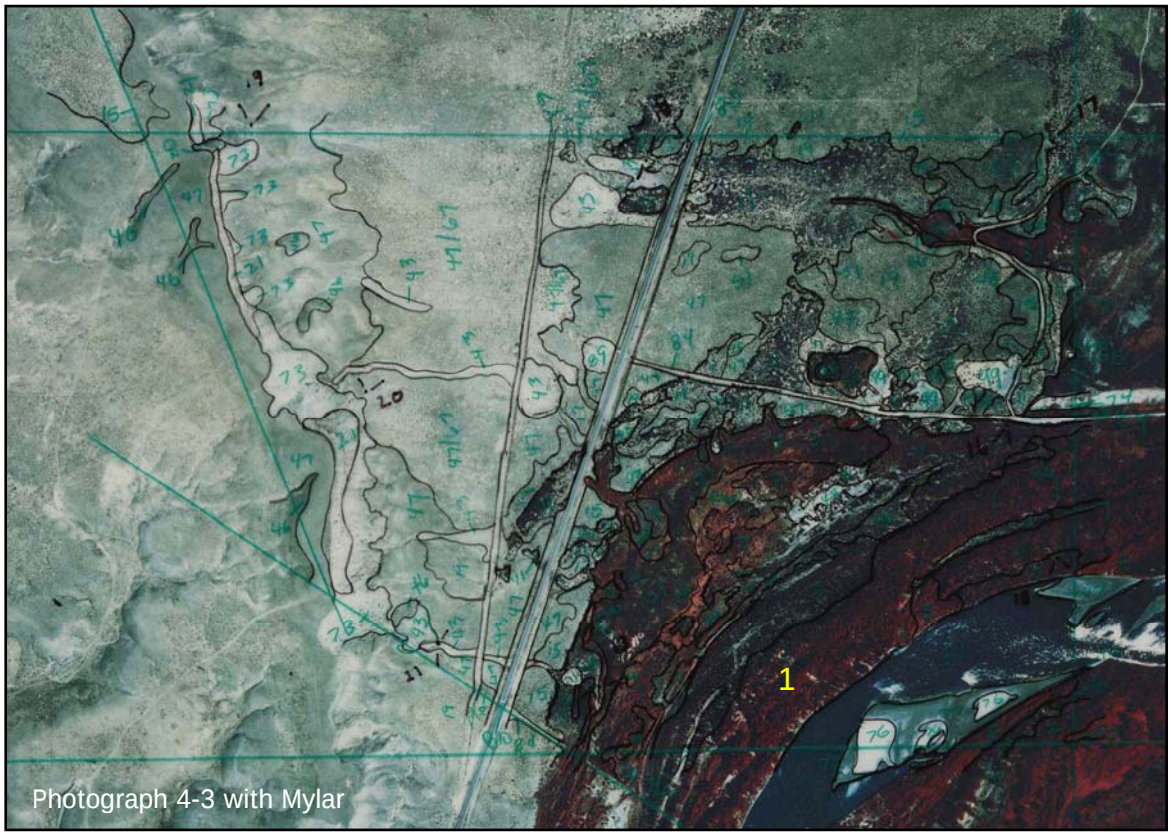




Fremont Cottonwood Temporarily Flooded Forest Alliance (Map Code 1) (cont.)



Signature: On CIR photography cottonwood forests appear as a dark red, heavily textured stands with evident height. Stands are usually in proximity to the Green River and can be distinguished from cottonwood woodlands (Code 2) by their closed or near-closed canopy.



Photograph 4-3 with Mylar

Fremont Cottonwood Temporarily Flooded Woodland Alliance (Map Code 2)

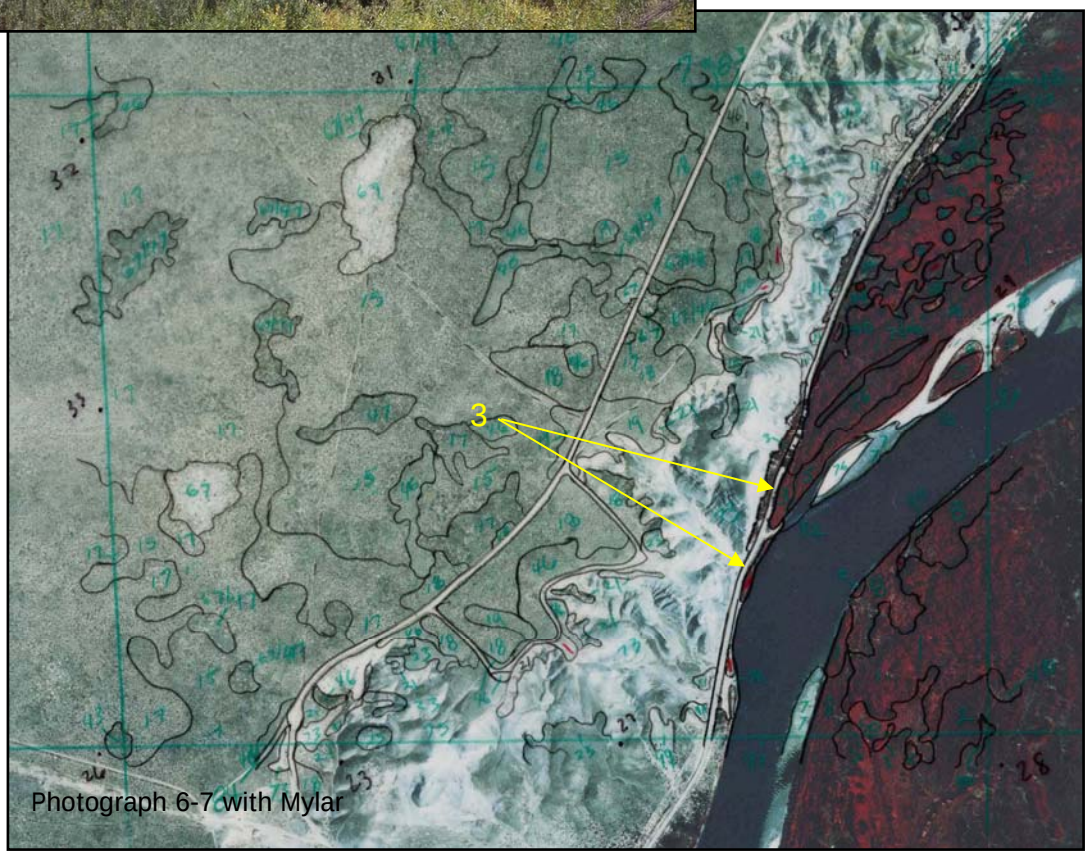
Location: Mature *Populus fremontii* trees have persisted on a third terrace from the Green River, probably for more than a century, resulting in an open woodland formation. The soils are silty clay and have become well vegetated with riparian grasses. The massive trunks of these trees exhibit fire scarring

Signature: Cottonwood woodlands appear as a dark red, heavily textured stands with evident height. Stands are usually in close proximity to the Green River and can be distinguished from cottonwood forests (code 1) by their open canopy.

Peachleaf Willow / Coyote Willow Woodland (Map Code 3)

Location: Only a few stands of *Salix amygdaloides / Salix exigua* Woodland occur within the Refuge. These were observed and sampled off the Hatchery Road near the boat ramp and in Wyasket Bottom.

Signature: The signature for this type is similar to the cottonwood map units. It appears as a dark red course stand. Mapping was based on known locations and field verification.

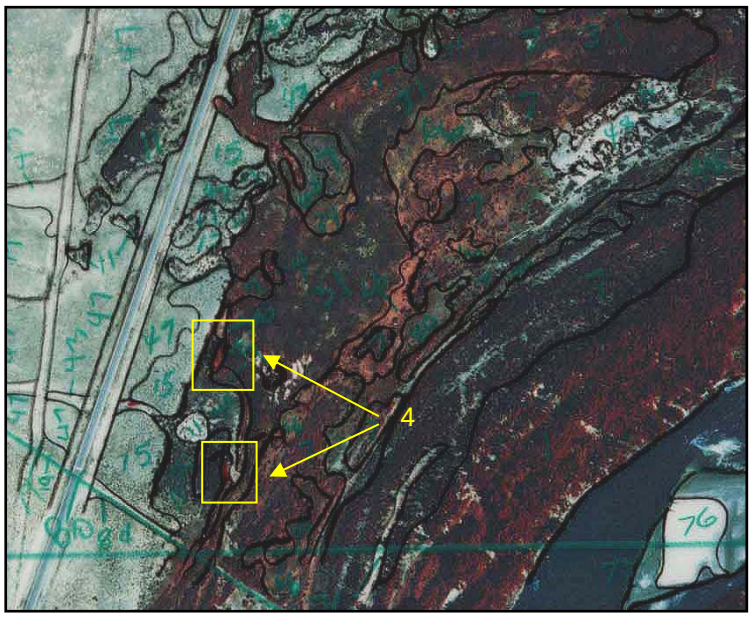


Photograph 6-7 with Mylar

Russian-olive Semi-Natural Woodland (Map Code 4)

Location: A few small stands of *Elaeagnus angustifolia* Semi-Natural Woodland are present within the Refuge, occurring as two types, e.g., riparian stands growing along the Green River and as understory to *Populus fremontii* forest and woodland stands and as upland stands growing in small basins and drainages that are more mesic than surrounding uplands. The largest stand of Russian-olive on the Refuge occupies one such upland basin in Brennan Flats. Most stands occur as several trees adjacent to the river.

Signature: This signature was based on field verification of known locations. On the photography the Russian-olive stands appeared bright red and slightly pebbled.



Photograph 4-3 magnified with Mylar

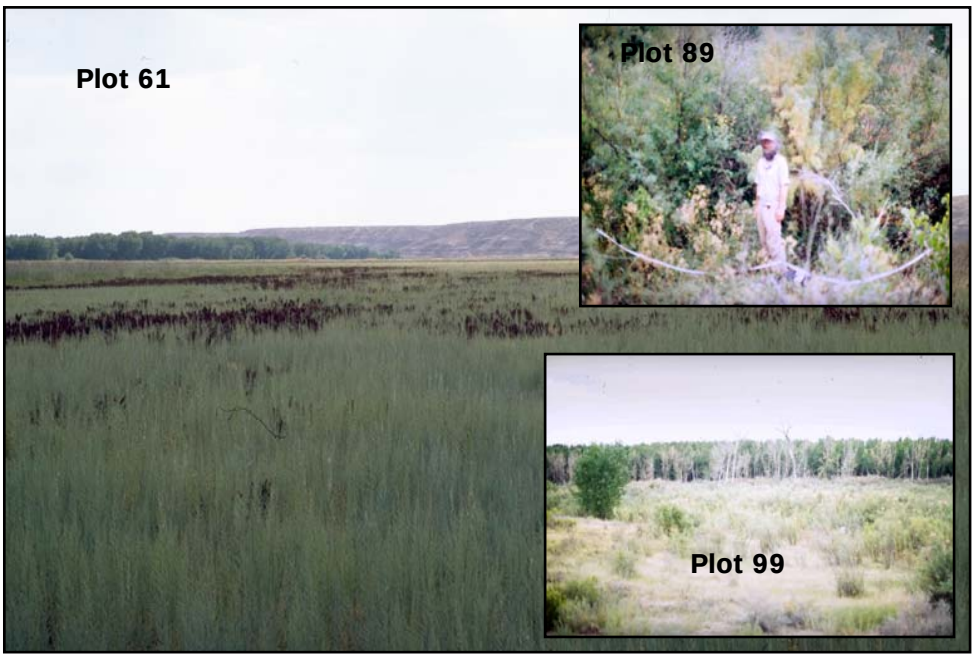
Coyote Willow / Barren Shrubland (Map Code 5)

Location: Salix exigua / Barren Shrubland stands are found along the banks of the Green River and on islands within the channel. Younger plants establish on the newly deposited, moist sediments nearest the river, while older stands occupy higher portions of point bars and islands in addition to side channels. Occasional coyote willow shrubs grow from dike, levee, and roadway edges and are also observed in intermittent drainages capable of supporting emergent wetlands.

Signature: This type exhibits a smooth to slightly bumpy pinkish-red signature. Location of this type on coyotes and point bars along the Green River greatly aids in identification.

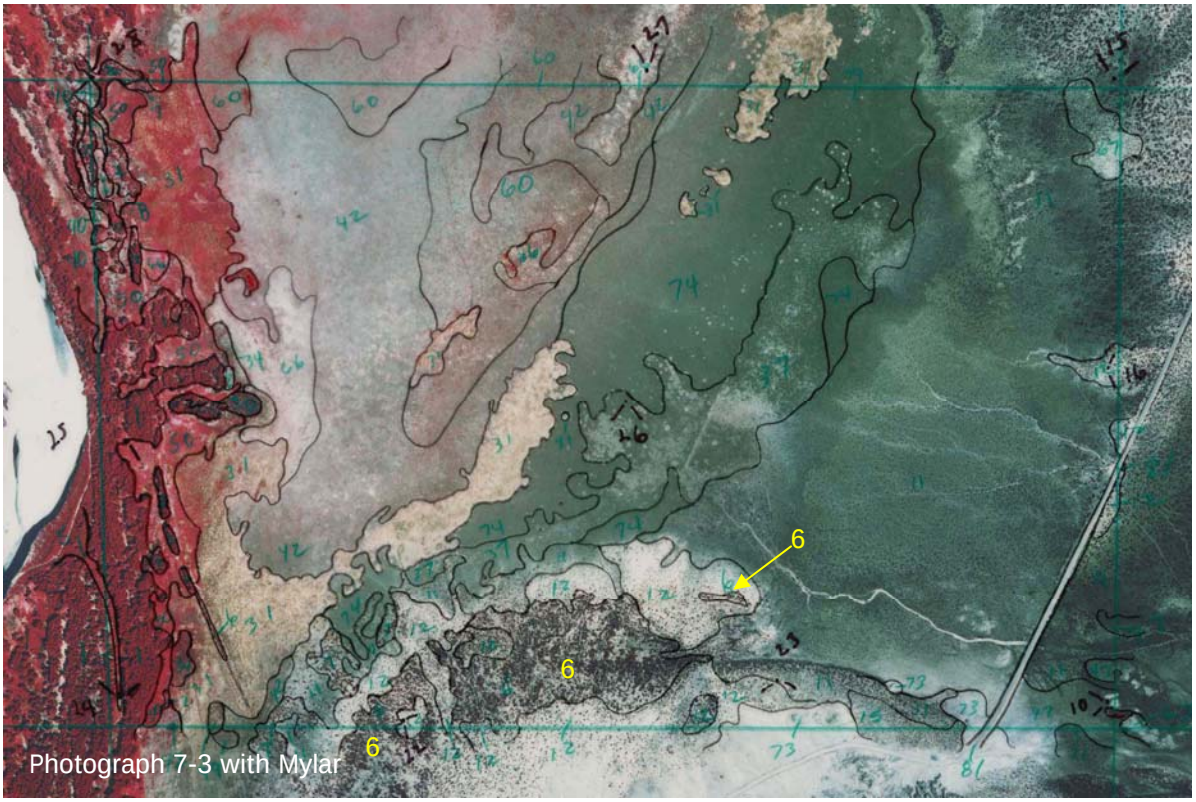
Photograph 5-3 with Mylar

Salt-cedar spp. Temporarily Flooded Shrubland (Map Code 6)



Location: Tamarix spp. shrubland is becoming established along the Green River, its floodplain and basins, and along the unnamed tributary drainage near the Refuge entryway. This exotic shrub type occupies sand bars and islands, side channels, basin edges, drying basins, dikes, levees, roadsides, and riparian habitats within the Refuge.

Signature: This type has a deep burgundy-red signature on CIR photography. The lack of vegetation in the sub-canopy provides a whitish/bluish undertone that can be used to distinguish it from the other salt cedar class (map code 7).

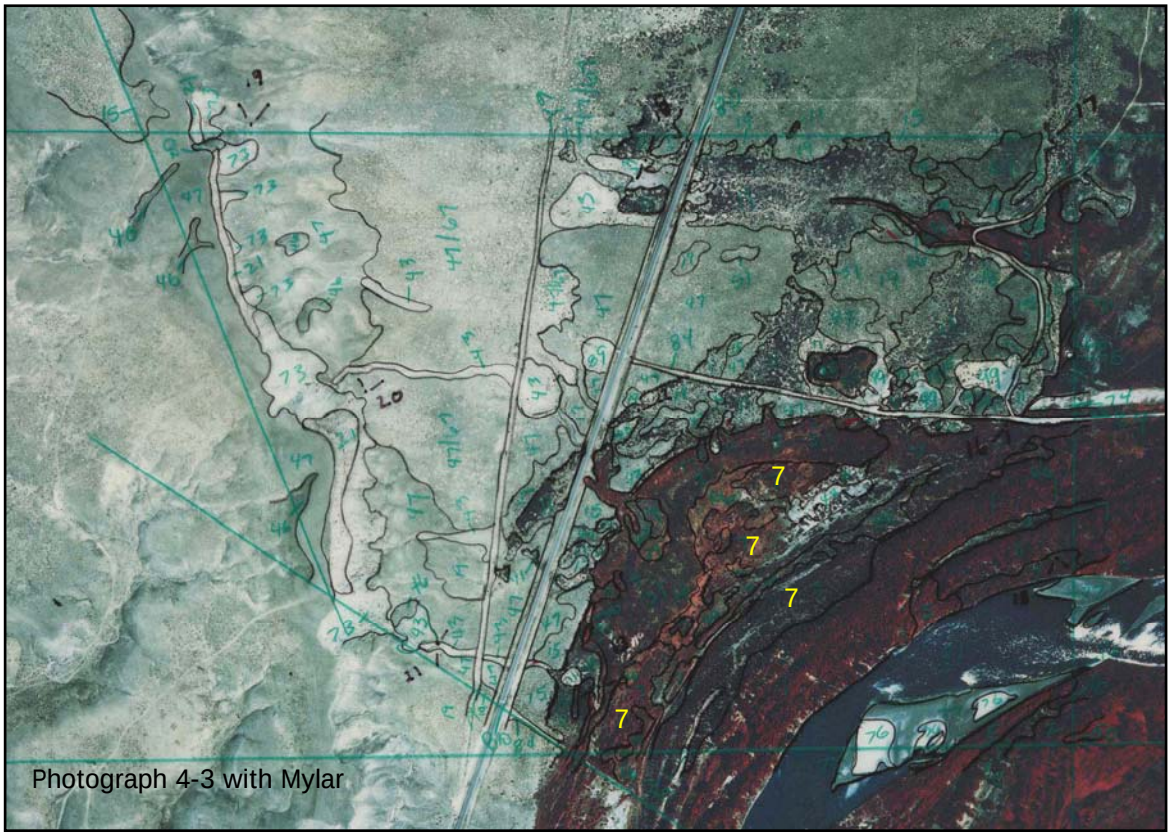


Photograph 7-3 with Mylar

Salt-cedar spp. / Alkali Sacaton Shrubland (Map Code 7)

Location: The *Tamarix* spp. / *Sporobolus airoides* shrubland occurs in similar situations as the previous salt-cedar class (map code 6, see above). This type is distinguished by having a herbaceous understory.

Signature: This type has a deep burgundy-red signature on CIR photography. Vegetation in the sub-canopy provides a variety of undertones that can vary from orange to tan. This type can be distinguished from the other salt cedar class (Map Code 6) by the presence of associated vegetation in the sub-canopy and occurs in higher densities.



Photograph 4-3 with Mylar

Ill-scented Sumac – Coyte Willow Shrubland (Map Code 8)

Location: Rhus aromatica – Salix exigua Shrubland grows within the floodplain of the Green River. This association is typically found on second terraces between stands of Fremont cottonwood (upper second or third terrace) and coyote willow (first terrace or lower second terrace). Ill-scented shrubland is also present as understory to Fremont cottonwood forest and woodland types, in addition it grows adjacent to silver buffaloberry stands on the river banks. Perhaps the most well-developed stands occupy Sheppard Bottom and Wyasket Bottom.

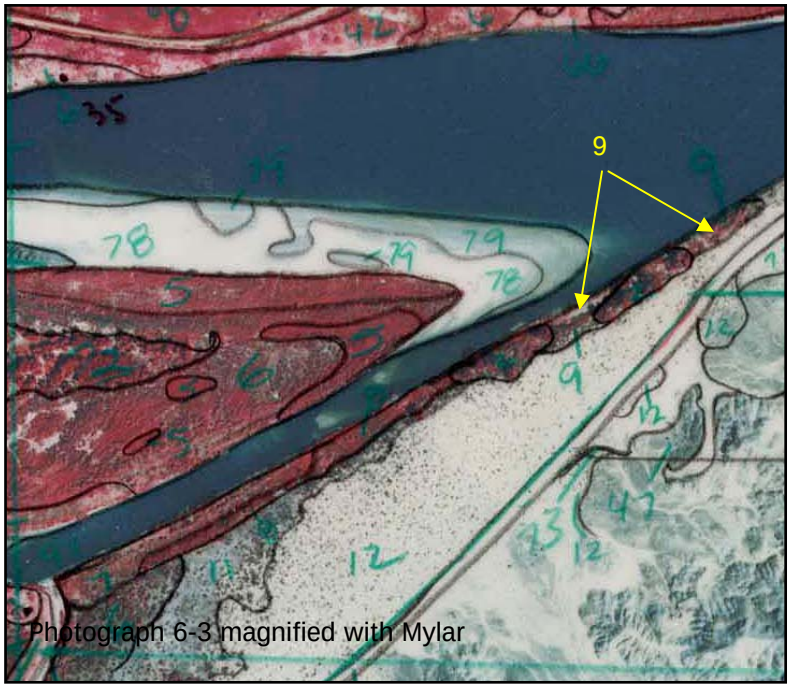
Signature: This tall shrub typically occurs along the upper terraces of the Green River Floodplain and its location can be used to help with its identification. Photo signatures on CIR photography for this type range from light pink to darker red corresponding to age of the shrubs. This type was identified in part based on location and contrast with other riparian shrublands and woodlands.

Photograph 5-3 with Mylar

Silver buffaloberry Great Basin Shrubland (Map Code 9)

Location: Shepherdia argentea Great Basin Shrubland stands are located on the banks of the Green River and along a few historic side channels which were once perennial channels. The stands are linear, occurring intermittently along the riverbanks, and can be confused with similar sized stands of *Elaeagnus angustifolia* Semi-natural Woodlands. The banks tend to be elevated 2-5 m above the flowing water.

Signature: This type appears as small stands that are slightly red with an undertone of gray. Signatures are similar to Russian Olive in color but are usually less coarse and occur in higher densities. Identification of this type was based in part on field verification.



Photograph 6-3 magnified with Mylar

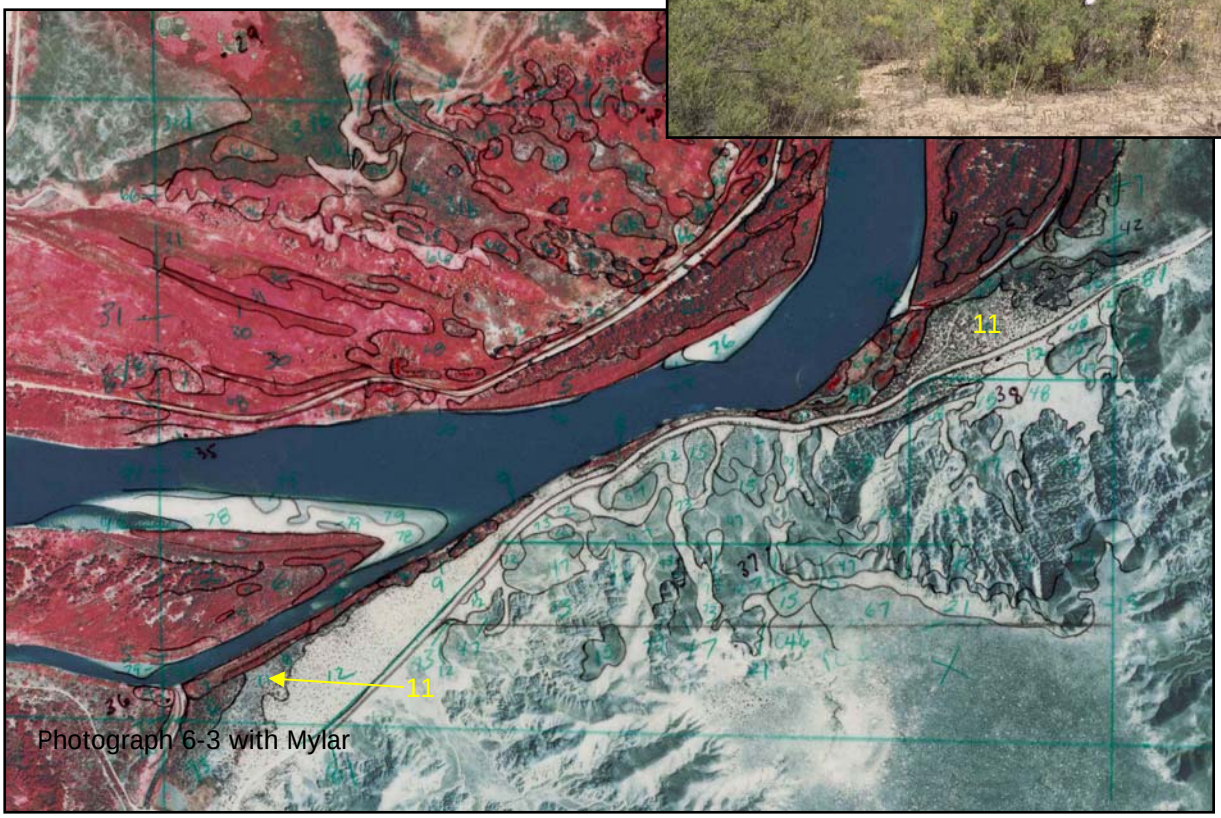
SHRUB VEGETATION

(includes Sparse Shrublands and Dwarf Shrublands)

Black Greasewood - / Saltgrass Shrubland (Map Code 11)

Location: Sarcobatus vermiculatus is a widespread shrub within the Refuge. However, this association with *Distichlis spicata*. occurs only on the floodplain of the Green River, usually on the second or third terrace. Sparse stands of greasewood in association with saltbush species and species of grasses are described as the *Sarcobatus vermiculatus - Atriplex gardneri* Shrubland.

Signature: This greasewood type appears as a mottled dark burgundy red signature with very small circles representing the shrubs. This type is distinguished from the other greasewood type by having slightly more foliar cover of associated species. This translates to more red and dark blue undertones.

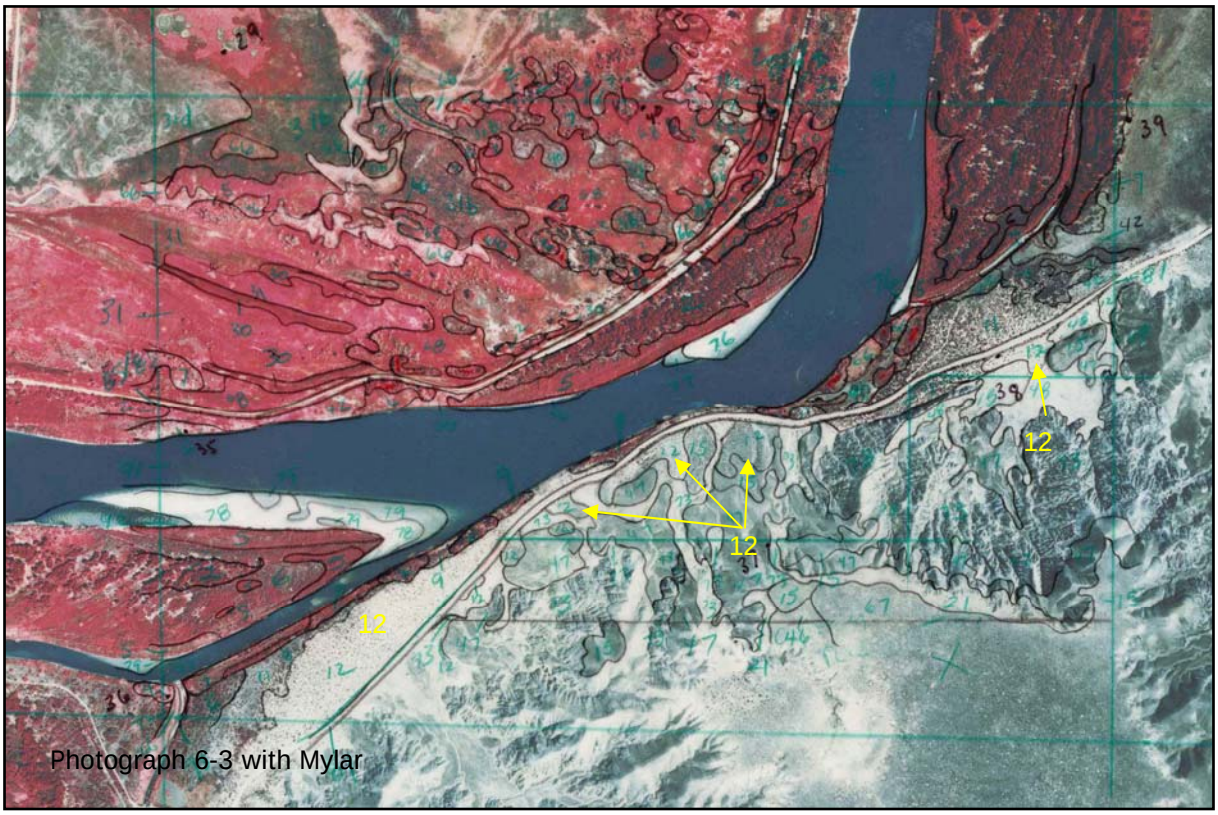


Photograph 6-3 with Mylar

Black Greasewood – Gardner's Saltbush Shrubland (Map Code 12)

Location: The *Sarcobatus vermiculatus - Atriplex gardneri* Shrubland type is best developed above the basin in Wyasket Bottom and on the large erosion fan west of Leota Bottom. It is farily common throughout the Refuge.

Signature: This greasewood type is represented on the CIR photography as very small dark red bumps. The lack of associated species cover makes the background very light, ranging from bright white to grey. Location of this type is usually higher on the landscape than the other greasewood community (map code 11) and can be used to help distinguish between them.

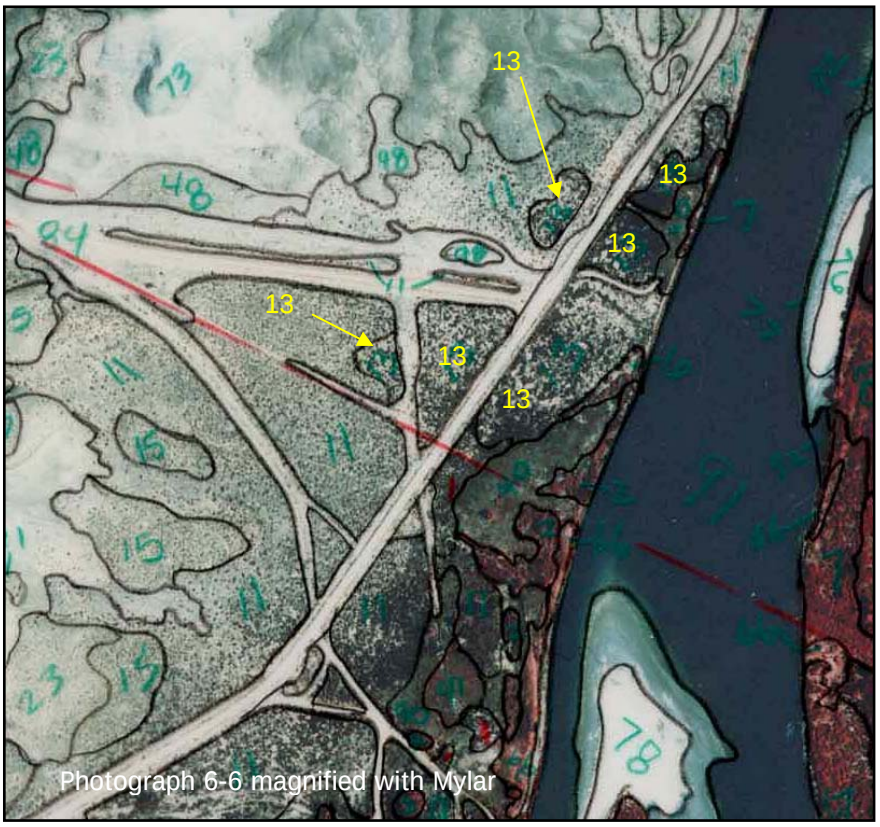


Photograph 6-3 with Mylar

Big Sagebrush Shrubland (Map Code 13)

Location: Artemisia tridentata ssp. *tridentata* Shrubland is known only from a small stand about 0.5 mi north of headquarters on Hatchery Road (the road divides the stand), a small stand in Johnson Bottom, and a larger stand in the northern portion of Brennan Flat.

Signature: This shrub type is similar to the greasewood shrublands but usually occurs in higher densities. Also the color of sagebrush on CIR photography is a darker, almost black but similar in size to the greasewood types. Texture is pebbled or finely mottled.

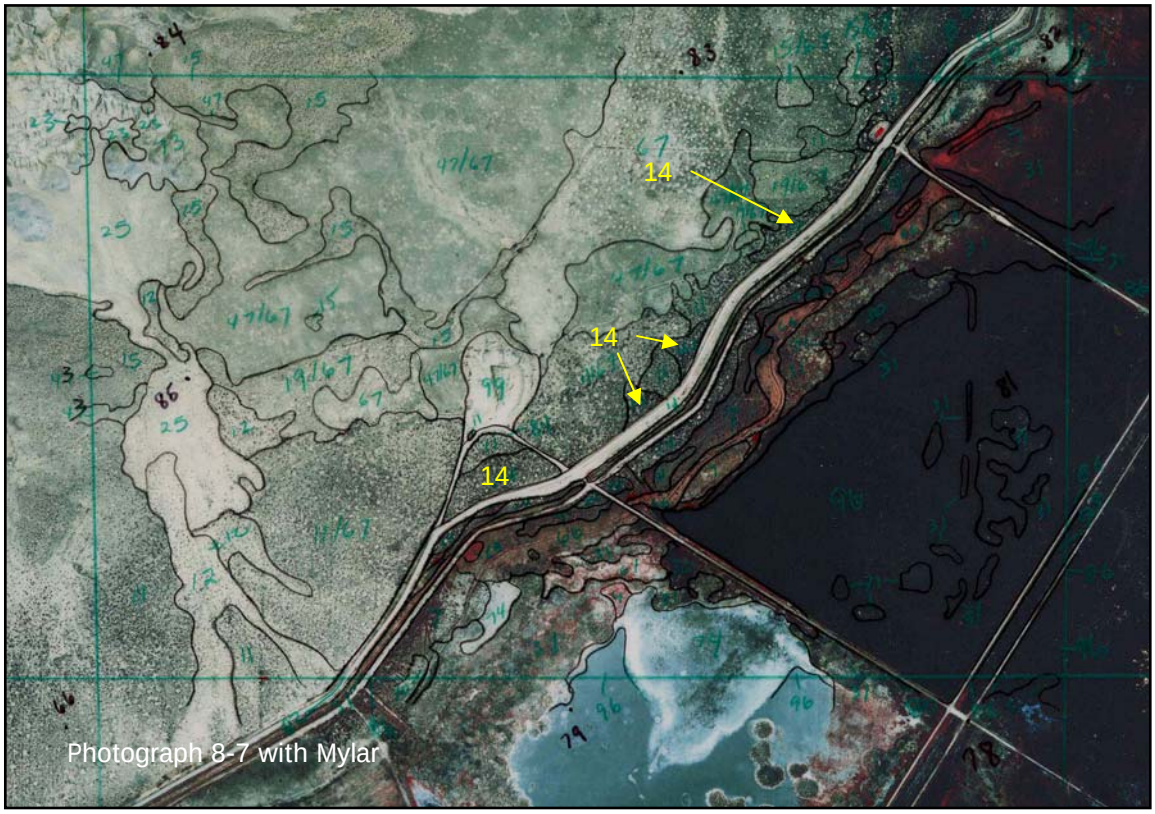


Photograph 6-6 magnified with Mylar

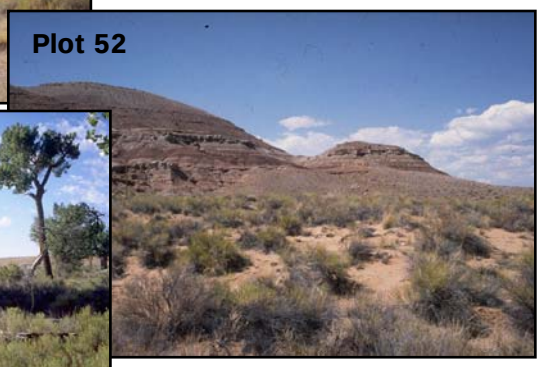
Parryi Rabbitbrush – Black Greasewood Shrubland [Provisional] (Map Code 14)

Location: The Ericameria *parryi* – Sarcobatus vermiculatus Shrubland occurs in small stands on the outer edges of the Green River floodplain. One stand of *Ericameria nauseosus* was observed with in this type, just north of Wyasket Bottom. A few stands of *Ericameria parryi* have become established adjacent to *Sarcobatus vermiculatus* shrublands near the Fish Hatchery.

Signature: Parryi rabbitbrush appears similar to other floodplain shrubs on CIR photography. It appears dark red to black usually on a blue to to grey background. Due to its limited distribution this type was mapped primarily from known locations and field verification. It can be separated from the other rabbitbrush based on its lower poistion on the landscape and its darker (caused by more vegetation) and courser (caused by larger shrubs) signature.

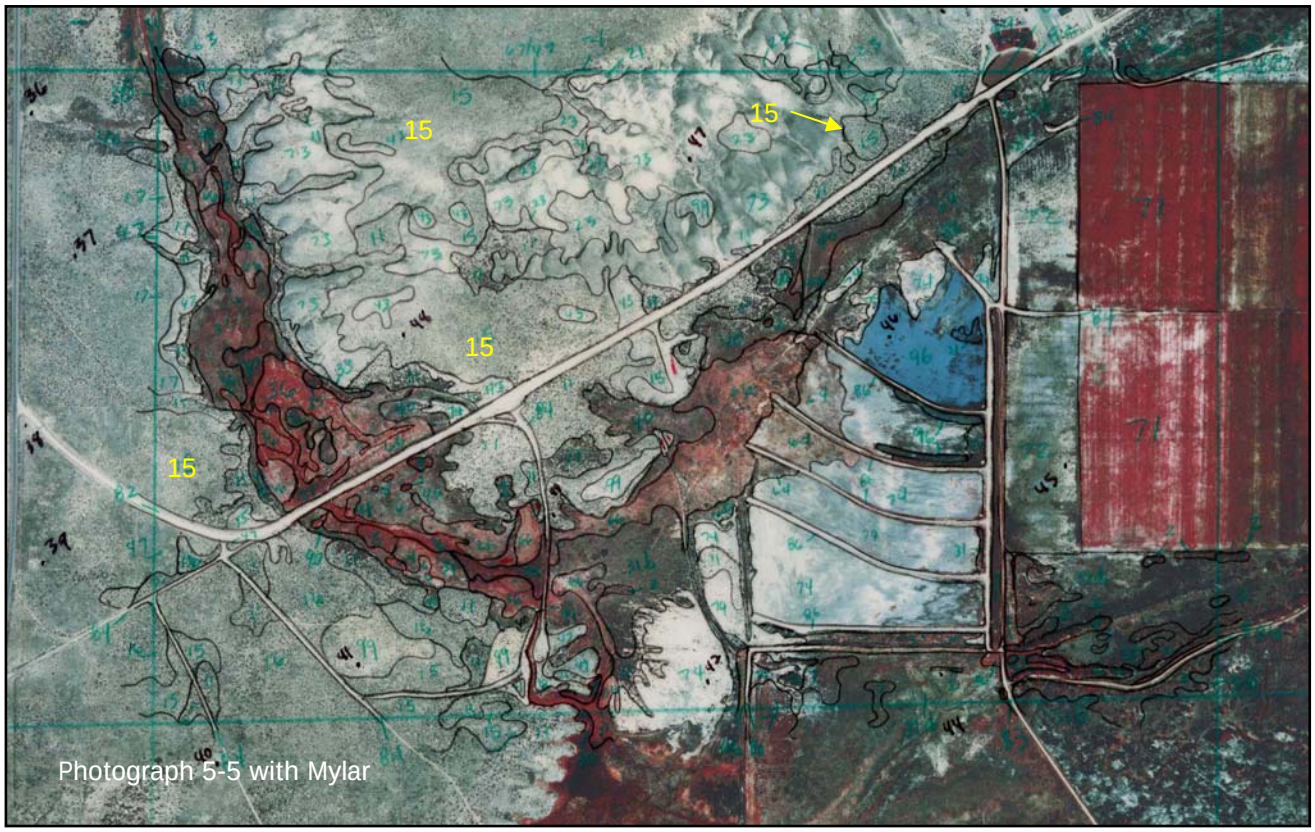


Rubber Rabbitbrush Sand Deposit Sparse Vegetation (Map Code 15)



Location: Ericameria nauseosus Sand Deposit Sparse Vegetation occupies sand dunes and deep, sandy soils within the Refuge. These sites typically occur on the knolls or mid-slopes below bluffs where wind-blown sand (eolian deposits) collects and forms dunes. *Ericameria nauseosus* also occupies deep sandy deposits on more even terrain on the west side of the Refuge, but here it often does not supply sufficient foliar cover to be considered a shrubland type.

Signature: This type has a slightly more reddish signature than similar floodplain shrubs. Due to the sparse vegetation in the interstitial spaces the background color is a white to blue. Considerable field verification for this type was used to accurately delineate between similar types.

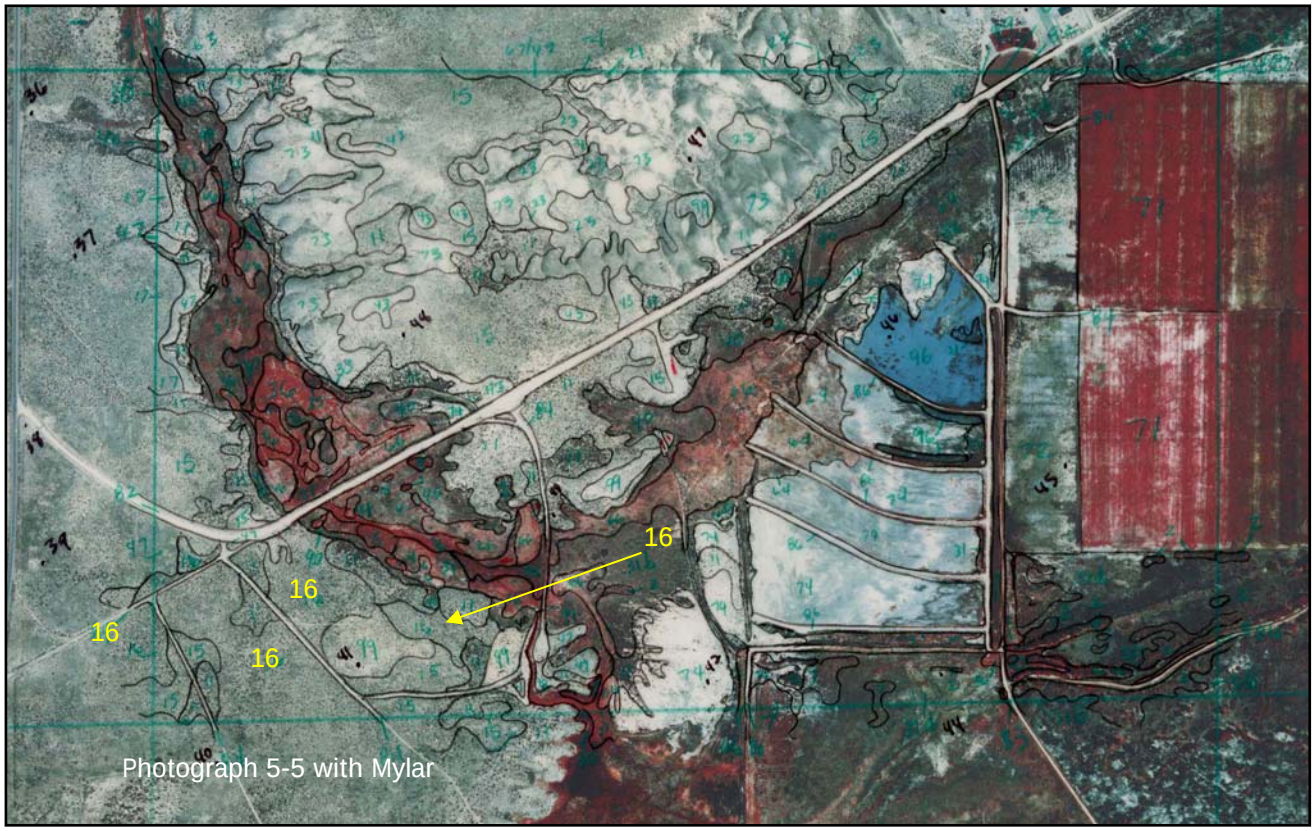


Photograph 5-5 with Mylar

Four-wing Saltbush / James' Galleta Shrubland (Map Code 16)

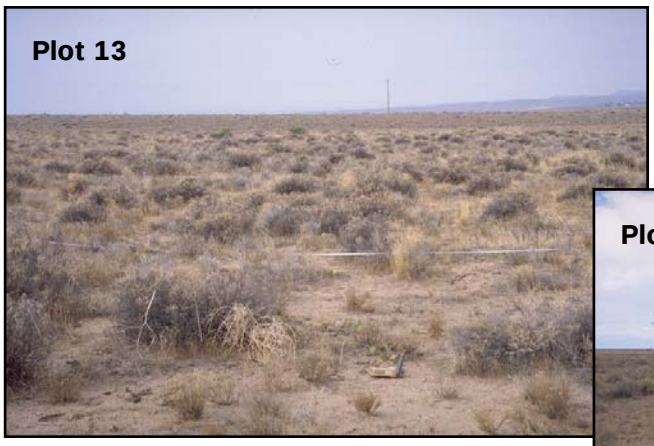
Location: Atriplex canescens / Pleuraphis jamesii Shrubland is distributed mostly on sandy soils near the entryway gate, and along the SH 88 corridor paralleling the west side of the Refuge. Some sandy soils in the western portion of the Refuge, northwest of the headquarters building, also support small stands of four-wing saltbush.

Signature: An almost barren, non-vegetated appearance is characteristic of this type due to the xeric nature of the community and resulting sparse vegetation. The signature for this type on CIR photography is partially obscured by the reflectance from the substrates and can vary from blue to white with a reddish tinge. Under magnification small gray or white bumps are present.

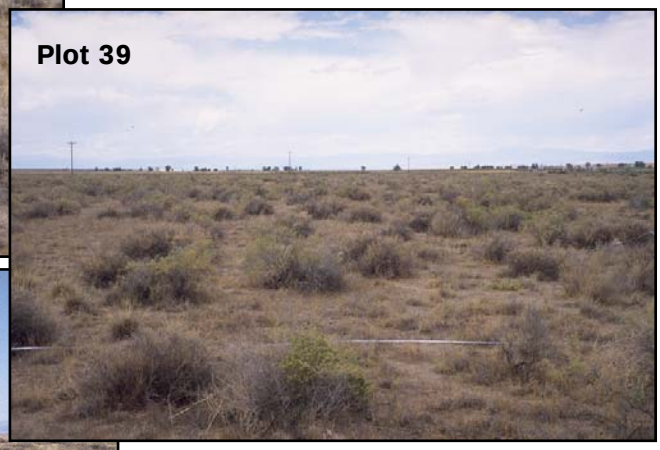


Photograph 5-5 with Mylar

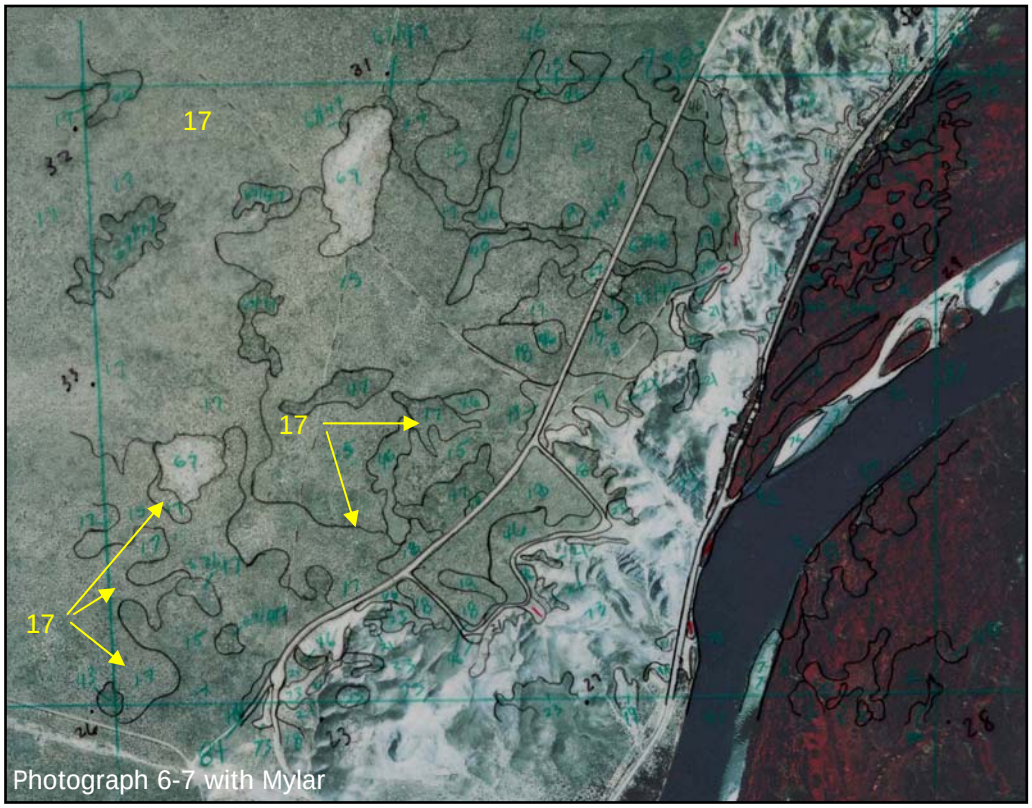
Spiny Hopsage / James' Galleta Shrubland (Map Code 17)



Location: Grayia spinosa / Pleuraphis jamesii Shrubland is present on deeper, sandy and silty clay soils of the plains and rolling hills along the western one-third of the Refuge.



Signature: This upland shrub appears gray to blue due to the xeric nature of the community with a dark gray tinge caused by abundance of dead foliage. The location of this type above the barren clay bluffs (map code 73) aids in delineation. Under magnification white and gray bumps (individual shrubs) are evident.

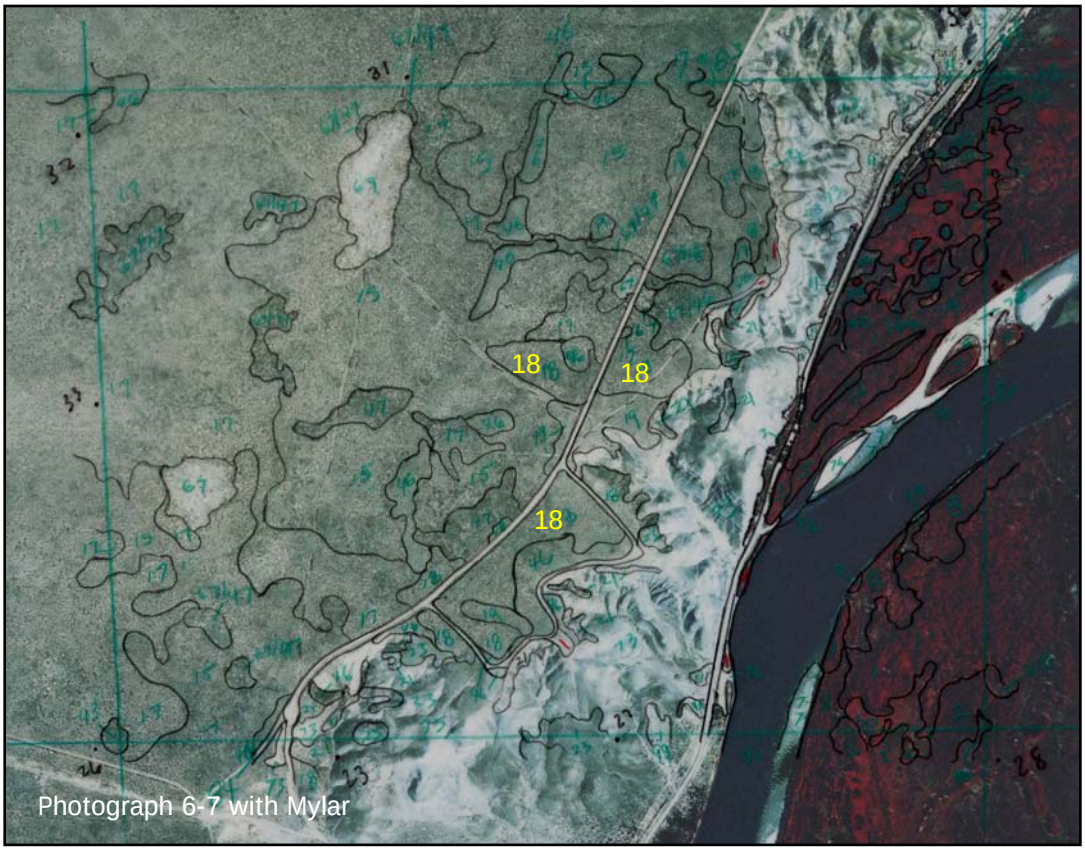


Photograph 6-7 with Mylar

Short-spine Horsebrush / James' Galleta Dwarf Shrubland (Map Code 18)

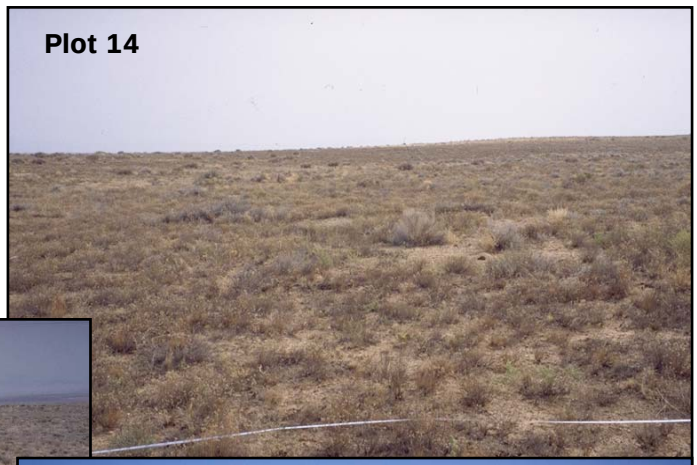
Location: *Tetradymia spinosa / Pleuraphis jamesii* Dwarf Shrubland is distributed in the western one-third of the Refuge, mostly occupying deeper, silty clay soils.

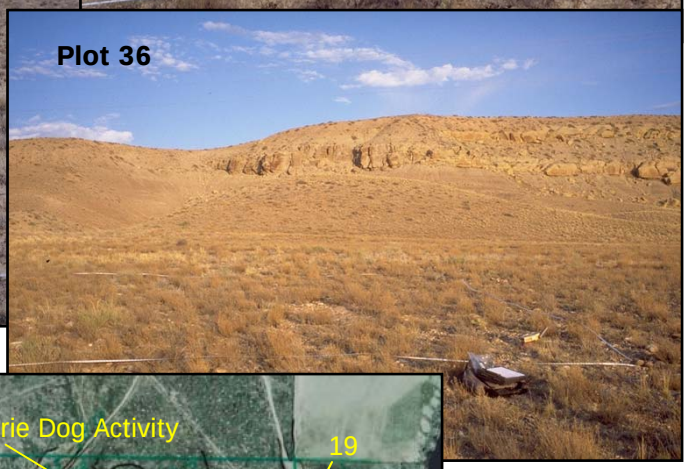
Signature: This type occurs in similar situations as other xeric grasslands and can be easily confused with spiny hopsage or rubber rabbitbrush. On the photos, it appears as a pale blue to gray background smeared with a slightly mottled dark gray pattern.

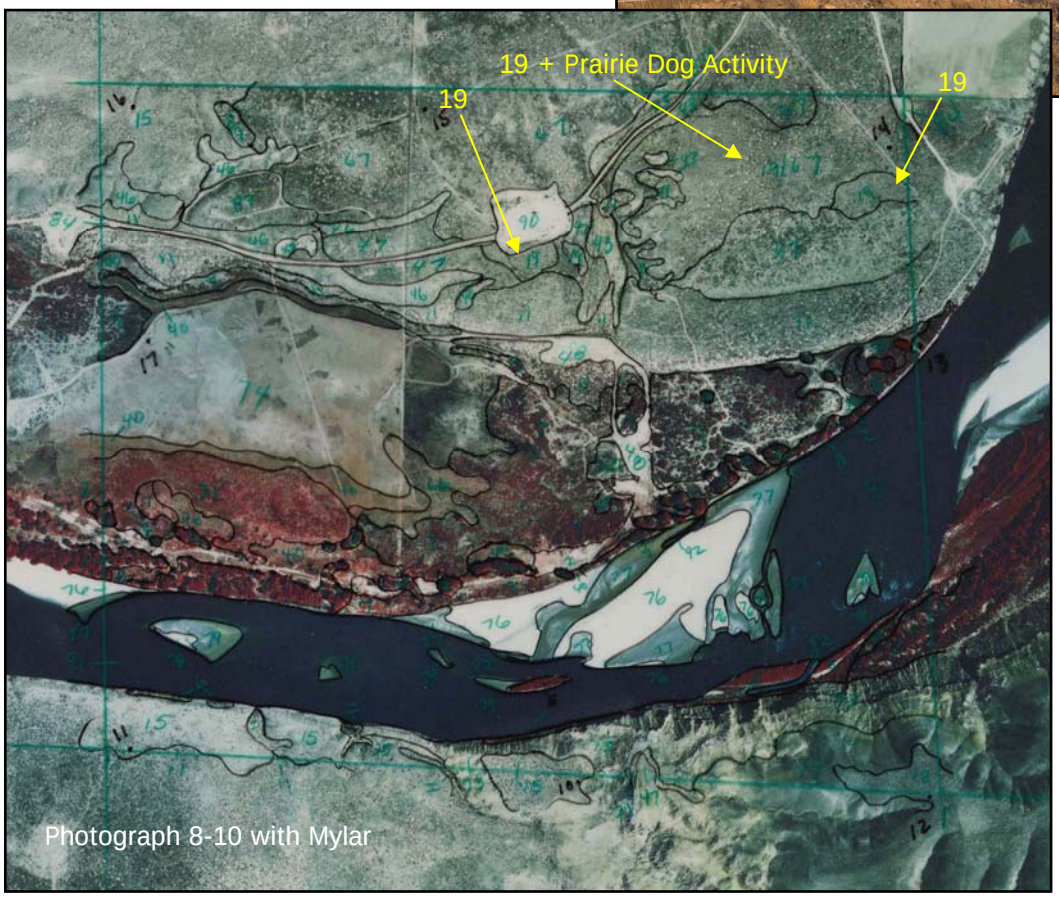


Snakeweed – (Prickyl pear spp.) / James' Galleta Dwarf Shrubland (Map Code 19)

Location: Gutierrezia sarothrae – (*Opuntia* spp.) / *Pleuraphis jamesii* Dwarf Shrubland occupies silty-clay soils and gravel and cobble beds, on relatively flat surfaces. The largest stands are located at the overlooks for Leota and Johnson Bottoms and west of SH 88.







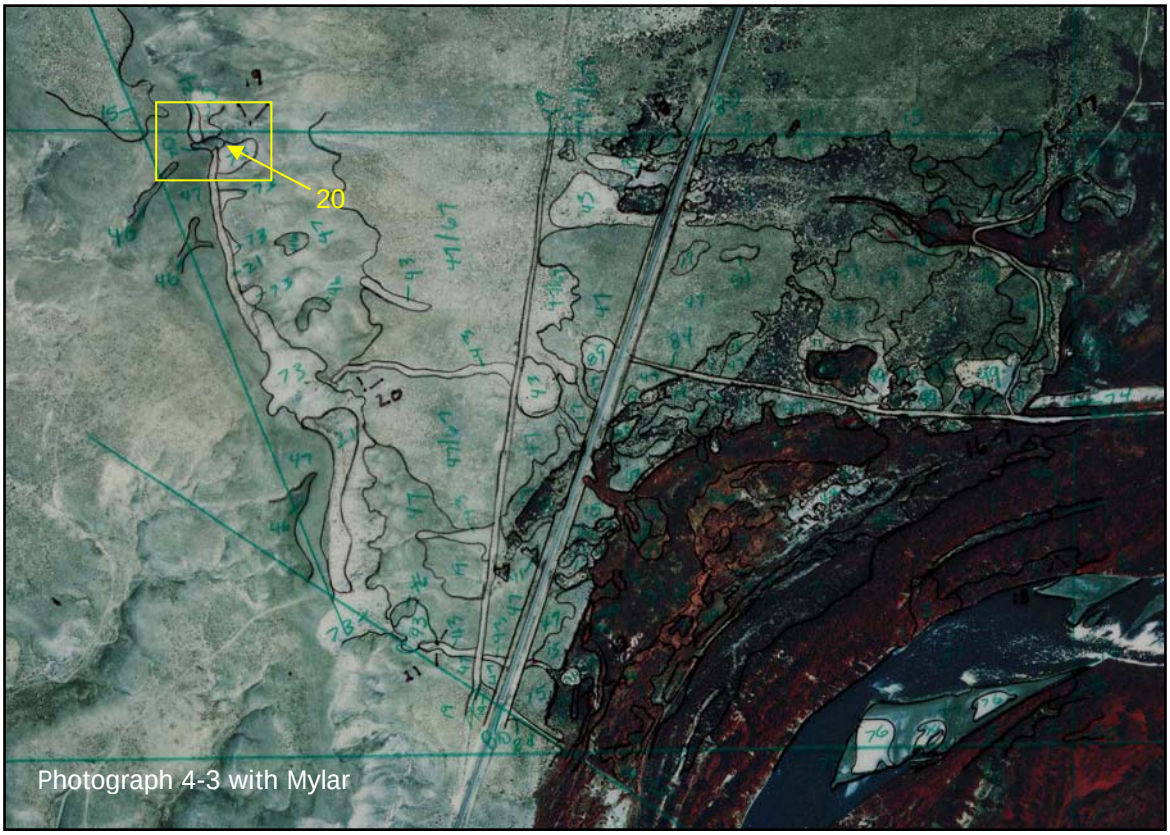
Signature: This type appears almost barren on the photos due to lack of substantial living vegetation. Colors on CIR photography range from blue to gray and usually have a brown or red tinge. Much of this type was mapped from field verification.

Tarragon Dwarf Shrubland (Map Code 20)

Location: Only one patch of *Artemisia dracunculus* Dwarf Shrubland was observed on a mesa edge in the southwestern portion of the Refuge (west of SH 88).

No ground photo was taken.

Signature: Due to the limited distribution and small size of this community no distinctive photo signature was observed or developed for this type. Delineation was based entirely on field verification.

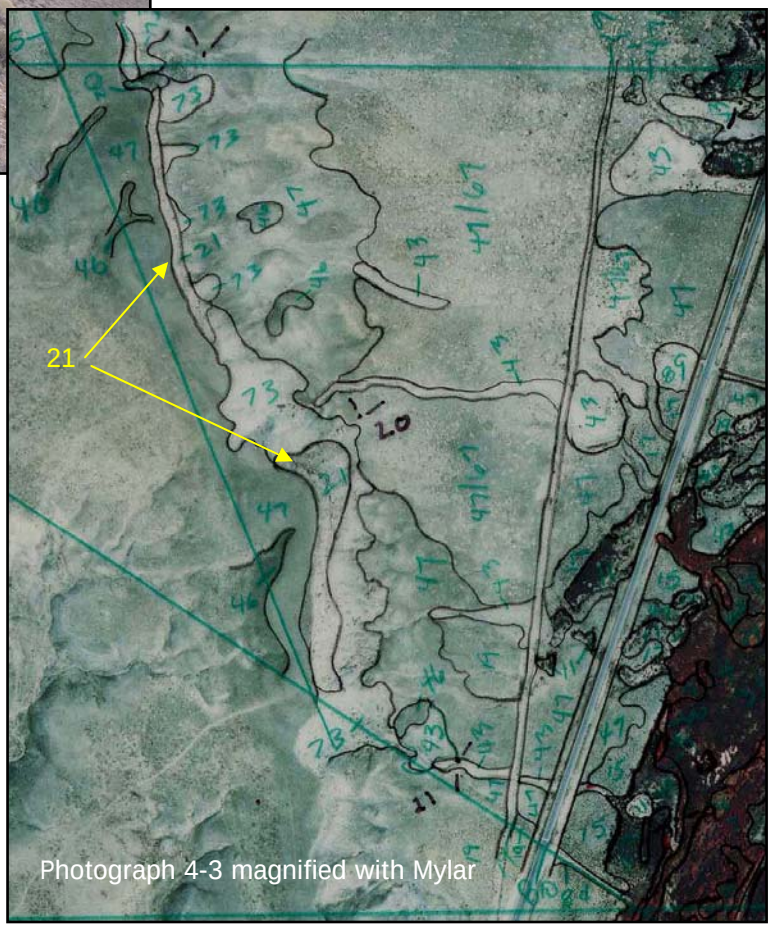


Photograph 4-3 with Mylar

Torrey's Joint-fir (Fourwing Saltbush, Shadscale) Sparse Veg. [P] (Map Code 21)

Location: This provisional type occupies mesa and bluff edges, ridgetops, and hilltops within the badlands area of the Refuge. Typically this type is found associated with gravel and cobble substrates.

Signature: This type is typical of sparsely vegetated communities in Ouray NWR since its CIR signature was dominated by the reflectance of the underlying substrate. However, Torrey's joint-fir plants yielded an extremely sparse dark red pebbly color that dictated delineation. The location of this type on rocky, steep slopes also helped with the identification and interpretation.

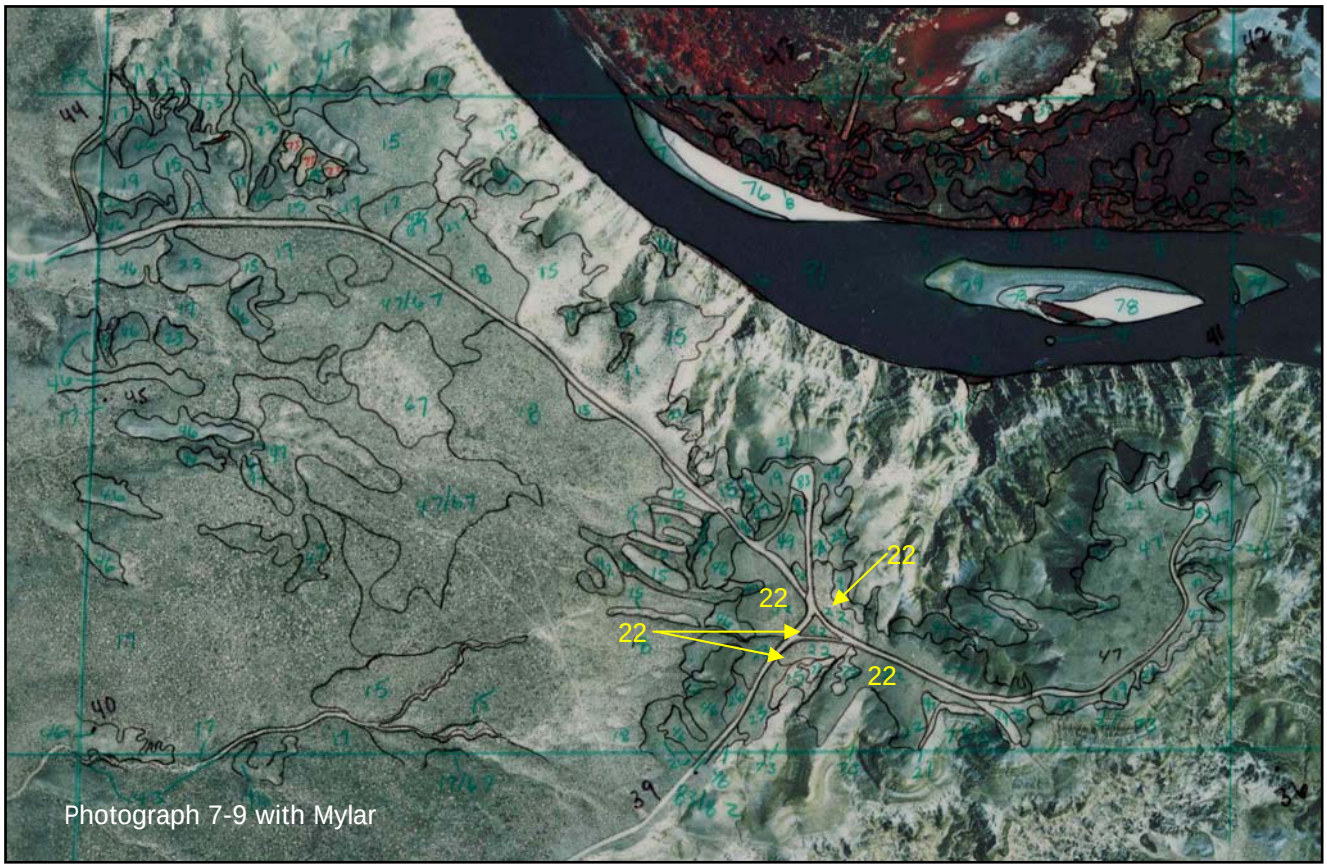


Photograph 4-3 magnified with Mylar

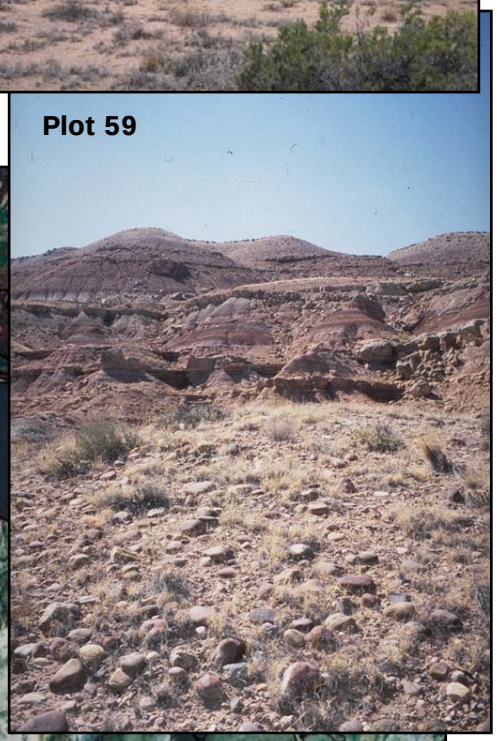
Black Sagebrush Dwarf Shrubland (Map Code 22)

Location: Only one stand of *Artemisia nova* Dwarf Shrubland is present within the Refuge, at the junction of Leota Bottom Overlook and Johnson Bottom Overlook roads. This stand occupies the ridgeline and mesa edge, extending northeastward approximately half the distance up the Leota Bottom Overlook Road and just a short distance up the Johnson Bottom Overlook Road. A small patch of *Artemisia nova* is also present on the mesa edge approximately 200 m northwest of the Johnson Bottom Overlook parking area.

Signature: Black sagebrush at Ouray NWR exhibited a very similar photo signature to other xeric, dwarf (*i.e.* low-growing) shrublands. It typically appeared as blue or gray with a sparse scattering of dark red bumps corresponding to individual shrubs. This type was mapped in large part through ground verification based on its limited size and distribution.

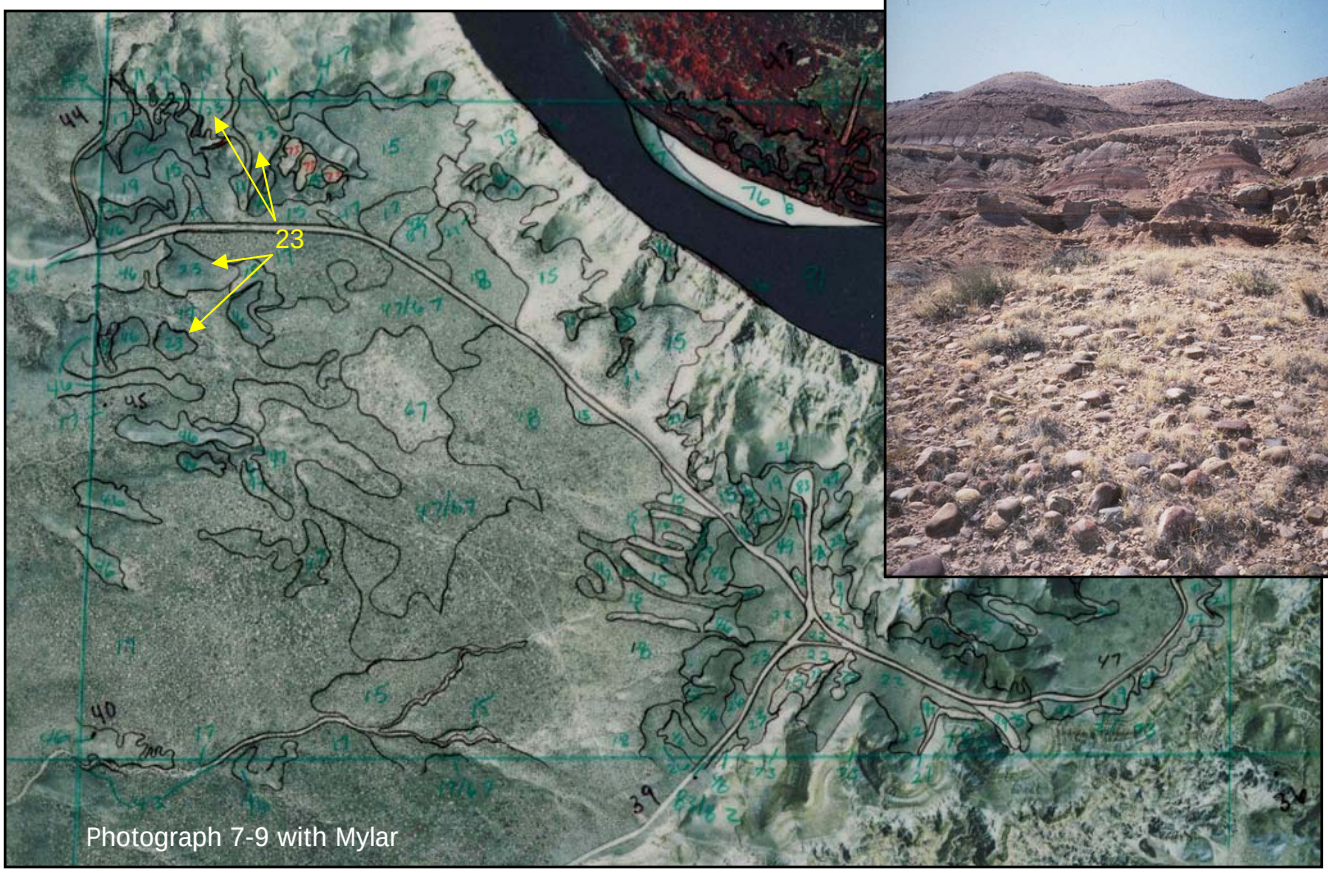


Shadscale / James' galleta Shrubland (Map Code 23)



Location: Atriplex confertifolia Shrubland is typically distributed on gravel and cobble outcrops/exposures that are found on mesa edges in the vicinity of the Leota Bottom and Johnson Bottom overlooks, bluff toeslopes in the vicinity of both Headquarters and the Fish Hatchery, and rolling hills along the Green River near Wyasket Bottom. One stand was observed growing on deep, silty clay soils, about two miles northwest of the Johnson Bottom overlook parking area.

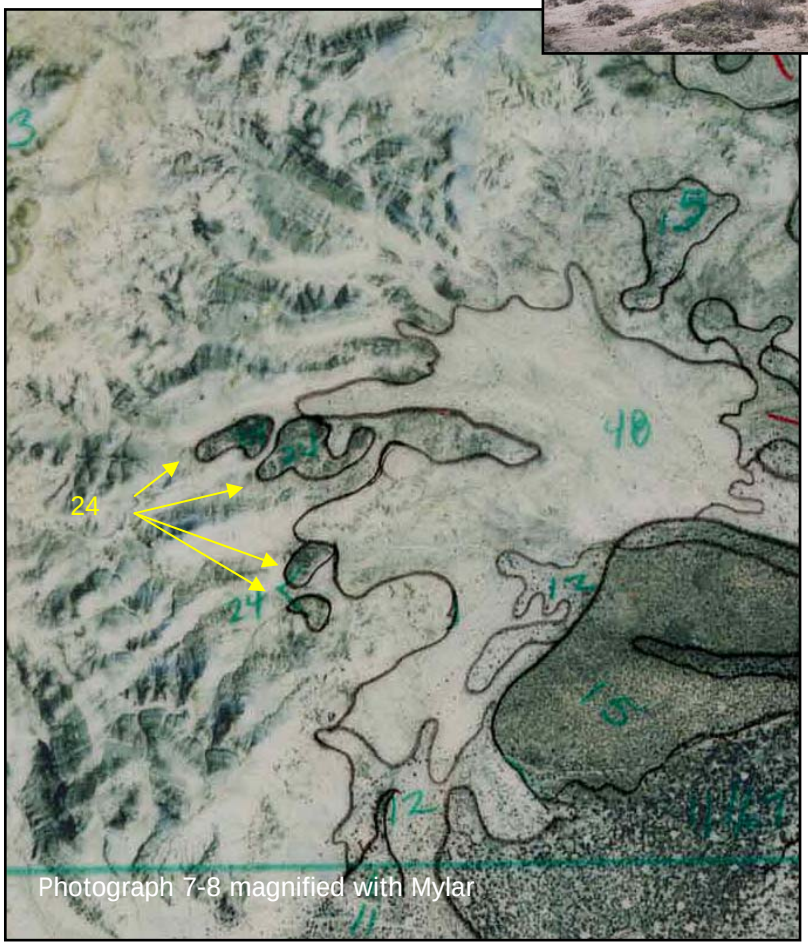
Signature: This type had a signature similar to barren lands; blue-grey with no texture. Most of the shadscale was delineated by extensive field verification.



Photograph 7-9 with Mylar

Mat Saltbush Dwarf Shrubland (Map Code 24)

Location: Atriplex corrugata Dwarf Shrubland was observed only on clay barrens in the Wonsit Valley and just south of the Fish Hatchery complex.

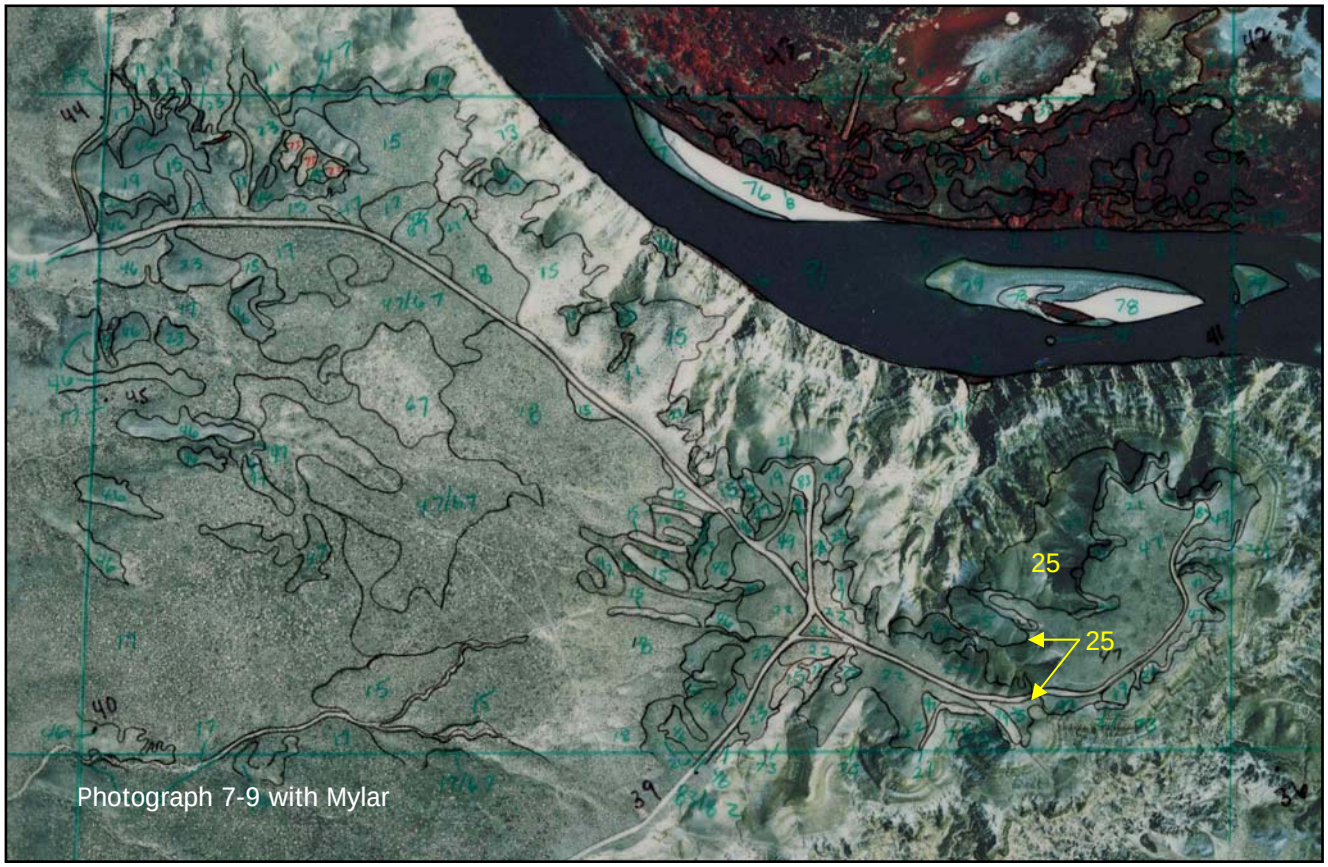


Signature: Common on clay, this type expressed a signature typical of monotypic shrubs on an otherwise barren substrate. The color on CIR was dark red to brown stipples with a white undertone. This type was mapped using field verification due to its small size and limited distribution.

Gardner's Saltbush Dwarf Shrubland (Map Code 25)

Location: The *Atriplex gardneri* Dwarf Shrubland type has become established on an erosion fan west of Leota Bottom. *Atriplex gardneri* is a component of sparse greasewood shrublands just above Wyasket Bottom. Small patches of *Atriplex gardneri* have become established on hillslopes south of the Leota Bottom Overlook.

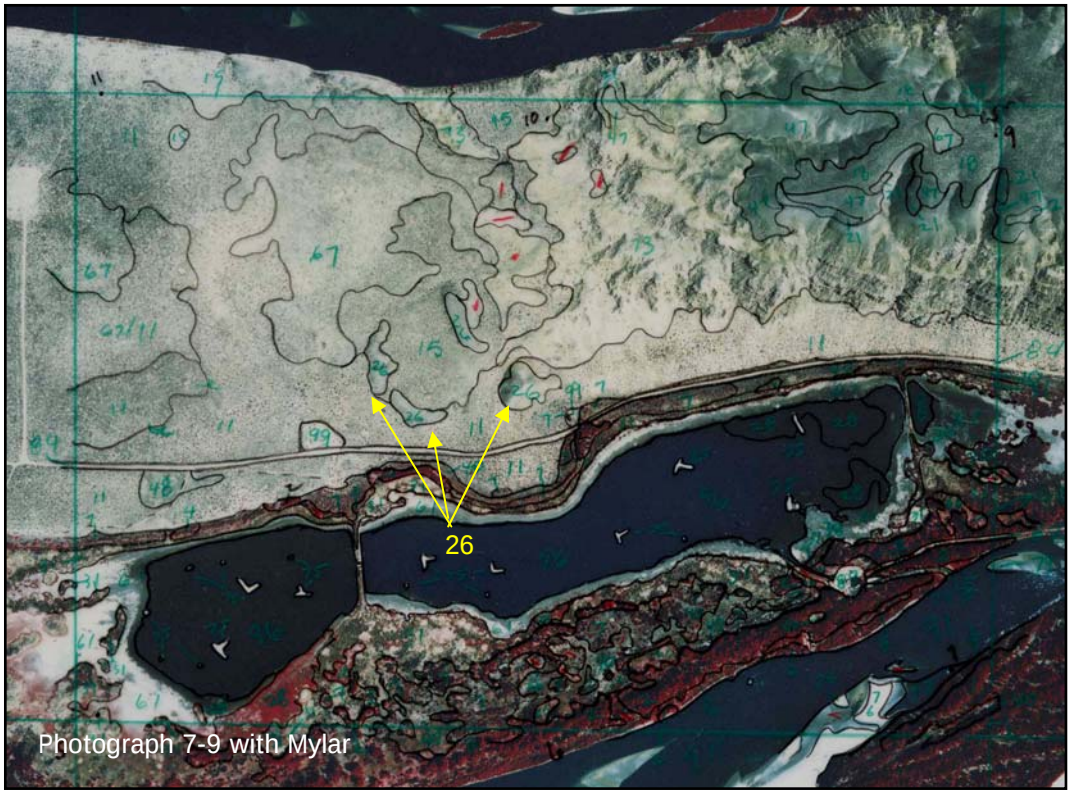
Signature: This type was dominated by the reflectance of the underlying substrate creating a slick blue/gray signature. The location of this type on clay slopes and erosion fans was verified in the field.



Schockley's Buckwheat Badlands Sparse Vegetation [Provisional] Shrubland (Map Code 26)

Location: Small stands/areas of exposed gravel and cobble support *Eriogonum schockleyi*; these occur on the toeslopes and hillslopes related to badlands bluffs.

Signatrure: This type had a signature similar to barren lands; white to blue with no texture. Most of the buckwheat was delineated by extensive field verification.



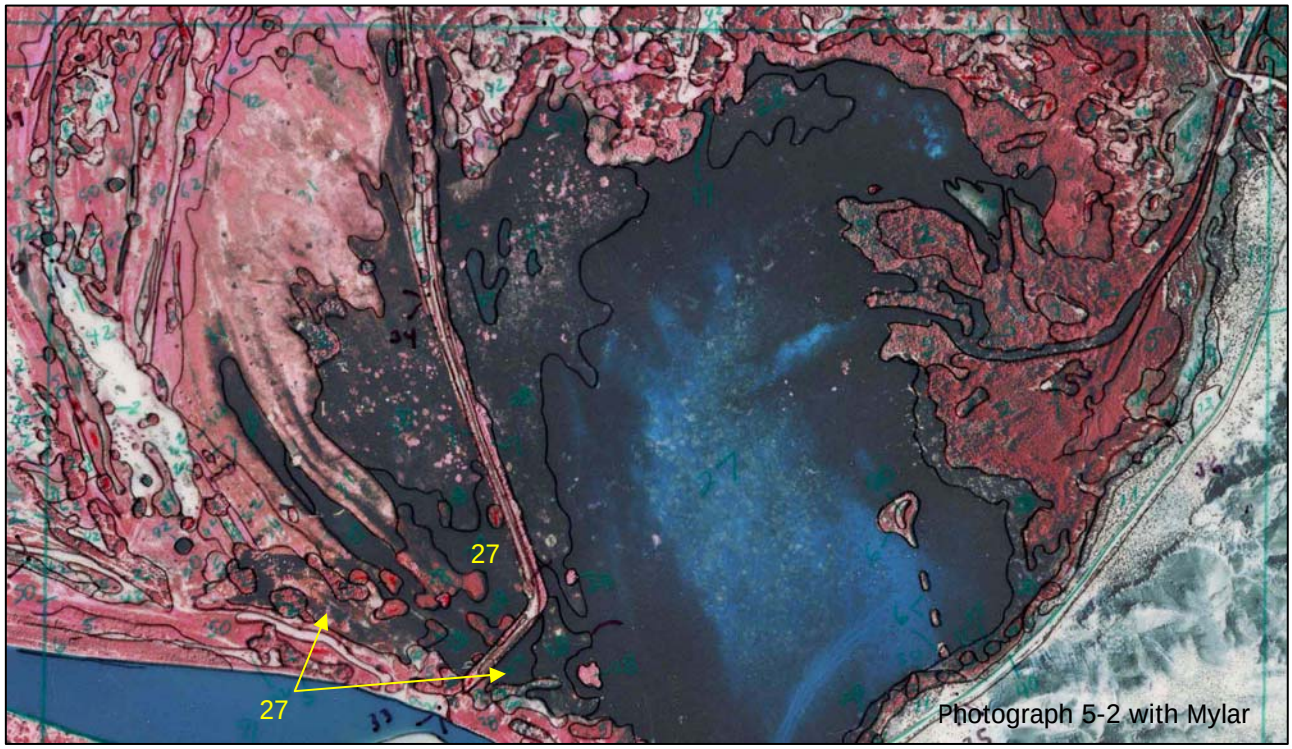
HERBACEOUS VEGETATION

(includes Forblands, Shrub-like Forblands, Grasslands, Emergent Wetlands, and Aquatic Types)

Floating Pondweed Herbaceous Vegetation (Map Code 27)

Location: The *Potamogeton natans* submergent type was observed at only two sites within the Refuge, *e.g.*, the entire Woods Bottom basin and a small depression in Leota Bottom. The Woods Bottom basin is a large area, perhaps up to 25 hectares, while the smaller depression covers only about a hectare.

Signature: This type varied from dark blue (open water) to very bright pink in color due to its tendency to be interspersed with pools of water. Texture of this type is smooth and its overall pattern is swirled. Density of this community varies with water depth further causing variation in photo signature.

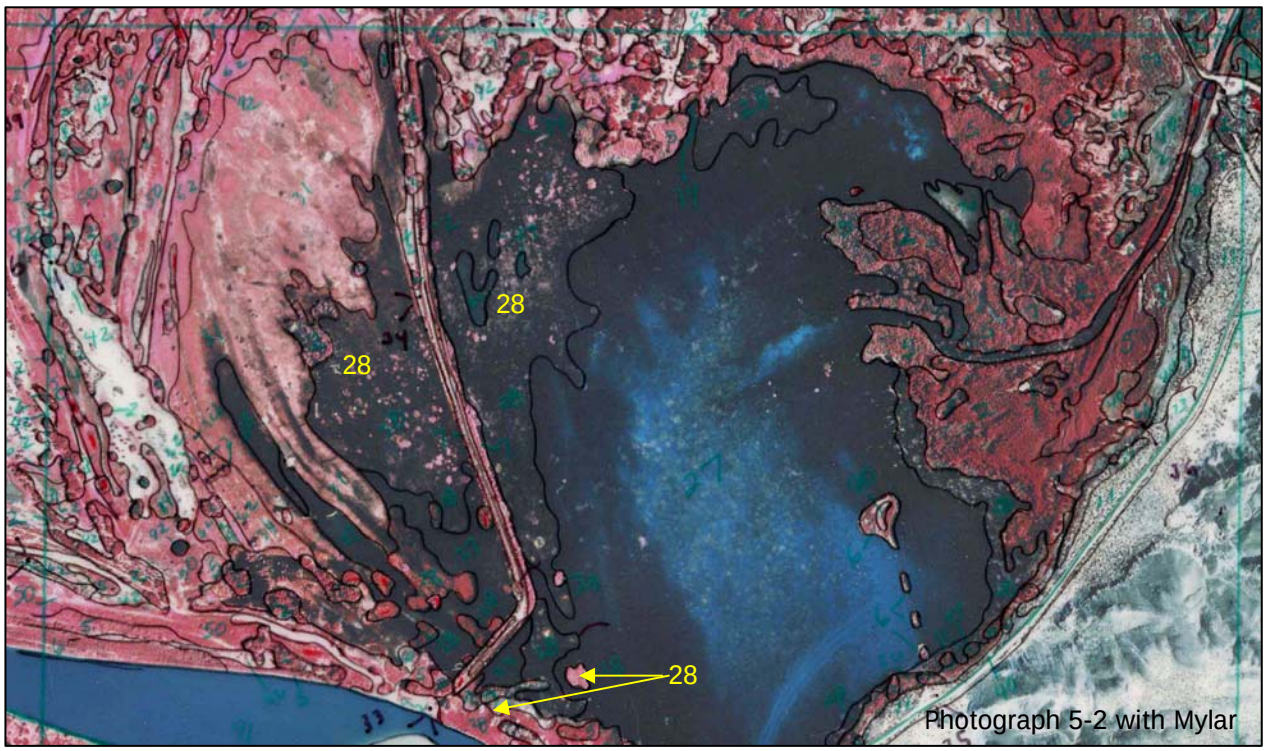


Photograph 5-2 with Mylar

Water Smartweed Permanently Flooded Herbaceous Alliance (Map Code 28)

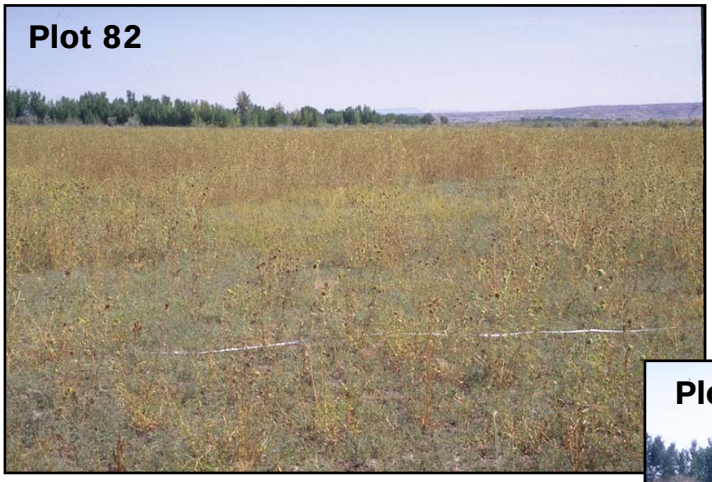
Location: Polygonum amphibium was observed in Leota Bottom on the west side of the Green River and in Woods Bottom and Johnson Bottom on the east side of the river. All of the stands observed occupy basins that had been flooded early in the growing season; the basins are located on terraces of oxbow bends in the Green River. It appears that the basin in Woods Bottom is natural and maintains a relatively stable hydrologic regime. The other two basins are filled with water and dry if environmental conditions warrant.

Signature: The lush growth of smartweed translates into a bright pink to bright red signature on CIR photography. However, due to water level fluctuations from season to season and year to year signatures may appear more blue (open water) or patchy (blue with pink) at the time of the photography. The short growth and uniform height of this monotypic type create a smooth texture that may appear smeared.



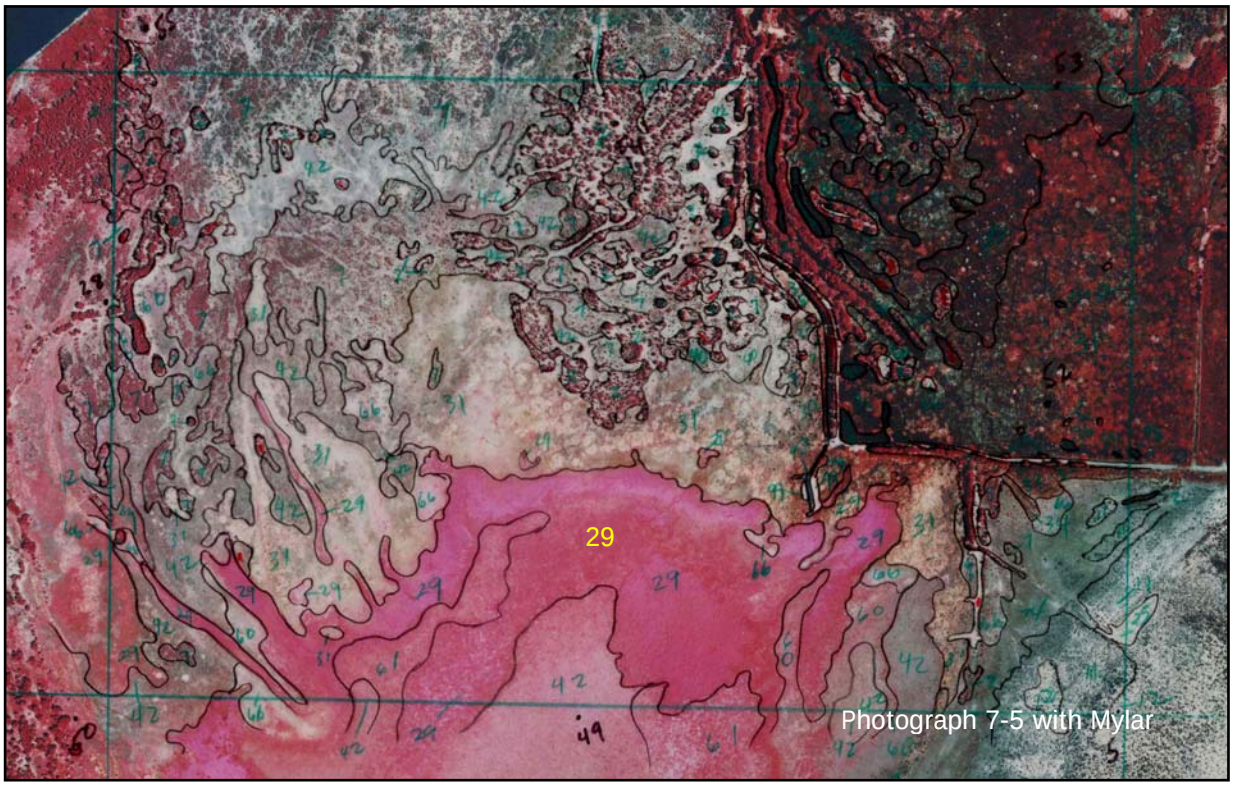
Photograph 5-2 with Mylar

Pale Smartweed Permanently Flooded Herbaceous Vegetation (Map Code 29)



Location: Only one large stand of *Polygonum lapathifolium* Herbaceous Vegetation was observed on the deepest portion of Wyasket Bottom, a basin which occupies a terrace along the east side of the Green River. This stand grew/was exposed by July 2000, as the basin in which it grows dried seasonally, until it was completely without water.

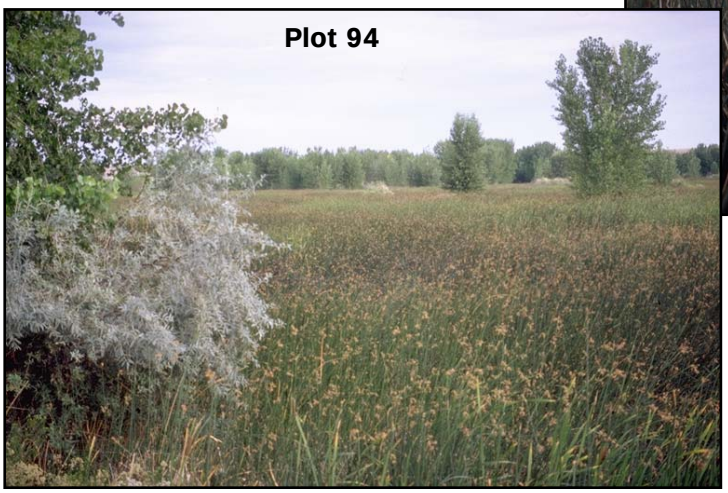
Signature: The lush growth of smartweed creates a very vibrant and distinctive pink signature on CIR photography. Also, the uniform height of this monotypic type creates a characteristic smooth texture. In dry areas the dramatic pink color fades to white and turns to deep blue in flooded areas.

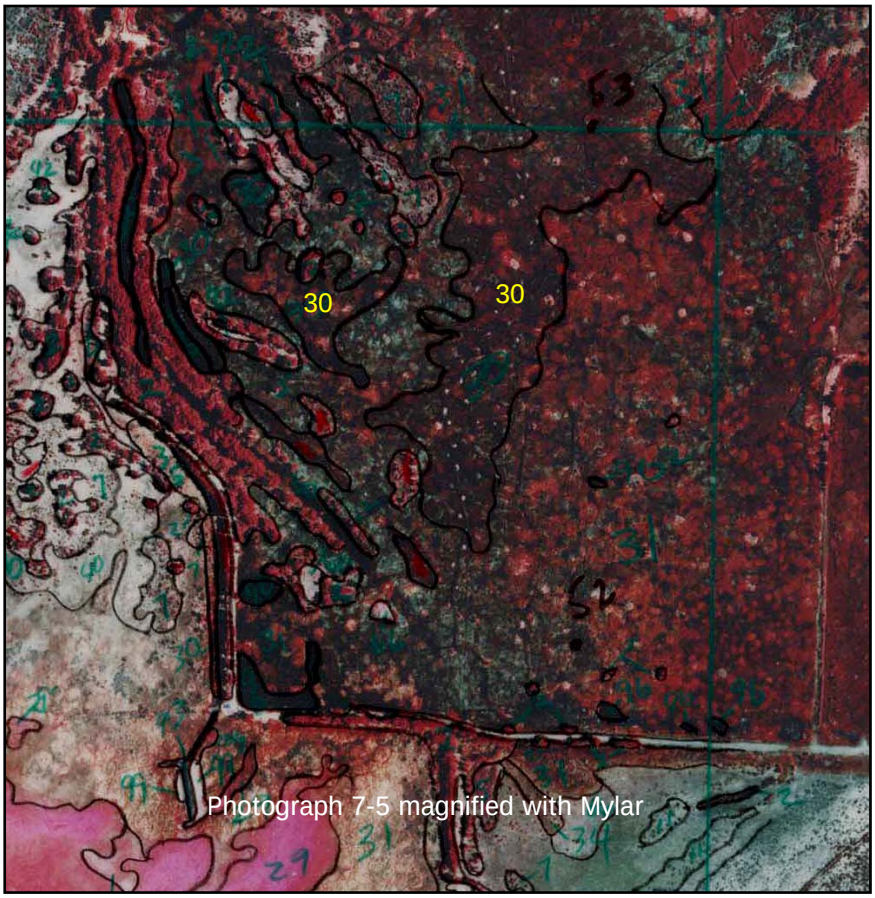


Photograph 7-5 with Mylar

Hardstem Bulrush Herbaceous Vegetation (Map Code 30)

Location: Schoenoplectus acutus Herbaceous Vegetation occurs as nearly monotypic stands in managed Green River floodplain bottoms, tributary drainages, and in wetland depressions within the Refuge.

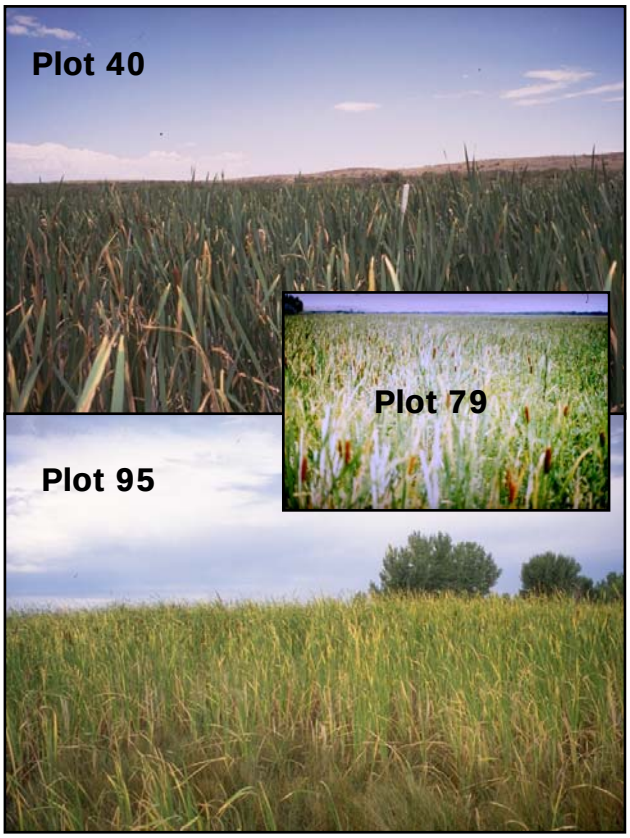




Photograph 7-5 magnified with Mylar

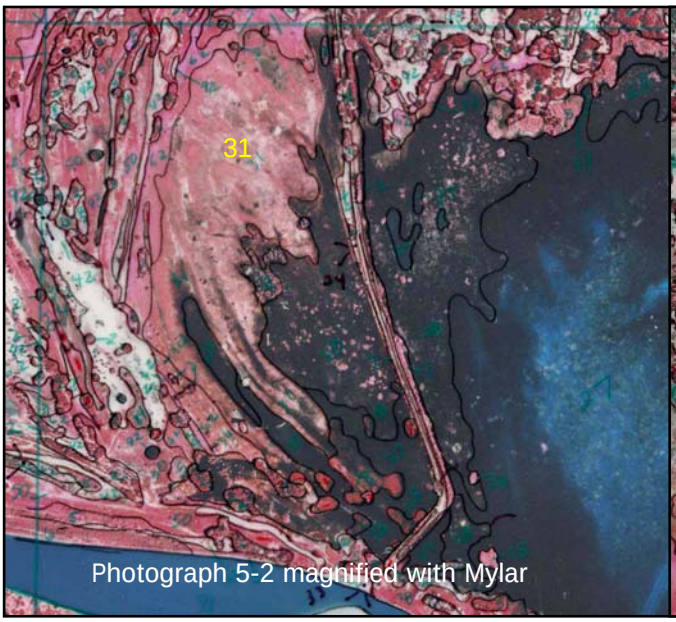
Signature: Bulrush occurs in similar habitat as cattails and can easily be confused for it on CIR photography. Bulrush usually has a darker, more brick red appearance than the pinker cattail. This is due to the lush, broadleaf cattail compared to thinner bulrush stems. Texture for bulrush is rather rough and blotchy and the undertone is usually blue (open water).

Southern (Broad-leaved, Narrow-leaved) Cattail Herbaceous Vegetation (Map Code 31)

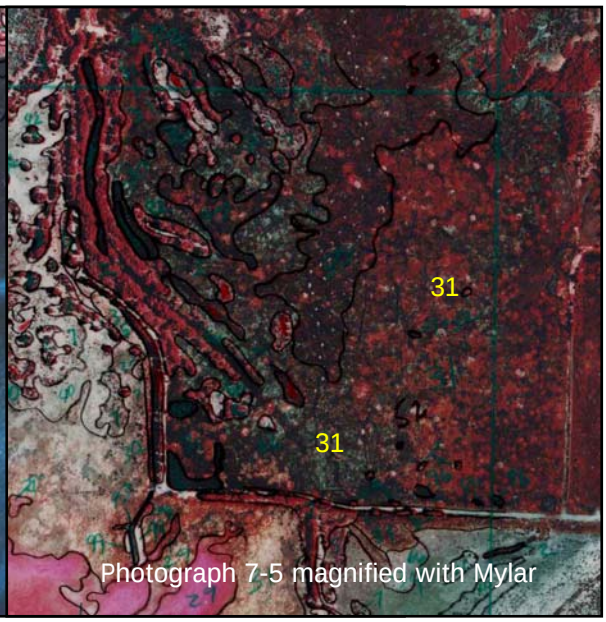


Location: Typha latifolia is present in drainages, canals, ditches, basins, side channels, on seeps, and along the Green River channel throughout the Refuge. Broad-leaved cattail grows best on/in fresh to slightly alkaline water sources, particularly when flowing water and active seeps are present. *Typha domingensis* covers more area within the Refuge, than does the broad-leaved and it occupies flooded basins, primarily, which have been constructed in the various bottoms of the Green River. These basins tend to be more alkaline, which is tolerated by southern cattail, and they usually dry during the course of the growing season. Soils of the basins are clay, and were dry and cracked at the time of data collection. Some deer bedding sites were evident in the stands.

Signature: Cattail signatures on CIR vary with the amount of dead vegetation and deep standing water. Typically, cattail clones appear as circular blotches that vary in color from bright pink (lush growth) to white (dead or dried-out areas). Stands at Ouray usually had a light pink or dark red color with white areas interspersed. Different species of cattail did not appear to have any discernable difference in photographic signature.



Photograph 5-2 magnified with Mylar



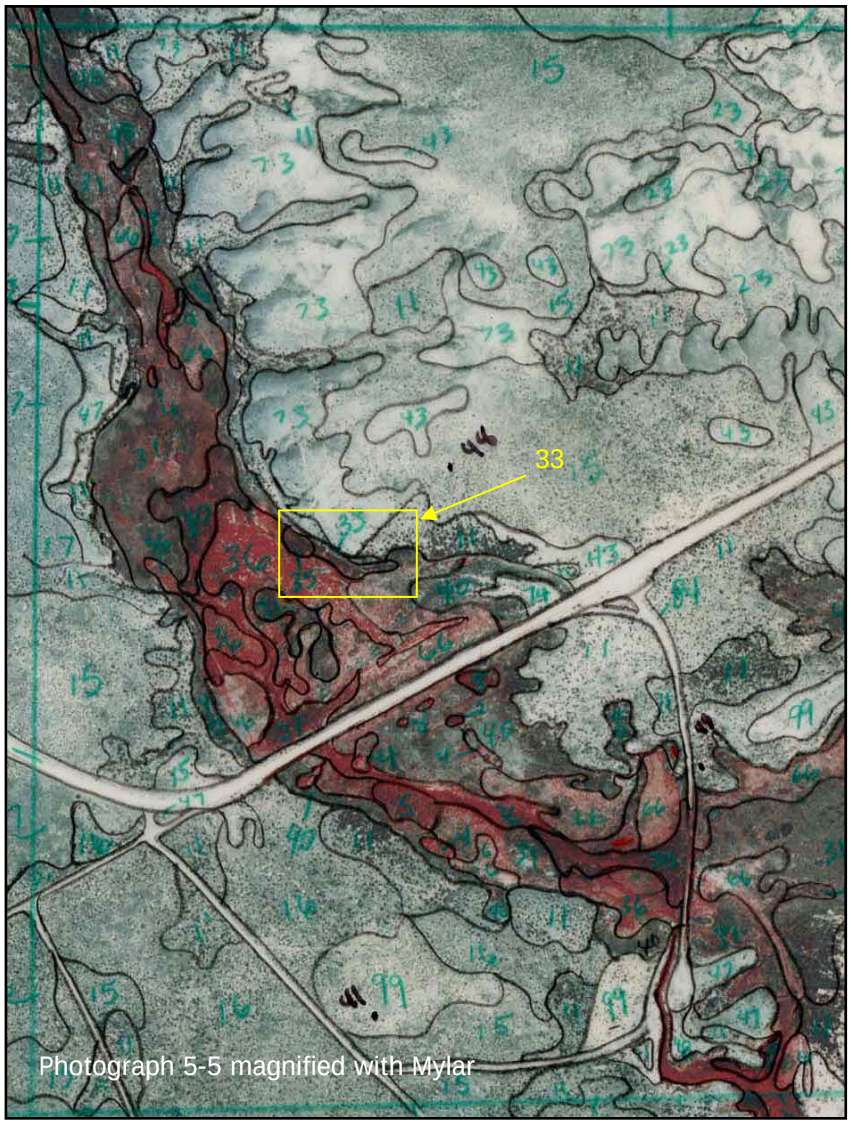
Photograph 7-5 magnified with Mylar

Baltic Rush Herbaceous Vegetation (Map Code 33)

Location: One patch of *Juncus balticus* Herbaceous Vegetation was observed in the large drainage near the Refuge entryway. *Juncus balticus* is only a minor component of some emergent wetlands within the Refuge.

No ground photo was taken.

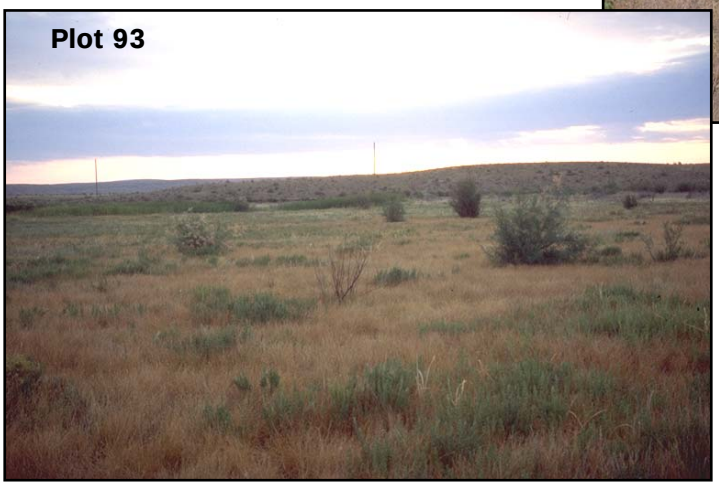
Signature: The dark red with blue background signature for this type was similar to other low growing, emergent aquatics at Ouray. Due to its limited distribution and size this type was mapped exclusively by field verification.



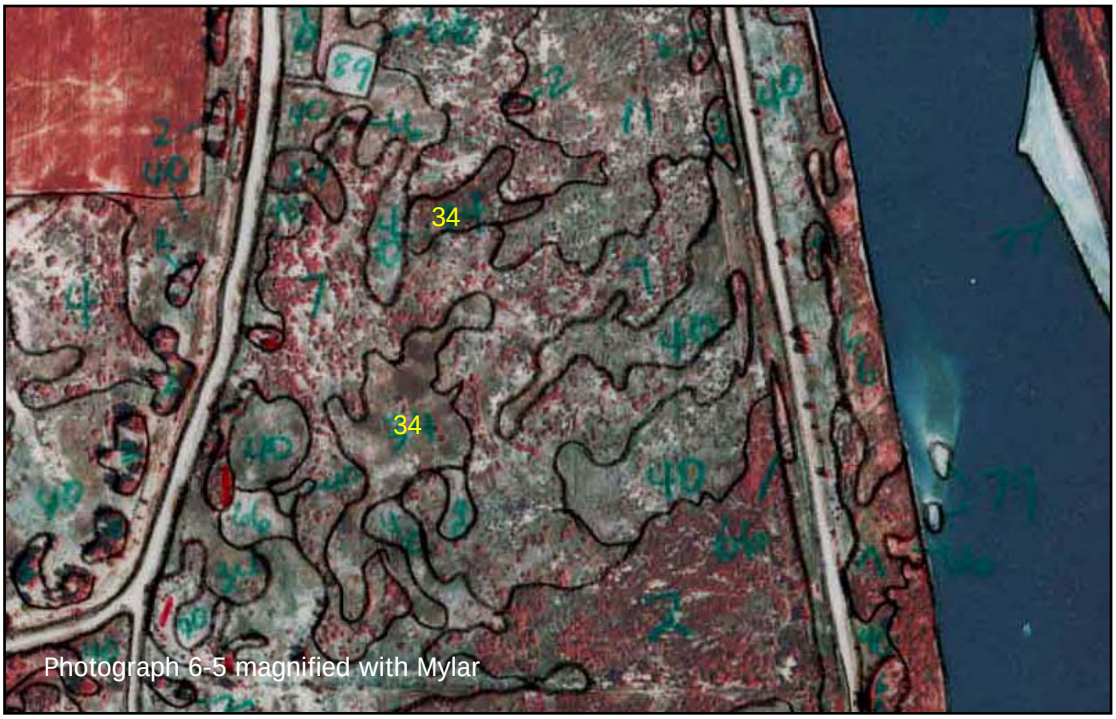
Photograph 5-5 magnified with Mylar

Common Spikerush Herbaceous Vegetation (Map Code 34)

Location: Eleocharis palustris occurs as an understory species in many wetland plant associations within the Refuge and as a narrow fringe on the north edge of the lake in Woods Bottom. Only two stands large enough to map were observed near Sheppard Bottom and in Wyasket Bottom; in both stands *Pascopyrum smithii* is an associate.



Signature: This type exhibited smeared reddish purple to light blue-green color with no texture. Low-growing vegetation typically has this smooth appearance and moist areas appear violet in the absence of lush vegetation. This type was distinguished from other wetland types by its combination of no texture and unique color.



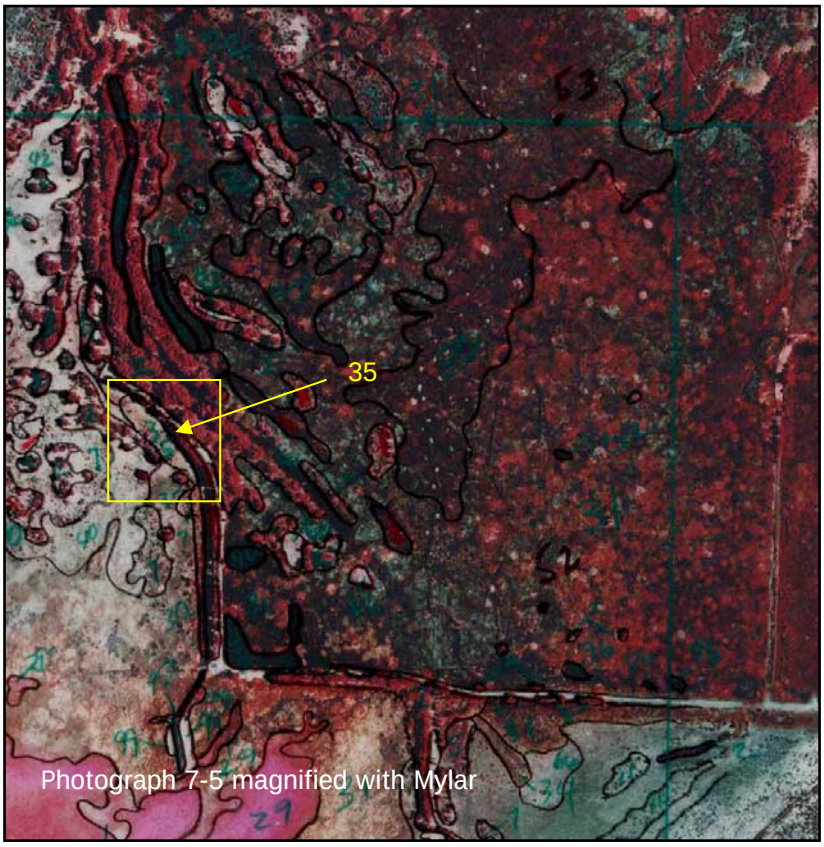
Photograph 6-5 magnified with Mylar

Common Reed Western North America Temperate Semi-natural Herbaceous Vegetation (Map Code 35)

Location: Only two large patches of *Phragmites australis* were observed in the Refuge, one in the large drainage near the entryway and the other in Wyasket Bottom. *Phragmites australis* is observed occasionally in the Refuge, intermixed with other emergent plant species, or growing along dikes and levees.

No ground photo was taken.

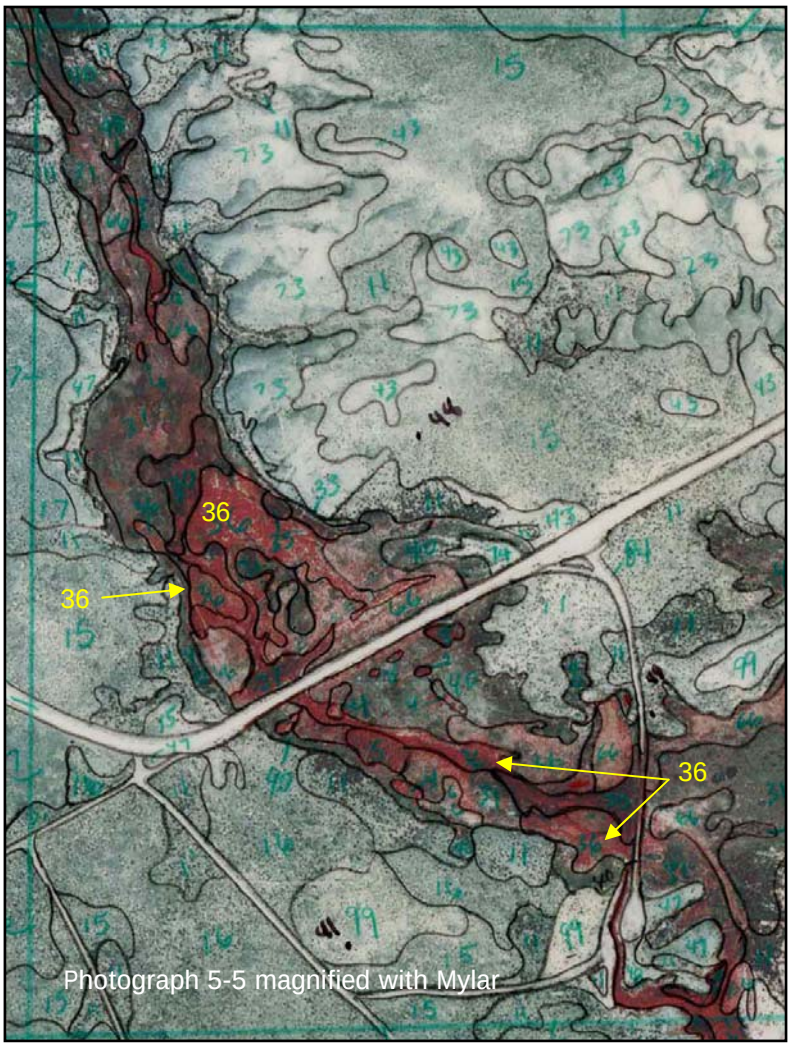
Signature: This type was very limited at Ouray and no consistant signature was needed for mapping. The signature does appear to be slightly pink with white undertones. No texture was evident.



Photograph 7-5 magnified with Mylar

Reed Canarygrass Western Herbaceous Vegetation (Map Code 36)

Location: Phalaris arundinacea plants are found intermixed with other emergent wetland species, particularly *Typha* spp., at various sites around the Refuge; a small stand was observed in Leota Bottom. However, two stands that meet the minimum mapping unit of 0.5 hectares are present in the unnamed drainage near the main Refuge entryway, near State Highway 88.



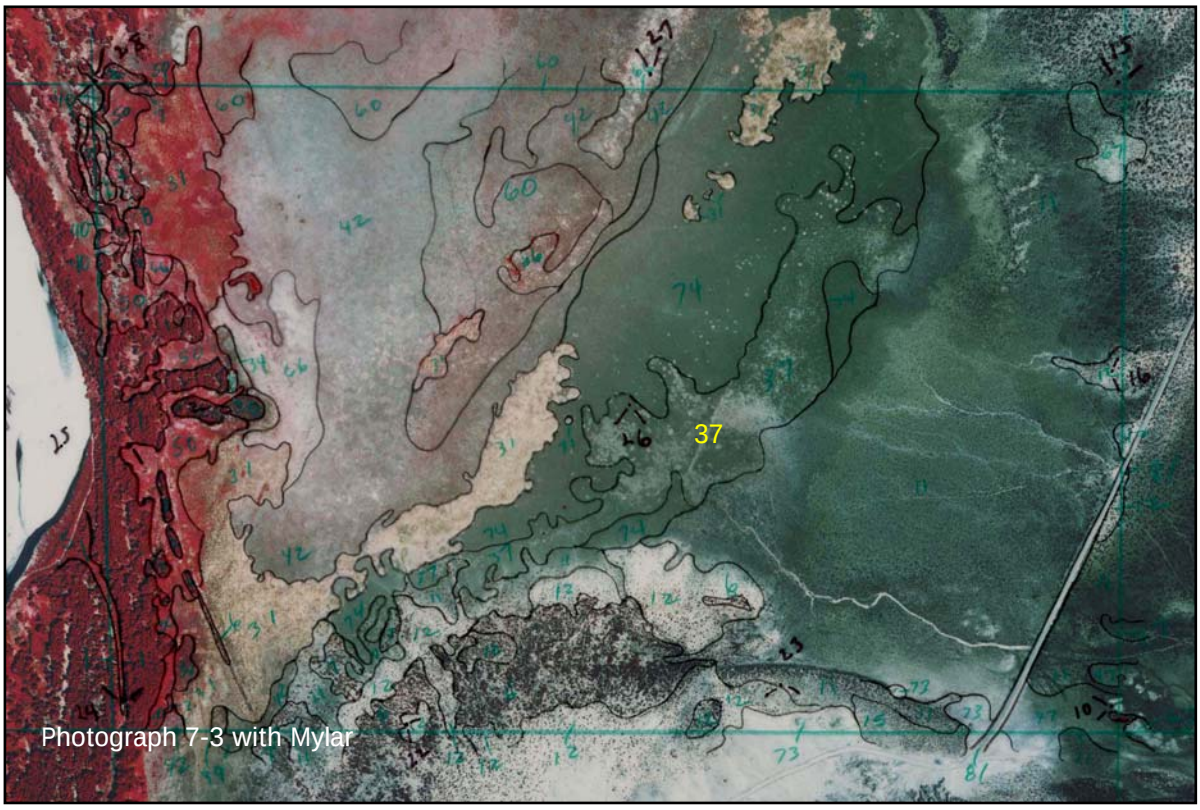
Photograph 5-5 magnified with Mylar

Signature: The signature for this type has a very rough and course appearance with a deep red color. The intermixing of this type with other wetland species can cause the color to become more pink or light red. Field verification was used to help map this type.

Foxtail Barley Herbaceous Vegetation (Map Code 37)

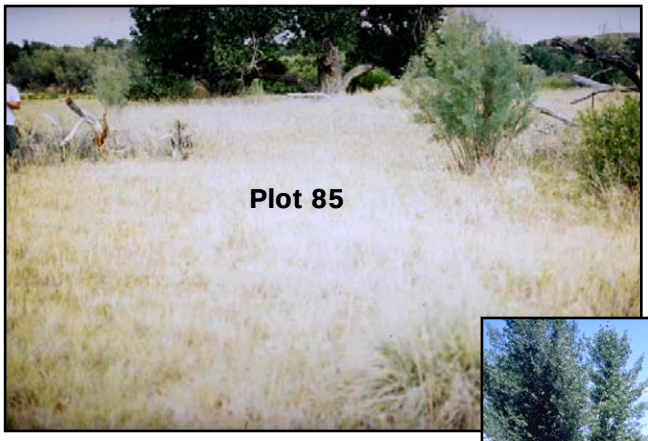
Location: Small stands of *Hordeum jubatum* annual grasslands were observed in the natural basin of Wyasket Bottom and a drained basin in Sheppard Bottom. *Hordeum jubatum* is a common associate of most emergent wetland vegetation types within the Refuge.

Signature: This very barren grassland had very little green vegetation during the timing of the photography. This resulted in a very barren or blue/gray color with a very smooth signature. Some large patches of dead vegetation appeared as white patches that helped with delineation.

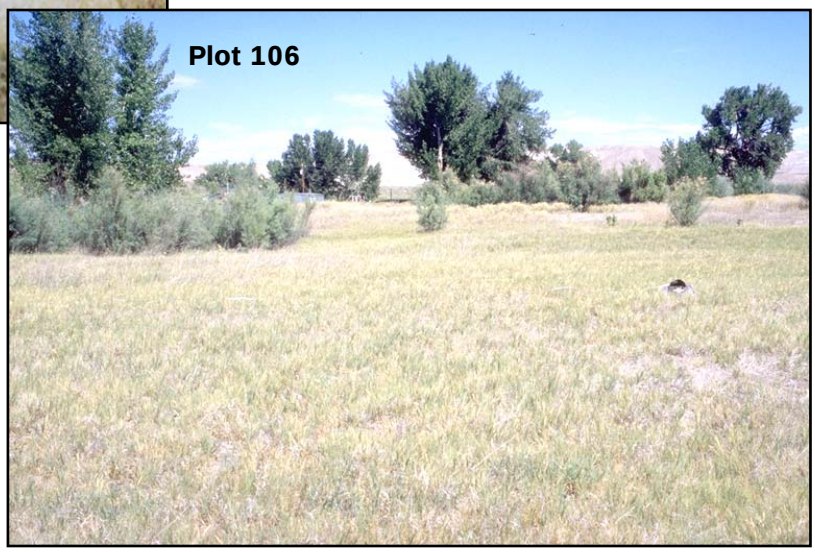


Photograph 7-3 with Mylar

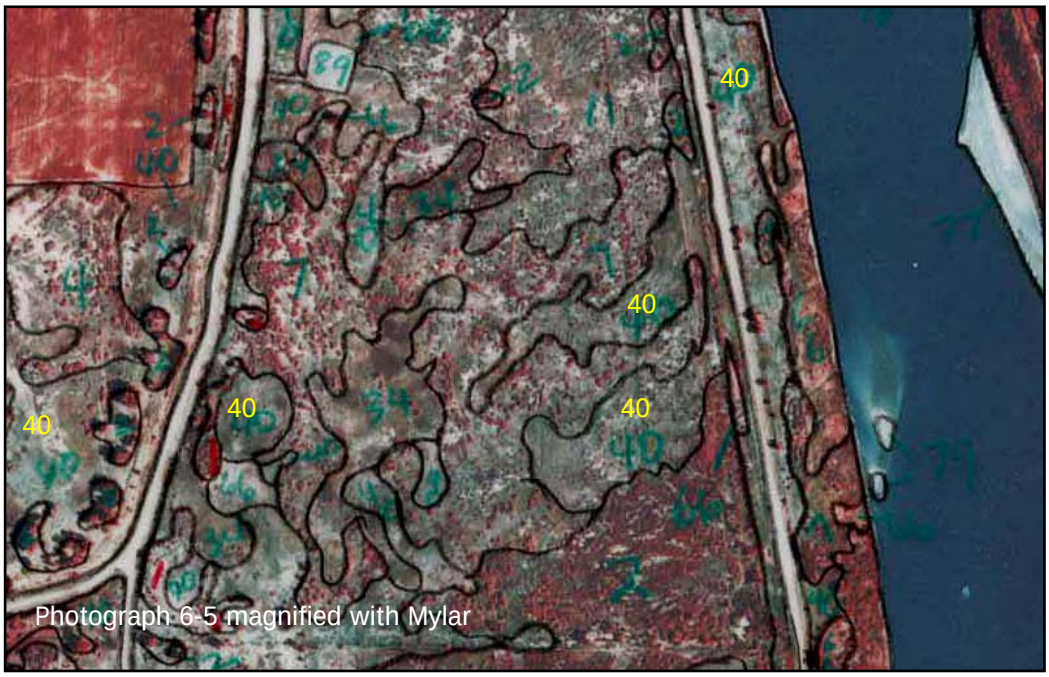
Saltgrass Herbaceous Vegetation (Map Code 40)



Location: *Distichlis spicata* Herbaceous Vegetation occupies flats on floodplain terraces within the Green River floodplain. This vegetation type is readily invaded by salt-cedar, and the most open stands observed were in Brennan Flats, Leota Bottom, and Sheppard Bottom.



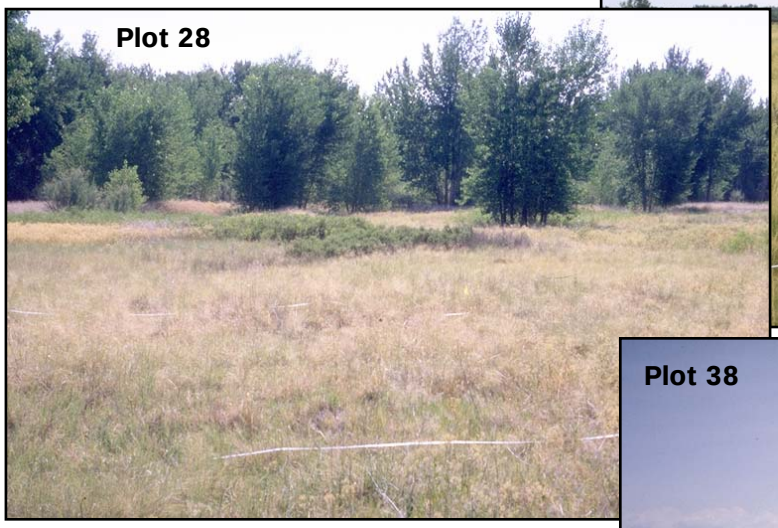
Signature: This type exhibited a very pale green to light blue signature resulting from little green vegetation. Texture for this type was generally course due to the presence of salt cedar and other shrubs. This type was partly delineated based on its topographic position in the floodplain.



Photograph 6-5 magnified with Mylar

Alkali Sacaton Southern Plains Herbaceous Vegetation (Map Code 41)

Location: Sporobolus airoides Southern Plains Herbaceous Vegetation grows on undisturbed floodplain terraces of the Green River.



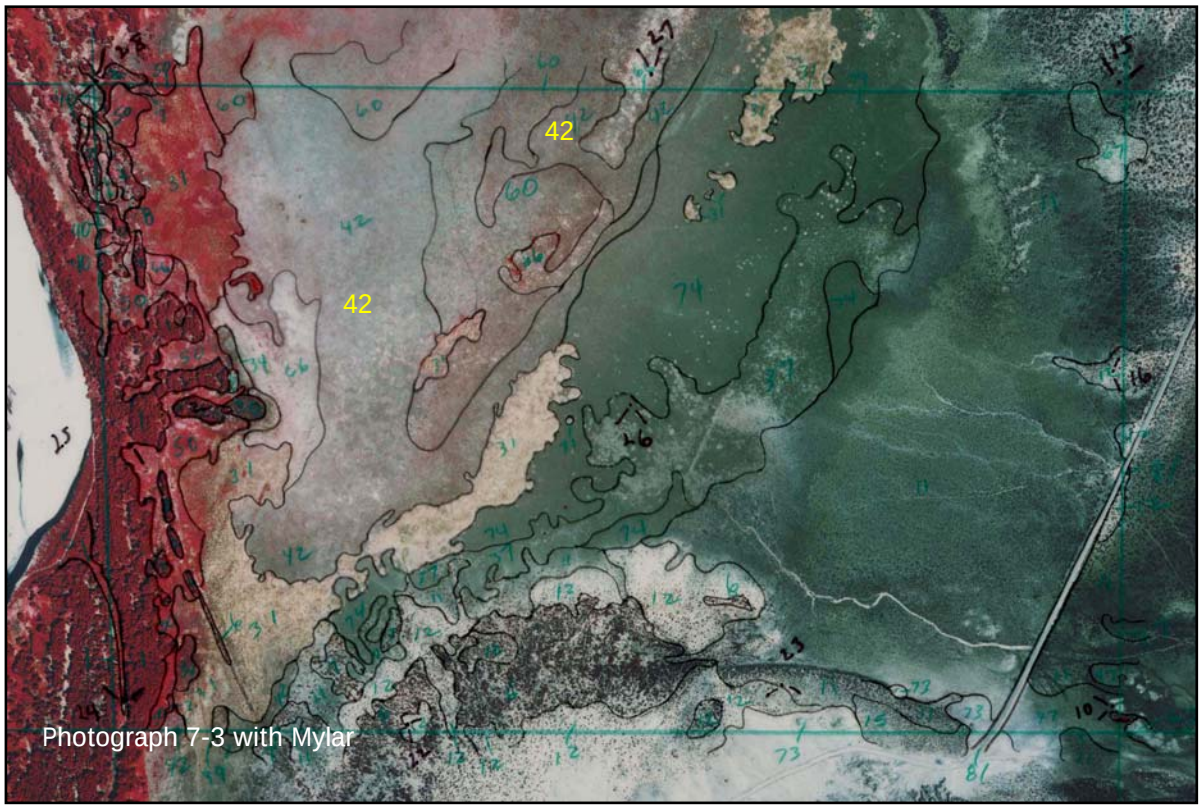
Signature: This grassland type had a very white signature that was relatively smooth and consistent. It was differentiated from other floodplain grasslands using the pale color and lack of texture.

Photograph 9-4 with Mylar

Western Wheatgrass Herbaceous Vegetation (Map Code 42)

Location: *Pascopyrum smithii* Herbaceous Vegetation is limited to portions of Leota Bottom and Wyasket Bottom on undisturbed terraces of the Green River floodplain.

Signature: Western wheatgrass exhibited pale green with some light pink on the CIR photography. The texture of this type was smooth but blotchy. The lack of texture and field verification helped separate this type from similar grasslands and dwarf shrublands.

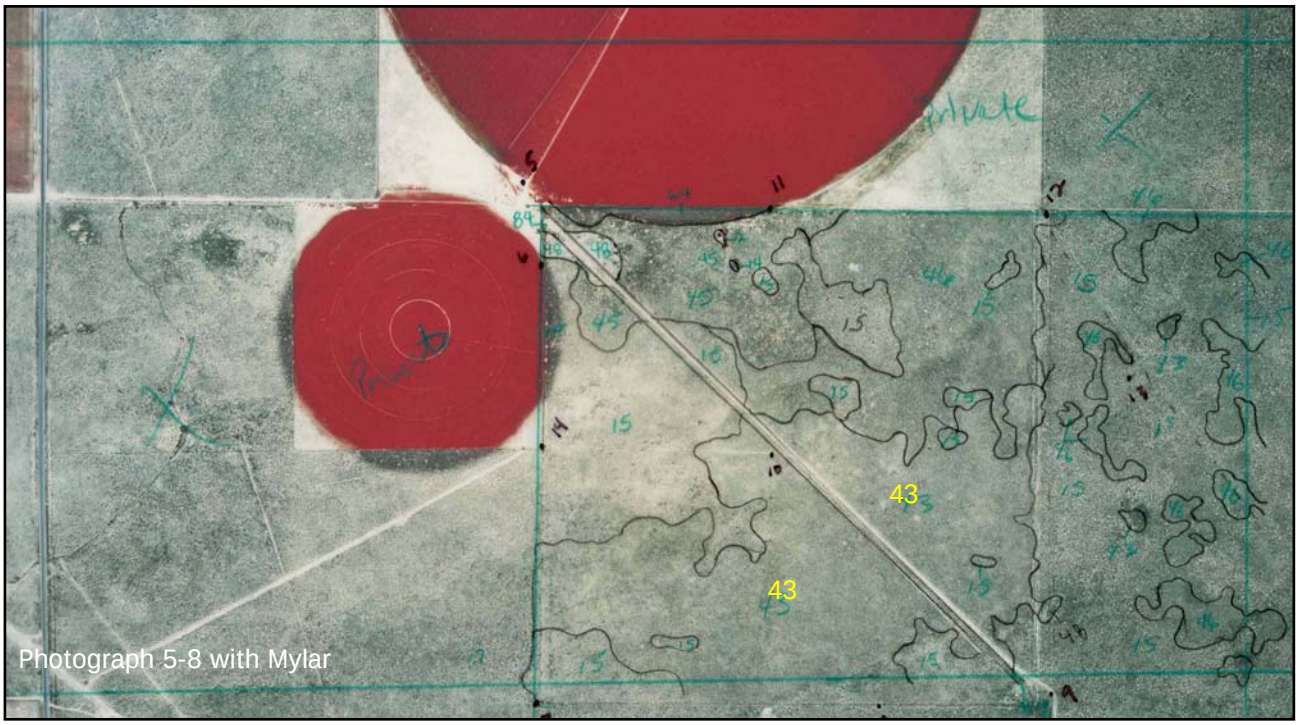


Photograph 7-3 with Mylar

Indian Ricegrass Herbaceous Vegetation (Map Code 43)

Location: Achnatherum hymenoides Herbaceous Vegetation occurs as one large stand on the western edge of the Refuge, and as smaller patches nearer the badlands bluff formations.

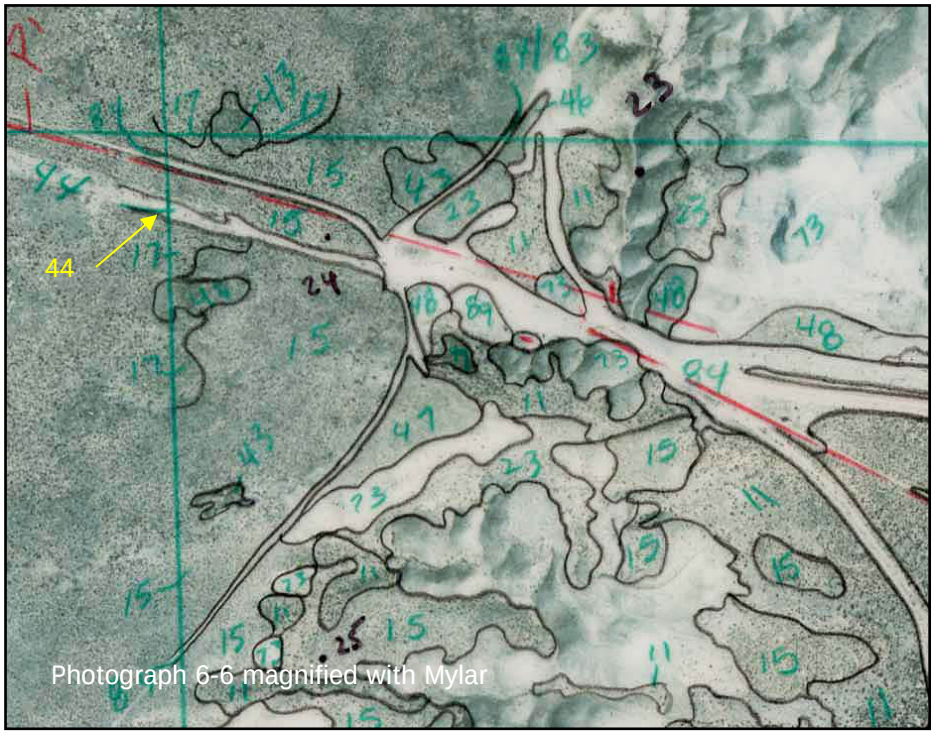
Signature: The dead vegetation at the time of the photography yielded a very blue-green signature with a relatively smooth signature for this type. This lack of texture helped distinguish it from sparse shrub types. Field verification also helped delineate this type.



Photograph 5-8 with Mylar

Indian Ricegrass – Crested Wheatgrass Herbaceous Vegetation (Map Code 44)

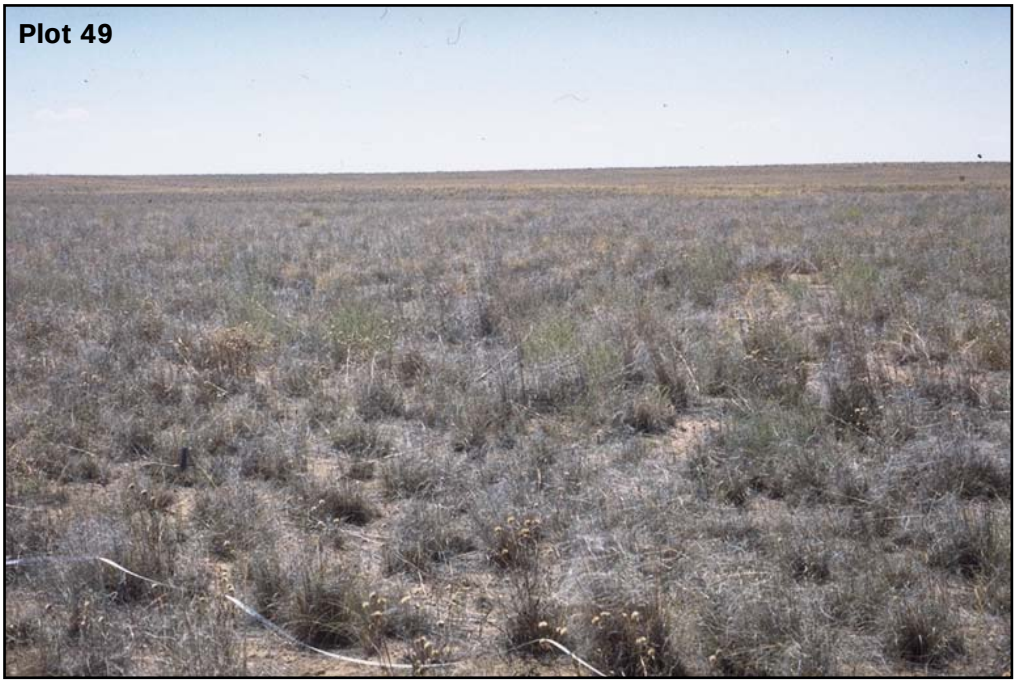
Location: The *Achnatherum hymenoides – Agropyron cristatum* Herbaceous Vegetation type was only observed in a pipeline corridor, northwest of Headquarters, where a reclamation seed mix had been introduced to provide soil erosion control.



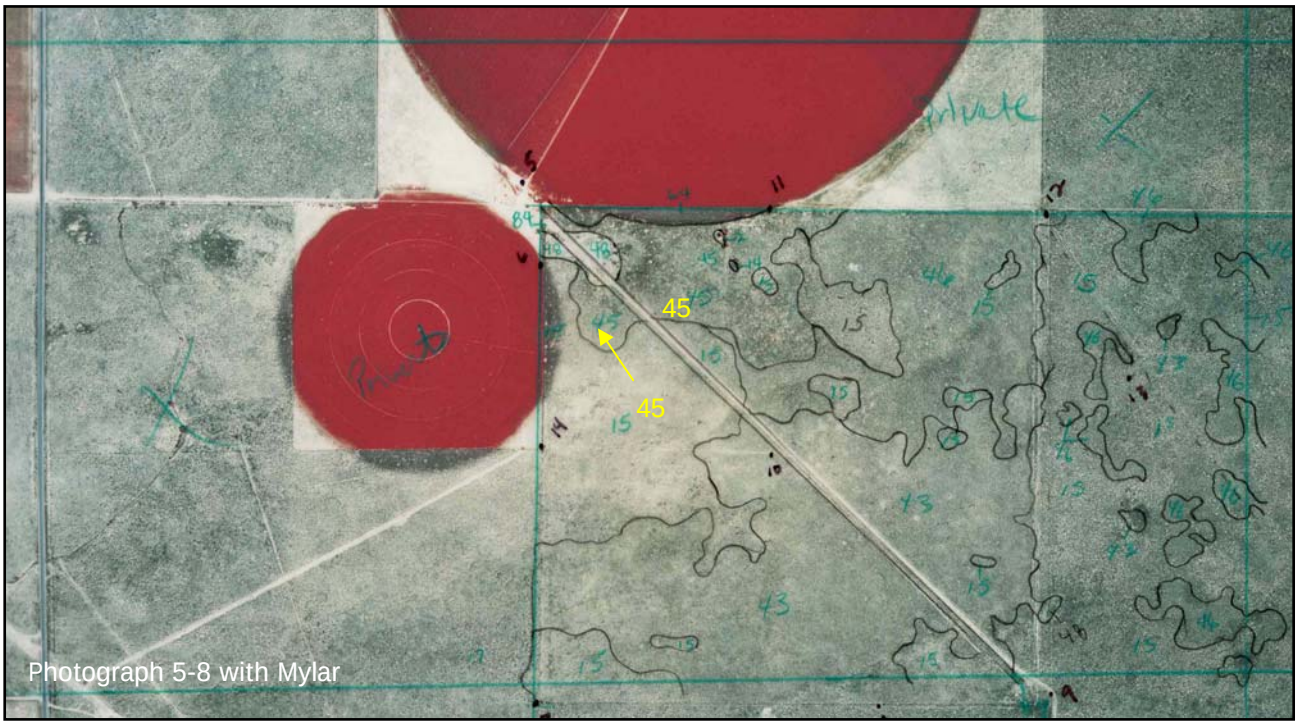
Signature: This type had a very white signature and occurred on an obvious disturbed linear feature (pipeline). Due to the limited size and distribution of this type final mapping was conducted using field verification.

Sand Dropseed Great Basin Herbaceous Vegetation (Map Code 45)

Location: Only one stand of *Sporobolus cryptandrus* Great Basin Herbaceous Vegetation was observed and sampled; it occurs near the western boundary fence of the Refuge.

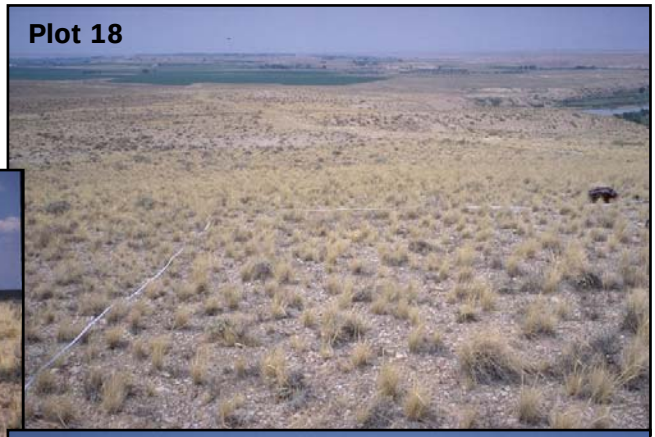


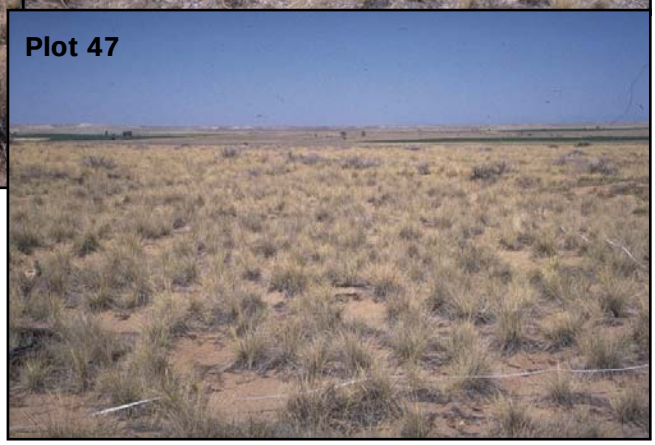
Signature: Sand dropseed had a signature similar to other grasslands types in the area. Generally, it was more blotchy and mottled from past disturbance. Since this type only occurred in one known location it was mapped using field verification.



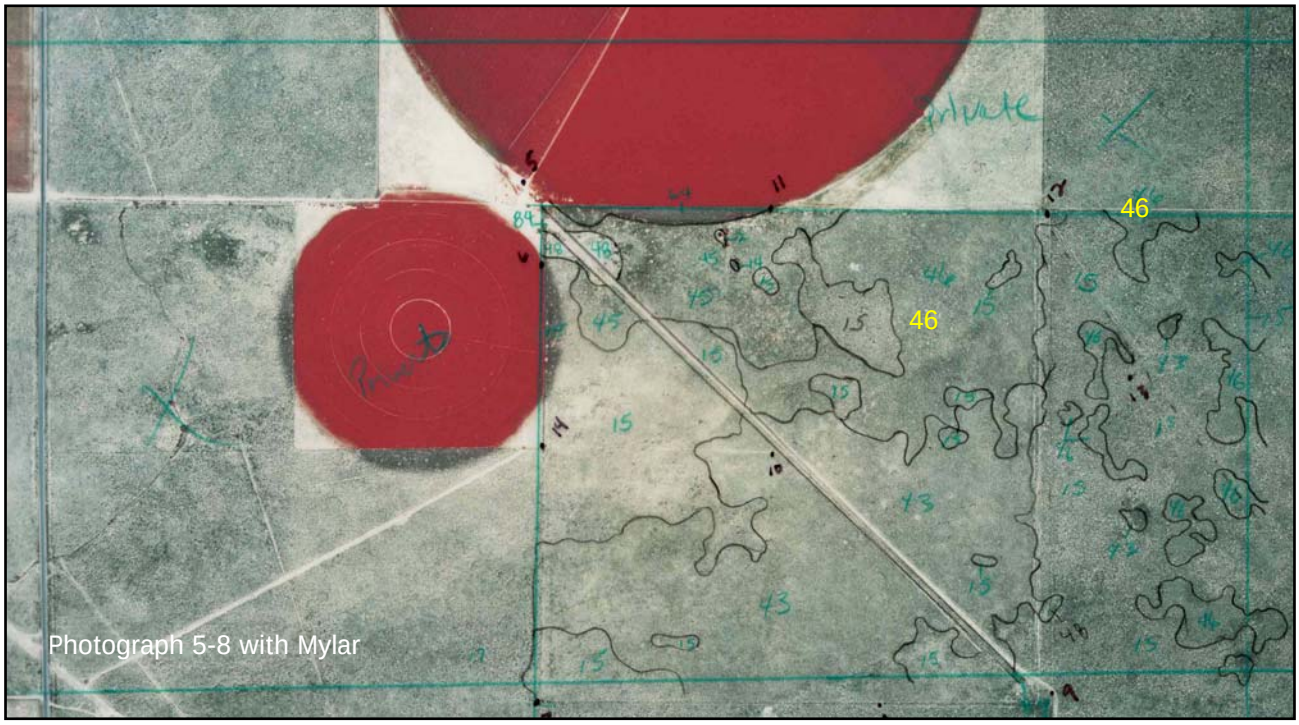
Needle-and-Thread Great Basin Herbaceous Vegetation (Map Code 46)

Location: Hesperostipa comata Great Basin Herbaceous Vegetation occurs as patches and stands throughout the western one-third of the Refuge.

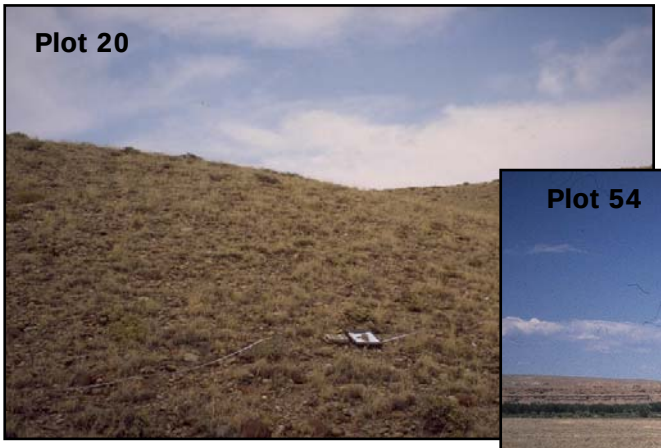




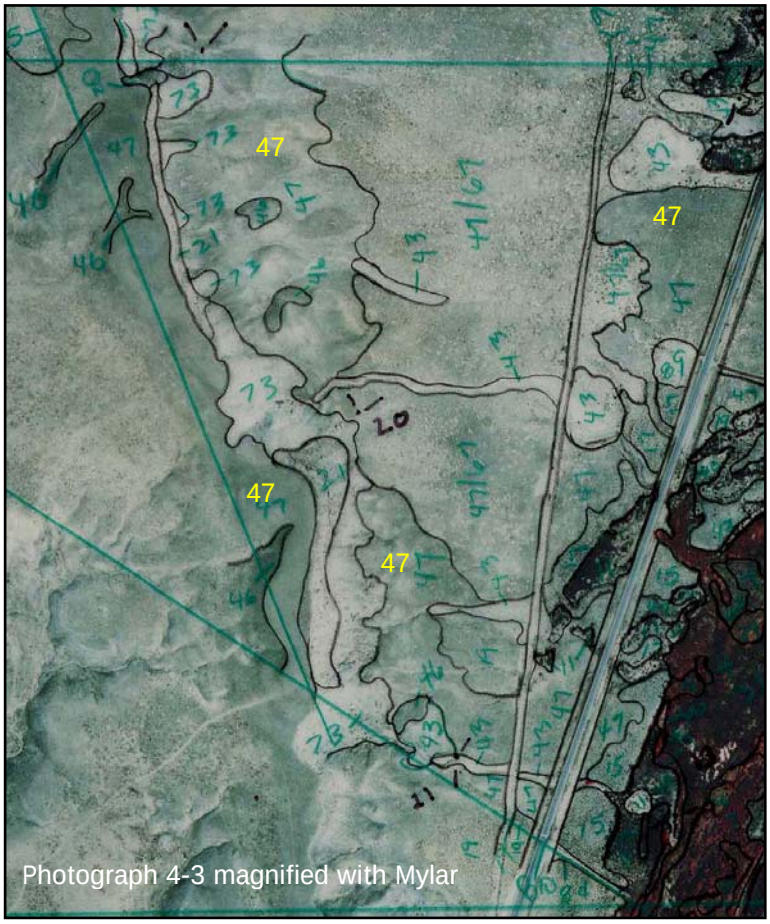
Signature: Needle-and-thread grasslands at Ouray appeared dark green-blue in color and had some fine-grained texture (less than shrublands, more than other grasslands). Under magnification this type had some small white bumps that helped with delineation.



James' Galleta Herbaceous Vegetation (Map Code 47)

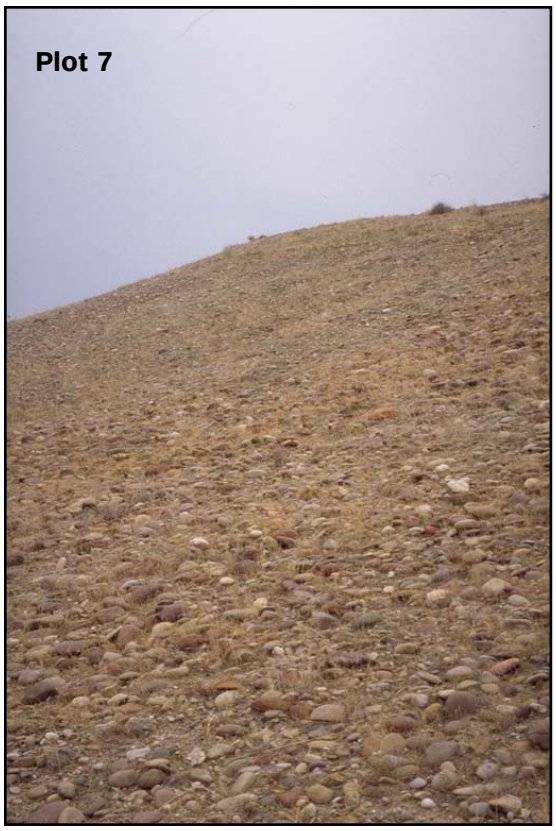


Location: Pleuraphis jamesii Herbaceous Vegetation is generally distributed across the Refuge, above the Green River floodplain, on a variety of soils, slopes, and aspects.



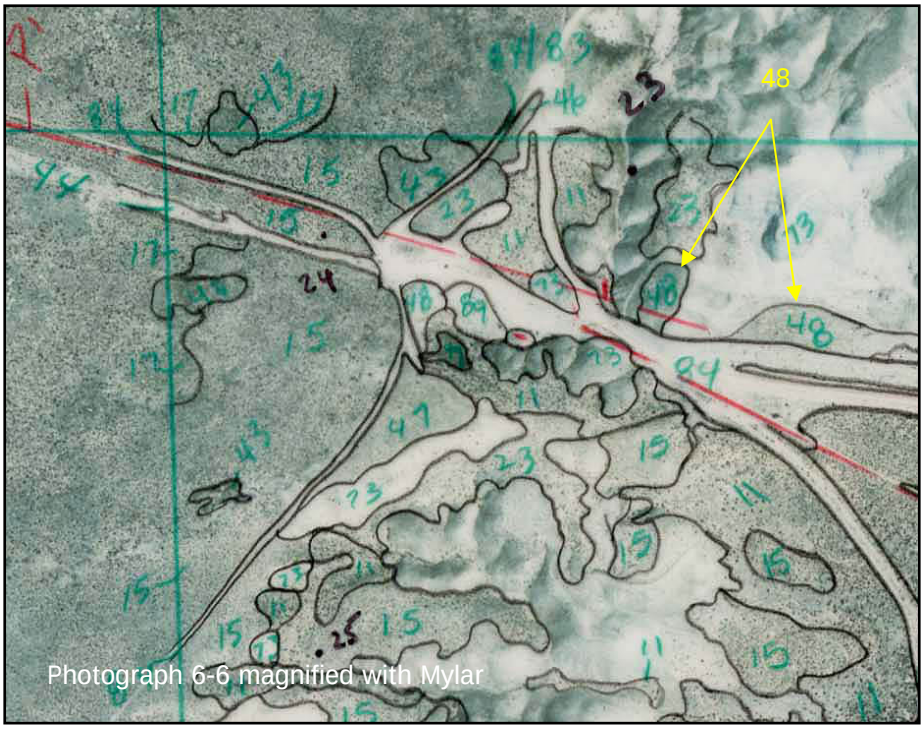
Signature: Galleta grasslands are common at Ouray and yielded several different signatures ranging from blue-green to white in color. This corresponded to the amount of living vs. dead material and density of associated species. Lack of vegetation on clay soils exhibited a white color and more vegetation on sand or silt loam soils yielded blue-green.

Cheatgrass Semi-natural Herbaceous Alliance (Map Code 48)



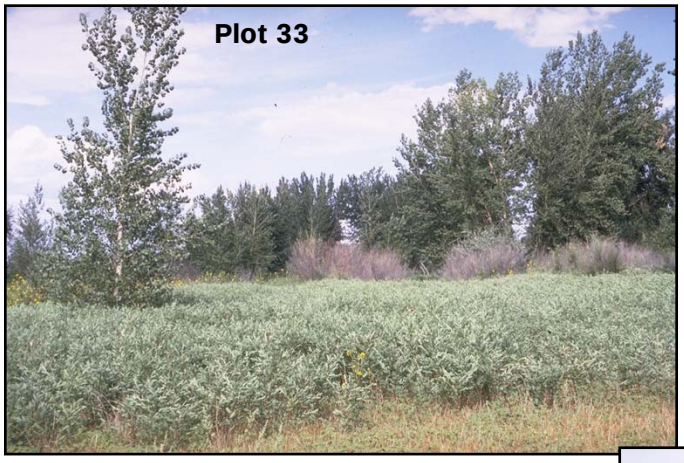
Location: The *Bromus tectorum* Semi-natural Herbaceous Alliance is dominant on badlands slopes comprised of river cobble and erosion fans along the base of badlands bluffs. Cheatgrass is sometimes a component of prairie dog towns and other disturbed sites; it is also widely distributed as a minor component of many upland sites. Near Woods Bottom and on the uplands of Johnson Bottom, sites disturbed by early settlers and for oil exploration have become dominated by cheatgrass and other annual species.

Signature: Cheatgrass dominated grasslands usually had very little living vegetation at the time of the photography. This yielded a very white or barren signature. Texture for this type was somewhat course due to the rocky nature of the substrate. Delineation of this type and distinguishing it from other sparse grasslands types was difficult. Finding likely areas based on topographic positions and then following-up with field verification helped with its interpretation.

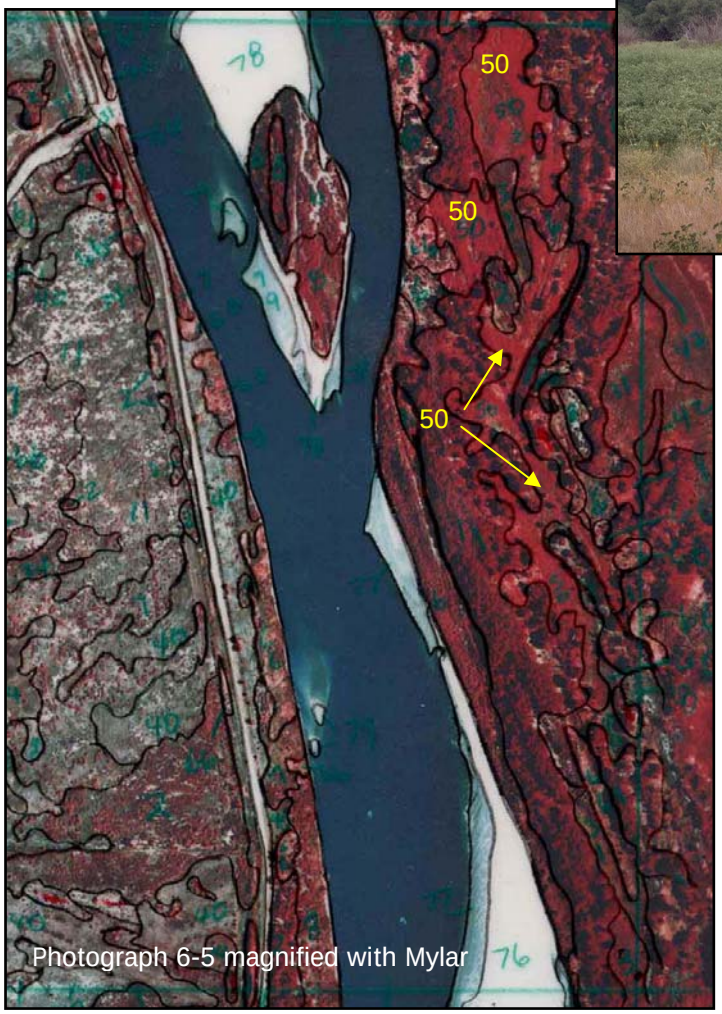


Photograph 6-6 magnified with Mylar

Hemp Dogbane Herbaceous Vegetation (Map Code 50)



Location: Three nearly pure stands of *Apocynum cannabinum* Herbaceous Vegetation are present in the Green River floodplain, two between the boat ramp and the access road to Leota Bottom, and a third in a drainage in Wyasket Bottom. Individual plants and small patches of hemp dogbane are present along the Green River, within the floodplain, however, they are only minor components of other plant communities.



Signature: This broadleaf shrub or sub-shrub is fairly lush and stands up to three feet tall. This translates into a very dark pink to red color and a rough textured signature on CIR photography. Using its signature characteristics and location on the floodplain this type was relatively easy to delineate.

Winterfat Sparse / James' Galleta Dwarf-shrubland (Map Code 51)

Location: Krascheninakovia lanata / Pleuraphis jamesii Dwarf-shrubland was observed at only two sites near SH 88 in the vicinity of Sheppard Bottom. The larger stand just equals the project minimum mapping unit, but the smaller stand does not. Both stands occupy nearly flat ground on the large plain that lies adjacent to the Green River floodplain.

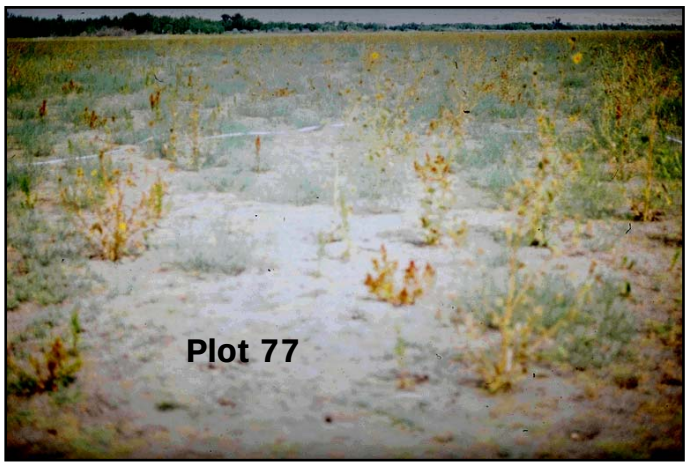
No ground photo was taken.

Signature: This shrub type had a signature very similar to other shrub communities. Due to its limited distribution and size it was entirely mapped using ground verification.

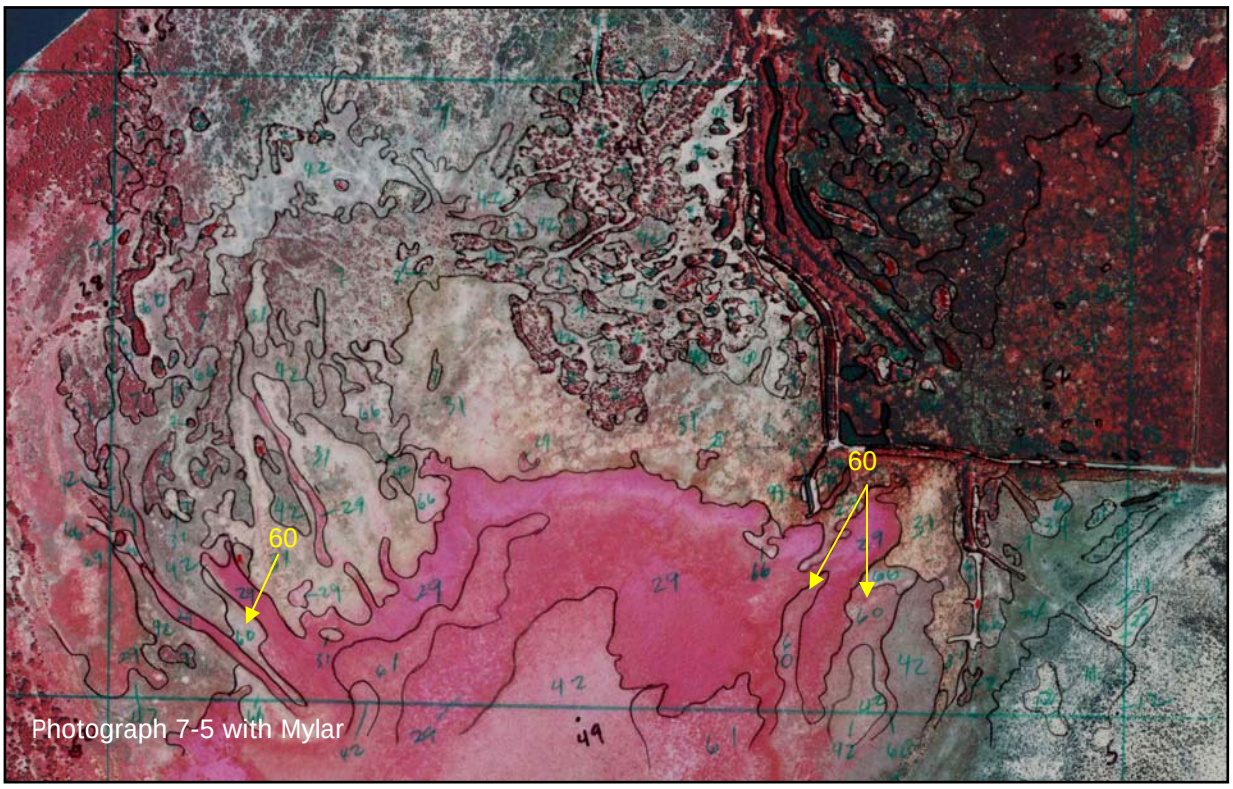
Photograph 4-3 magnified with Mylar

Bur Ragweed – Wild Sunflower Herbaceous Vegetation (Map Code 60)

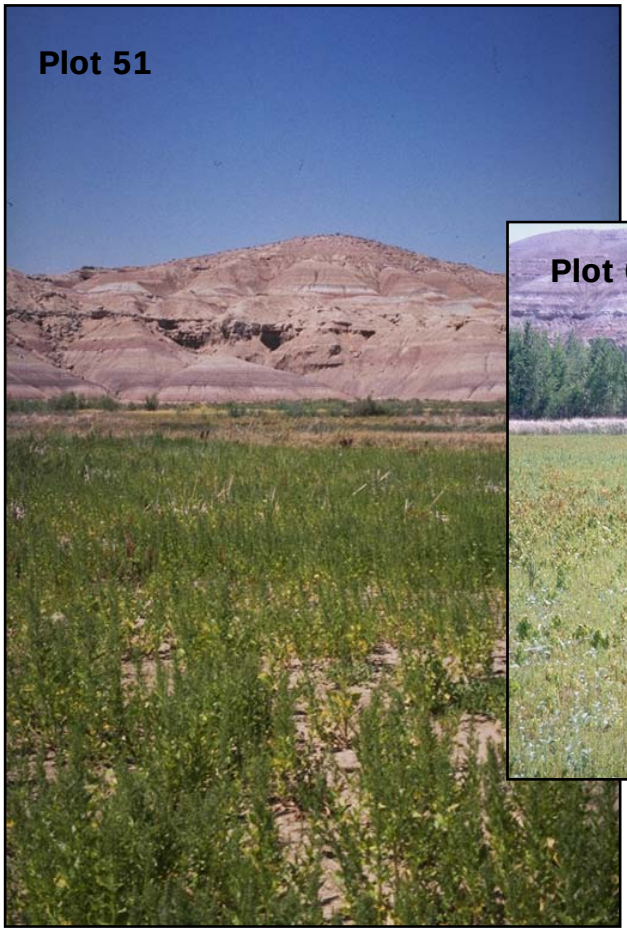
Location: This forb-dominated type is found only in Wyasket Bottom growing on the upper margins of a dry, natural basin. Stands of *Helianthus annuus* are observed elsewhere within the Refuge, particularly in Leota Bottom, but they are usually associated with *Apocynum cannabinum* or drying areas with species of cattail.



Signature: The signature for this type varied depending on the amount and density of living vegetation. In areas with high cover of sunflower and ragweed the color was pink and fairly smooth in texture. Areas with less cover and more bare soil exhibited a white to pale pink color. Ground verification of this type was critical in accurately separating it from other annual floodplain types.

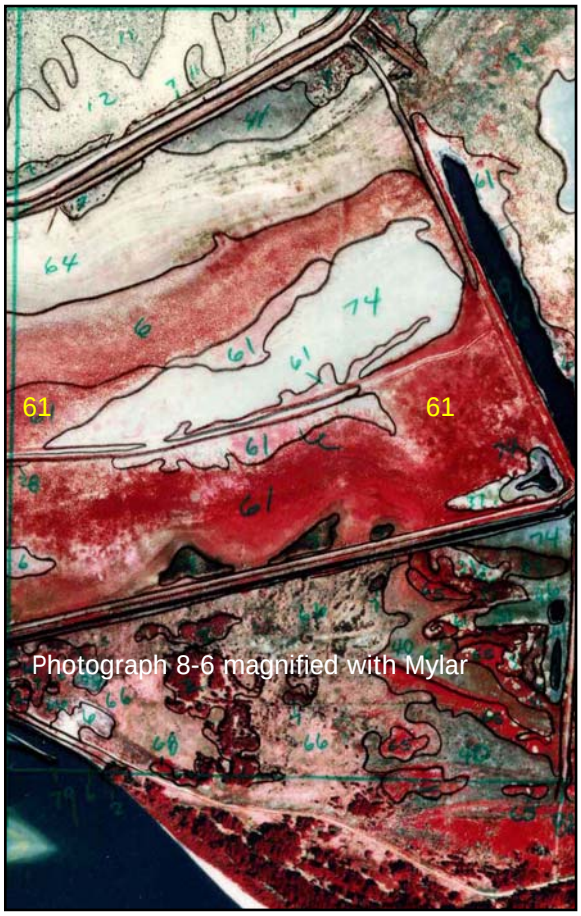


Red Orache Semi-natural Herbaceous Vegetation (Map Code 61)



Location: Atriplex rosea Semi-natural Herbaceous Vegetation has become established in drying basins of Leota Bottom, Sheppard Bottom, and Johnson Bottom within the floodplain of the Green River.

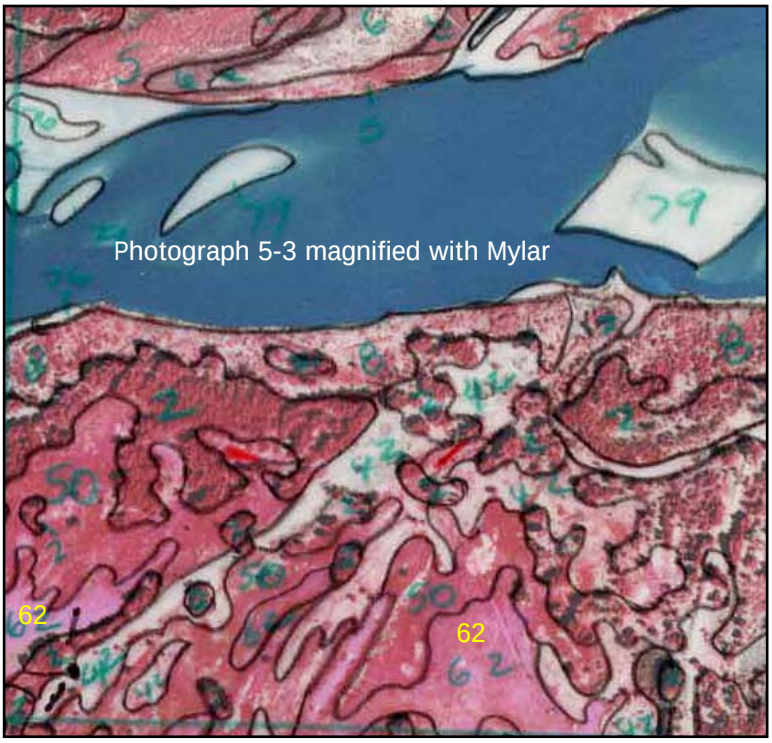
Signature: This monotypic vegetation type was very lush and green at the time of the photography producing a very bright red signature. Also, due to varying density the amount of bare ground changed across the stands creating a smeared or blotchy signature with whitish areas. This type was very low growing yielding a smooth or non-textured signature.



Cocklebur Herbaceous Vegetation (Map Code 62)

Location: Several large stands of *Xanthium strumarium* occupy shallow, overflow channels on the floodplain at Woods Bottom. Only one small stand of *Xanthium strumarium* Herbaceous Vegetation was observed elsewhere, occupying a small cut-off basin, adjacent to a dike in Leota Bottom.

Signature: This broadleaved annual produced a very intense pink signature in the Green River floodplains. Also since it was very low growing, no texture was evident on the CIR photography.

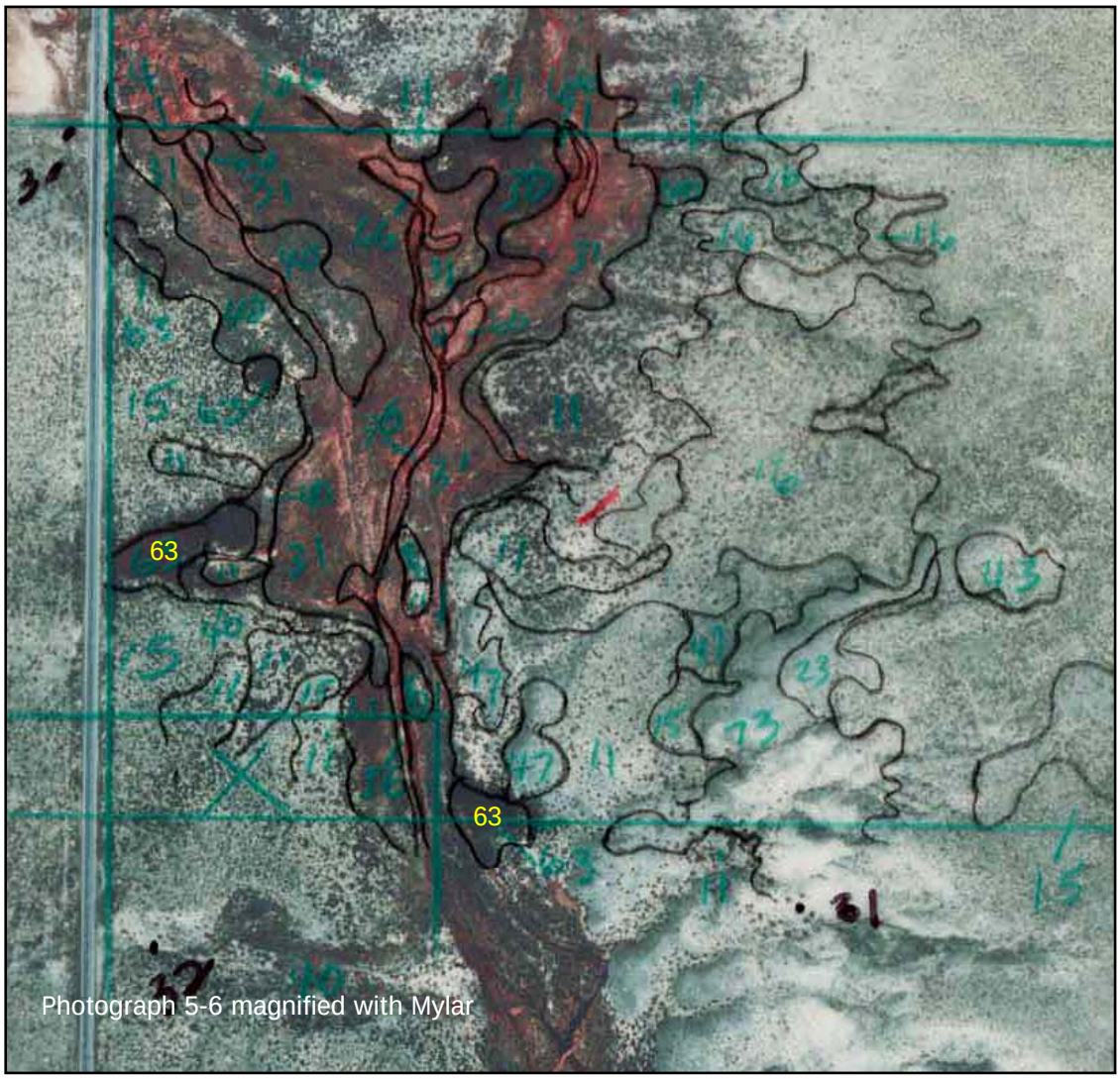


Poverty Sumpweed Herbaceous Vegetation (Map Code 63)

Location: One patch of *Iva axillaris* Herbaceous Vegetation was observed near SH 88 and the northwestern Refuge boundary. This was a nearly pure stand; elsewhere *Iva axillaris* is an associate of nearly every riparian and wetland plant association.

No ground photo was taken.

Signature: This type was difficult to distinguish from other low-growing wetland species such as bulrush and rush. It seemed to have a dark red to brown (almost black) color with no texture. Due to its very limited distribution and size, this type was mapped extensively with ground verification.

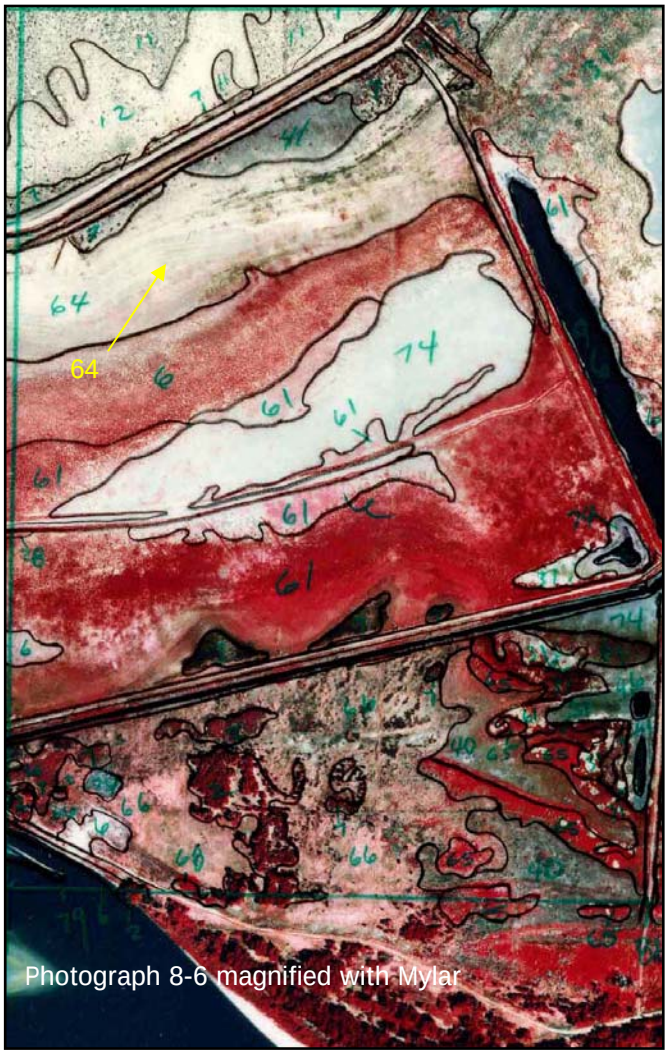


Photograph 5-6 magnified with Mylar

Kochia Herbaceous Semi-natural Herbaceous Vegetation (Map Code 64)

Location: Kochia scoparia Semi-natural Herbaceous Vegetation occupies dried mud flats at the edge of a basin in Leota Bottom and disturbed areas near the agricultural lands.

Signature: The location of this type on dry mud flats created a very white signature typical of mud flats (map code 74). The presence of vegetation however created brown and green streaks and may reflect the flooding pattern over the substrate.



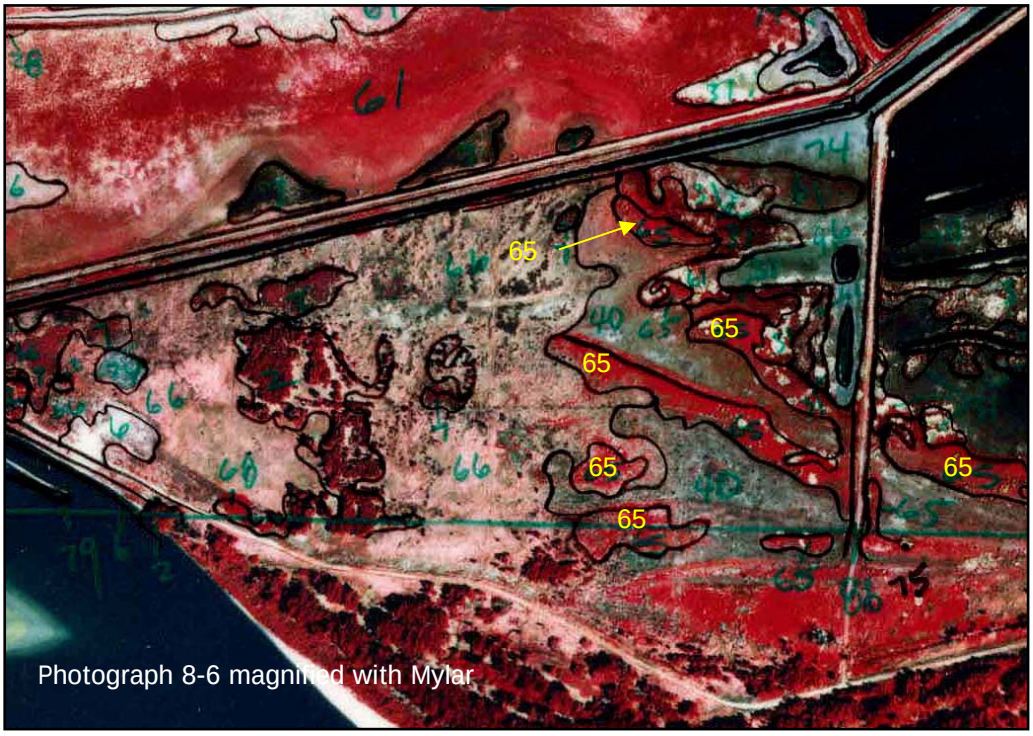
Photograph 8-6 magnified with Mylar

Alfalfa / Fremont Cottonwood Herbaceous Vegetation (Map Code 65)

Location: One stand of Medicago sativa / *Populus fremontii* Herbaceous Vegetation is known to occur in Leota Bottom. The density of *Medicago sativa* (approximately 80%) at this site is reminiscent of an agricultural planting. The stand of alfalfa has become invaded by seedling *Populus fremontii,* which provide foliar cover of approximately 20% and are about one m tall.

No ground photo was taken.

Signature: This type occurred in an obviously disturbed area with high amounts of alfalfa and seedling cottonwood. The total cover for this type was 100% creating a very dark red signature on the CIR photography. The lack of height provided a fine texture that helped indicate this types location.

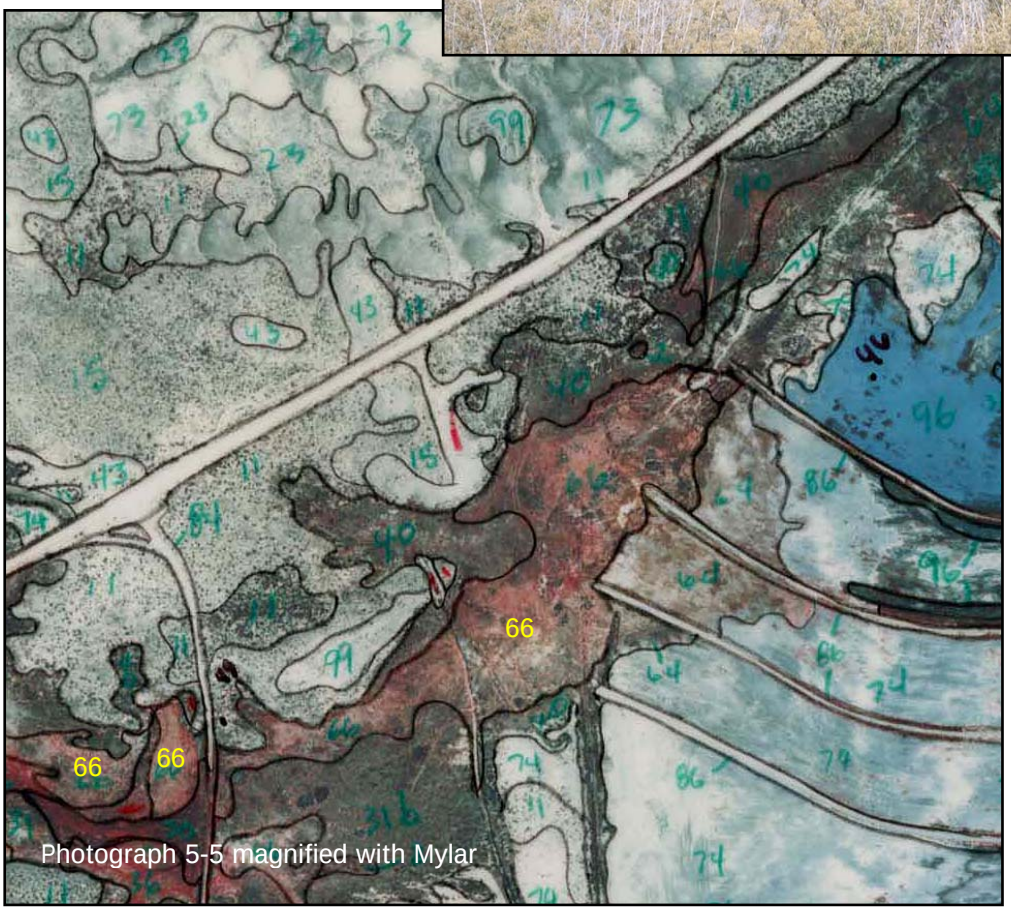


Photograph 8-6 magnified with Mylar

Pepperweed Semi-natural Herbaceous Vegetation (Map Code 66)

Location: Stands of *Lepidium latifolium* Semi-natural Herbaceous Vegetation occur within the floodplain of the Green River. This invasive exotic species occurs throughout the floodplain and is present in every riparian plant association, but is not always the dominant.

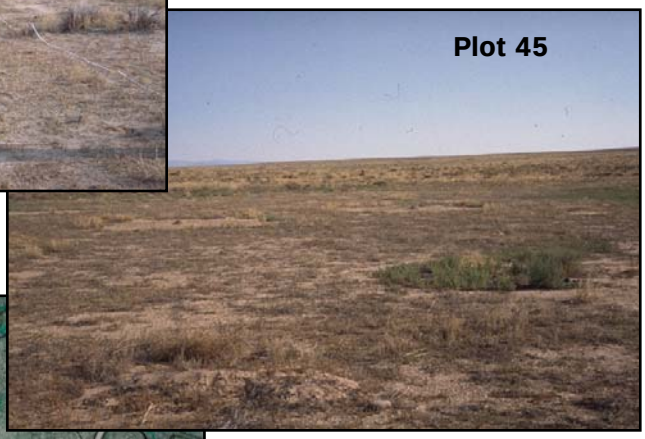
Signature: This invasive type contained various amounts of both living and dead material. On the CIR photography this appeared as a characteristic smeared or mottled pink signature. Texture was smooth with no stipples.



Photograph 5-5 magnified with Mylar

Prairie Dog Town Disturbed Vegetation (Map Code 67)

Location: White-tailed Prairie Dog Town Disturbed Vegetation occurs on terrestrial sites with soils deep enough and of a consistency to support burrowing activity. White-tailed prairie dog towns occur outside the Green River floodplain and range from currently occupied to unoccupied or abandoned for several years.



Photograph 6-7 magnified with Mylar

Signature: This type contained very little living vegetation at the time of the photography creating a very barren or white signature. The paleness of this type's signature was readily apparent against the blue-green color of surrounding grasslands and sparse shrublands.