Appendix A. Arapaho National Wildlife Refuge Species List

Birds

Taxonomic list of birds at Arapaho NWR (Order follows the A.O.U. Check-list of North American Birds, 7th ed. 1998) January, 2002.
General: 203 species occurring. 82 species breeding, 13 accidental/vagrant. 2 on the ESA: 0 Federal Endangered, 2 Federal Threatened, 0 Federal Candidate: Threatened.

Grebes	
Pied-billed Grebe	*Podilymbus podiceps*
Eared Grebe	*Podiceps nigricollis*
Western Grebe	*Aechmophorus occidentalis*
Pelicans	
American White Pelican	*Pelecanus erythrorhynchos*
Cormorants	
Double-crested Cormorant	*Phalacrocorax auritus*
Bitterns, Herons, and Egrets	
American Bittern	*Botaurus lentiginosus*
Great Blue Heron	*Ardea herodias*
Snowy Egret	*Egretta thula*
Cattle Egret	*Bubulcus ibis*
Green Heron	*Butorides virescens*
Black-crowned Night-Heron	*Nycticorax nycticorax*
Yellow-crowned Night-Heron	*Nyctanassa violaceus*
Ibises and Spoonbills	
White-faced Ibis	*Plegadis chihi*
New World Vultures	
Turkey Vulture	*Cathartes aura*
Swans, Geese, and Ducks	
Snow Goose	*Chen caerulescens*
Canada Goose	*Branta canadensis*
Trumpeter Swan	*Cygnus buccinator*
Tundra Swan	*Cygnus columbianus*
Wood Duck	*Aix sponsa*
Gadwall	*Anas strepera*
American Wigeon	*Anas americana*
Mallard	*Anas platyrhynchos*
Blue-winged Teal	*Anas discors*
Cinnamon Teal	*Anas cyanoptera*
Northern Shoveler	*Anas clypeata*
Northern Pintail	*Anas acuta*
Green-winged Teal	*Anas crecca*
Canvasback	*Aythya valisineria*
Redhead	*Aythya americana*
Ring-necked Duck	*Aythya collaris*
Lesser Scaup	*Aythya affinis*
Bufflehead	*Bucephala albeola*
Common Goldeneye	*Bucephala clangula*
Hooded Merganser	*Lophodytes cucullatus*
Common Merganser	*Mergus merganser*
Ruddy Duck	*Oxyura jamaicensis*
Osprey, Kites, Hawks, and Eagles	
Osprey	*Pandion haliaetus*
Bald Eagle	*Haliaeetus leucocephalus*
Northern Harrier	*Circus cyaneus*
Sharp-shinned Hawk	*Accipiter striatus*
Cooper's Hawk	*Accipiter cooperii*
Northern Goshawk	*Accipiter gentilis*
Swainson's Hawk	*Buteo swainsoni*
Red-tailed Hawk	*Buteo jamaicensis*
Ferruginous Hawk	*Buteo regalis*
Rough-legged Hawk	*Buteo lagopus*
Golden Eagle	*Aquila chrysaetos*
Falcons and Caracaras	
American Kestrel	*Falco sparverius*
Merlin	*Falco columbarius*
Peregrine Falcon	*Falco peregrinus*
Prairie Falcon	*Falco mexicanus*
Gallinaceous Birds	
Sage Grouse	*Centrocercus urophasianus*
Rails	
Virginia Rail	*Rallus limicola*
Sora	*Porzana carolina*
American Coot	*Fulica americana*
Cranes	
Sandhill Crane	*Grus canadensis*
Plovers	
Black-bellied Plover	*Pluvialis squatarola*
Killdeer	*Charadrius vociferus*
Stilts and Avocets	
Black-necked Stilt	*Himantopus mexicanus*
American Avocet	*Recurvirostra americana*
Sandpipers and Phalaropes	
Greater Yellowlegs	*Tringa melanoleuca*
Lesser Yellowlegs	*Tringa flavipes*
Solitary Sandpiper	*Tringa solitaria*
Willet	*Catoptrophorus semipalmatus*
Spotted Sandpiper	*Actitis macularia*
Upland Sandpiper	*Bartramia longicauda*
Long-billed Curlew	*Numenius americanus*
Marbled Godwit	*Limosa fedoa*
Western Sandpiper	*Calidris mauri*
Least Sandpiper	*Calidris minutilla*
Baird's Sandpiper	*Calidris bairdii*
Long-billed Dowitcher	*Limnodromus scolopaceus*
Common Snipe	*Gallinago gallinago*
Wilson's Phalarope	*Phalaropus tricolor*
Red-necked Phalarope	*Phalaropus lobatus*
Skuas, Jaegers, Gulls, and Terns	
Franklin's Gull	*Larus pipixcan*
Bonaparte's Gull	*Larus philadelphia*
Ring-billed Gull	*Larus delawarensis*
California Gull	*Larus californicus*
Forster's Tern	*Sterna forsteri*
Black Tern	*Chlidonias niger*
Pigeons and Doves	
Mourning Dove	*Zenaida macroura*

Cuckoos and Anis	
Yellow-billed Cuckoo	*Coccyzus americanus*
Barn Owls	
Barn Owl	*Tyto alba*
Typical Owls	
Great Horned Owl	*Bubo virginianus*
Burrowing Owl	*Athene cunicularia*
Long-eared Owl	*Asio otus*
Short-eared Owl	*Asio flammeus*
Northern Saw-whet Owl	*Aegolius acadicus*
Nightjars	
Common Nighthawk	*Chordeiles minor*
Hummingbirds	
Calliope Hummingbird	*Stellula calliope*
Broad-tailed Hummingbird	*Selasphorus platycercus*
Rufous Hummingbird	*Selasphorus rufus*
Kingfishers	
Belted Kingfisher	*Ceryle alcyon*
Woodpeckers	
Lewis' Woodpecker	*Melanerpes lewis*
Yellow-bellied Sapsucker	*Sphyrapicus varius*
Red-naped Sapsucker	*Sphyrapicus nuchalis*
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
Northern Flicker	*Colaptes auratus*
Tyrant Flycatchers	
Olive-sided Flycatcher	*Contopus cooperi*
Western Wood-Pewee	*Contopus sordidulus*
Willow Flycatcher	*Empidonax traillii*
Hammond's Flycatcher	*Empidonax hammondii*
Dusky Flycatcher	*Empidonax oberholseri*
Cordilleran Flycatcher	*Empidonax occidentalis*
Say's Phoebe	*Sayornis saya*
Western Kingbird	*Tyrannus verticalis*
Eastern Kingbird	*Tyrannus tyrannus*
Shrikes	
Loggerhead Shrike	*Lanius ludovicianus*
Northern Shrike	*Lanius excubitor*
Vireos	
Warbling Vireo	*Vireo gilvus*
Crows, Jays, and Magpies	
Steller's Jay	*Cyanocitta stelleri*
Pinyon Jay	*Gymnorhinus cyanocephalus*
Clark's Nutcracker	*Nucifraga columbiana*
Black-billed Magpie	*Pica pica*
American Crow	*Corvus brachyrhynchos*
Common Raven	*Corvus corax*
Larks	
Horned Lark	*Eremophila alpestris*
Swallows	
Tree Swallow	*Tachycineta bicolor*
Violet-green Swallow	*Tachycineta thalassina*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Bank Swallow	*Riparia riparia*
Cliff Swallow	*Petrochelidon pyrrhonota*
Barn Swallow	*Hirundo rustica*
Titmice and Chickadees	
Black-capped Chickadee	*Poecile atricapillus*
Mountain Chickadee	*Poecile gambeli*
Nuthatches	
Red-breasted Nuthatch	*Sitta canadensis*
Wrens	
Rock Wren	*Salpinctes obsoletus*
House Wren	*Troglodytes aedon*
Sedge Wren	*Cistothorus platensis*
Marsh Wren	*Cistothorus palustris*
Dippers	
American Dipper	*Cinclus mexicanus*
Kinglets	
Ruby-crowned Kinglet	*Regulus calendula*
Thrushes	
Eastern Bluebird	*Sialia sialis*
Western Bluebird	*Sialia mexicana*
Mountain Bluebird	*Sialia currucoides*
Veery	*Catharus fuscescens*
Swainson's Thrush	*Catharus ustulatus*
Hermit Thrush	*Catharus guttatus*
American Robin	*Turdus migratorius*
Mimic Thrushes	
Gray Catbird	*Dumetella carolinensis*
Northern Mockingbird	*Mimus polyglottos*
Sage Thrasher	*Oreoscoptes montanus*
Brown Thrasher	*Toxostoma rufum*
Starlings	
European Starling	*Sturnus vulgaris*
Wagtails and Pipits	
American (Water) Pipit	*Anthus rubescens*
Waxwings	
Bohemian Waxwing	*Bombycilla garrulus*
Cedar Waxwing	*Bombycilla cedrorum*
Wood Warblers	
Orange-crowned Warbler	*Vermivora celata*
Nashville Warbler	*Vermivora ruficapilla*
Virginia's Warbler	*Vermivora virginiae*
Yellow Warbler	*Dendroica petechia*
Chestnut-sided Warbler	*Dendroica pensylvanica*
Magnolia Warbler	*Dendroica magnolia*
Yellow-rumped Warbler	*Dendroica coronata*
MacGillivray's Warbler	*Oporornis tolmiei*
Common Yellowthroat	*Geothlypis trichas*
Wilson's Warbler	*Wilsonia pusilla*
Tanagers	
Western Tanager	*Piranga ludoviciana*

Sparrows and Towhees

Green-tailed Towhee	*Pipilo chlorurus*
Spotted Towhee	*Pipilo maculatus*
Eastern Towhee	*Pipilo erythrophthalmus*
American Tree Sparrow	*Spizella arborea*
Chipping Sparrow	*Spizella passerina*
Brewer's Sparrow	*Spizella breweri*
Vesper Sparrow	*Pooecetes gramineus*
Lark Sparrow	*Chondestes grammacus*
Sage Sparrow	*Amphispiza belli*
Lark Bunting	*Calamospiza melanocorys*
Savannah Sparrow	*Passerculus sandwichensis*
Fox Sparrow	*Passerelia iliaca*
Song Sparrow	*Melospiza melodia*
Lincoln's Sparrow	*Melospiza lincolnii*
Harris' Sparrow	*Zonotrichia querula*
White-crowned Sparrow	*Zonotrichia leucophrys*
Dark-eyed Junco	*Junco hyemalis*
McCown's Longspur	*Calcarius mccownii*
Lapland Longspur	*Calcarius lapponicus*
Chestnut-collared Longspur	*Calcarius ornatus*
Snow Bunting	*Plectrophenax nivalis*

Grosbeaks, and Allies

Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Black-headed Grosbeak	*Pheucticus melanocephalus*
Blue Grosbeak	*Guiraca caerulea*
Lazuli Bunting	*Passerina amoena*
Indigo Bunting	*Passerina cyanea*
Dickcissel	*Spiza americana*

Blackbirds and Orioles

Bobolink	*Dolichonyx oryzivorus*
Red-winged Blackbird	*Agelaius phoeniceus*
Western Meadowlark	*Surnella neglecta*
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
Brewer's Blackbird	*Euphagus cyanocephalus*
Common Grackle	*Quiscalus quiscula*
Brown-headed Cowbird	*Molothrus ater*
Bullock's Oriole	*Icterus bullockii*

Finches

Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*
Black Rosy-Finch	*Leucosticte atrata*
Brown-capped Rosy-Finch	*Leucosticte australis*
House Finch	*Carpodacus mexicanus*
Pine Siskin	*Carduelis pinus*
Lesser Goldfinch	*Carduelis psaltria*
American Goldfinch	*Carduelis tristis*
Evening Grosbeak	*Coccothraustes vespertinus*

Old World Sparrows

House Sparrow	*Passer domesticus*	*Introduced*

Mammals *(General: 33 species occurring. January, 2002.)*

Shrews

Masked Shrew	*Sorex cinereus*

Hares and Rabbits

Nuttall's Cottontail	*Sylvilagus nuttallii*
White-tailed Jackrabbit	*Lepus townsendii*

Squirrels

Least Chipmunk	*Eutamias minimus*
Yellow-bellied Marmot	*Marmota flaviventris*
Wyoming Ground Squirrel	*Spermophilus elegans*
Thirteen-lined Ground Squirrel	*Spermophilus tridecemlineatus*
Golden-mantled Ground Squirrel	*Spermophilus lateralis*
White-tailed Prairie Dog	*Cynomys leucurus*

Beaver

Beaver	*Castor canadensis*

Mice, Rats and Voles

Deer Mouse	*Permoyscus maniculatus*
Northern Grasshopper Mouse	*Onychomys leucogaster*
Montane Vole	*Microtus montanus*
Muskrat	*Ondatra zibethicus*

Old World Mice

House Mouse	*Mus musculus*

Jumping Mice

Western Jumping Mouse	*Zapus princeps*

Porcupine

Porcupine	*Erethizon dorsatum*

Dogs, Wolves and Foxes

Coyote	*Canis latrans*
Red Fox	*Vulpes vulpes*

Bears

Black Bear	*Ursus americanus*

Racoons

Racoon	*Procyon lotor*

Weasels, Skunks, etc.

Ermine	*Mustela erminea*
Long-tailed Weasel	*Mustela frenata*
Mink	*Mustela vison*
River Otter	*Lutra canadensis*
Badger	*Taxidea taxus*
Striped Skunk	*Mephitis mephitis*

Cats

Mountain Lion	*Puma concolor*
Bobcat	*Felis rufus*

Deer

Rocky Mountain Elk	*Cervus elaphus*
Mule Deer	*Odocoileus hemionus*
White-tailed Deer	*Odocoileus virginianus*
Moose	*Alces alces*

Pronghorn

Pronghorn	*Antilocapra americana*

Fish

General: 9 species occurring. January, 2002.

Trout	
Rainbow Trout	*Salmo gairdneri*
Brown Trout	*Salmo trutta*
Brook Trout	*Salvelinus fontinalis*
Dace, Minnows, Chub and Darters	
Northern Redbelly Dace	*Phoxinus eos*
Fathead Minnow	*Pimephales promelas*
Creek Chub	*Semotilus atromaculatus*
Johnny Darter	*Etheostoma nigrum*
Suckers	
Long-nosed Sucker	*Catostomus catostomus*
White Sucker	*Catostomus commeisoni*

Amphibians and Reptiles

General: 6 species occurring. January, 2002.

Amphibians	
Barred Tiger Salamander	*Ambystoma tigrinum mavortium*
Western Toad	*Bufo boreas*
Wood Frog	*Rana sylvatica*
Northern Leopard Frog	*Rana pipiens*
Striped Chorus Frog	*Pseudacris nigrita maculatat*
Reptiles	
Wandering Garter Snake	*Thamnophis elegans vagrans*

Plants

General: 390 species occurring. 1 on the ESA: 1 federally endangered. January 2002.

Parsley Family (Apiaceae = Umbelliferae)	
Sweet cicely	*Osmorhiza longistylis*
Douglas water hemlock	*Cicuta douglasii*
Poison-hemlock	*Conium maculatum*
Western hemlock	*Cicuta maculata angustifolia*
Lovage, licorice-root	*Ligusticum porteri*
Hemlock parsley	*Conioselinum scopulorum*
Cow parsnip	*Heracleum lanatum*
Fern Family (Aspleniaceae)	
Alpine ladyfern	*Athyrium distentifolium*
Aster Family (Asteraceae)	
Aster	*Aster campestris*
Golden aster	*Chrysopsis horrida*
Hairy golden aster	*Chrysopsis villosa*
Leafy aster	*Aster foliaceus*
Marsh aster	*Aster hesperius*
Arrowleaf balsamroot	*Balsamorhiza sagittata*
Heart-leaf arnica	*Arnica cordifolia*
Leafy or meadow arnica	*Arnica chamissonis*
Coulter's daisy	*Erigeron coulteri*
Daisy	*Erigeron elatior*
Daisy fleabane	*Erigeron ochroleucus scribneri*
Spear-leaf fleabane	*Erigeron lonchophyllus*
Subalpine daisy	*Erigeron peregrinus*
Common dandelion	*Taraxacum officinale*
Mountain dandelion	*Agoseris glauca glauca*
Common pearly-everlasting	*Anaphalis margaritacea*
Dune goldenrod	*Solidago simplex*
Canada goldenrod	*Solidago canadensis*
Missouri goldenrod	*Solidago missouriensis*
Goldenweed	*Haplopappus clematis*
Goldenweed	*Haplopappus lanceolatus*
Arrowleaf groundsel	*Senecio triangularis*
Groundsel	*Senecio mutabilis*
Goundsel	*Senecio soldanella*
Goundsel	*Senecio sphaerocephalus*
Few-leaved groundsel, alpine meadow butterweed	*Senecio cymbalarioides*
Thickleaf groundzel, butterweed, ragwort	*Senecio crassulus*
Water groundzel, alkali marsh butterweed	*Senecio hydrophilus*
Long-leaved hawksbeard	*Crepis acuminata*
Dandelion hawksbeard	*Crepis runcinata*
Gray horsebrush	*Tetradymia canescens*
Mule's ears	*Wyethia amplexicaulis*
Nothocalais	*Nothocalais nigrescens*
Pineapple-weed	*Matricaria matricaroides*
Field pussytoes	*Antennaria neglecta*
Nuttail's pussytoes	*Antennaria parvifolia*
Rosy pussytoes	*Antennaria microphylla*
Tall pussytoes	*Antennaria anaphaloides*
Gray rabbitbrush	*Chrysothamnus nauseosus albicaulis*
Rubber rabbitbrush	*Chrysothamnus nauseosus nauseosus*
Alkali Sage	*Artemisia arbuscula longiloba*
Big sage	*Artemisia tridentata tridentata*
Fringed sage	*Artemisia frigida*
Low sage	*Artemisia arbuscula arbuscula*

Mountain big sage	*Artemisia tridentata vaseyana*
Mountain silver sage	*Artemisia cana viscidula*
Plains sage	*Artemisia longifolia*
Prairie sage	*Artemisia ludoviciana*
Sage	*Artemisia tridentata rothrockii*
Silver sage	*Artemisia cana cana*
Western salsify	*Tragopogon dubius*
Broom snakeweed	*Gutierrezia sarothrae*
Orange sneezeweed	*Helenium hoopesii*
False sunflower	*Helianthus rigidus*
Thistle	*Cirsium canescens*
Thistle	*Cirsium drummondii*
Thistle	*Cirsium scopulorum*
Thistle	*Cirsium tioganum*
Canada thistle	*Cirsium arvense*
Flodman's thistle	*Cirsium flodmanii*
Star-thistle	*Centaureae cyanus*
Wavy-leaved thistle	*Cirsium undulatum*
Western yarrow	*Achillea millefolium*

Barberry Family (Berberidaceae)

Oregon grape	*Mahonia repens*

Birch Family (Betulaceae)

Mountain alder	*Alnus incana*
Bog birch	*Betula glandulosa*

Borage Family (Boraginaceae)

Houndstongue	*Cynoglossum officinale*
Bluebells	*Mertensia humilis*
Bluebells	*Mertensia lanceolata*
Cilate bluebells	*Mertensia ciliata*
Small bluebells	*Mertensia longiflora*
Forget-me-not, stickseed	*Hackelia leptophylla*
Minors candle	*Cryptantha caespitosa*
Stoneseed	*Lithospermum incisum*

Mustard Family (Brassicaceae = Cruciferae)

American wintercress	*Barbarea orthoceras*
Bitter cress	*Cardamine breweri*
Large mountain bittercress	*Cardamine cordifolia cordifolia*
Rock cress	*Arabis drummondi*
Yellowcress	*Rorripa obtusa*
Smallseed false flax	*Camelina microcarpa*
Tansy mustard	*Descurainia pinnata*
Common peppergrass	*Lepidium densiflorum*
Shepherd's purse	*Capsella bursa-pastoris*
Slender thelypody	*Thelypodium sagittatum*
Spreading wallflower	*Erysimum repandum*

Cactus Family (Cactaceae)

Pincushion cactus	*Coryphantha vivipara*
Prickly pear cactus, brittle cactus	*Opuntia fragilis*
Prickly pear cactus	*Opuntia polyacantha polyacantha*

Bluebell Family (Campanulaceae)

Arctic harebell, bellflower	*Campanula uniflora*
Bellflower, lady's thimble	*Campanula rotundifolia*

Caper Family (Capparaceae)

Rocky mountain beeplant	*Cleome serrulata*

Honeysuckle Family (Caprifoliaceae)

Buckbrush	*Symphoricarpos albus*
Elderberry	*Sambucus racemosa*
Bearberry honeysuckle	*Lonicera involucrata*
Snowberry	*Symphoricarpos orbiculatus*
Twinflower	*Linnaea borealis longiflora*

Pink Family (Caryophyllaceae)

Catchfly	*Lychnis drummondii*
Ballheaded sandwort	*Arenaria congesta*
Slender sandwort	*Arenaria stricta*
Longleaved starwort	*Stellaria longifolia*
Longstalked starwort	*Stellaria longipes*
Whitlow wort	*Paronychia sessiliflora*

Staff-tree Family (Celastraceae)

Mountain lover	*Pachistima myrsinites*

Goosefoot Family (Chenopodiaceae)

Summer cyperus	*Kochia americana*
Slimleaf goosefoot	*Chenopodium lepdtophyllum*
White goosefoot, pigweed	*Chenopodium album*
Greasewood	*Sarcobatus vermiculatus*
Mat saltbush	*Atriplex gardneri*
Winterfat	*Ceratoides lanata*

Orpine Family (Crassulaceae)

Rose crown	*Sedum rhodanthum*
Stonecrop	*Sedum lanceolatum*
Stonecrop	*Sedum stenopetalum*
Rose crown, stonecrop	*Sedum rhodanthum*

Cedar Family (Cupressaceae)

Common juniper	*Juniperus communis depressa*

Sedge Family (Cyperaceae)

Many spiked cottongrass	*Eriophorum polystachion*
Bulrush	*Scirpus pallidus*
Bulrush, clubrush	*Scirpus microcarpus*
Common spike rush	*Eleocharis palustris*
Small spike rush	*Eleocharis parvula*
Beaked sedge	*Carex rostrata*
Capitate sedge	*Carex capitata*
Dunhead sedge	*Carex phaeocephala*
Elk sedge	*Carex geyeri*
Hayden's sedge	*Carex ebenea*
Narrow-leaved sedge	*Carex eleocharis*
Nebraska sedge	*Carex nebrascensis*
Needleleaf sedge	*Carex filifolia*
Parry sedge	*Carex parryana*
Sedge	*Carex kellogi*
Shortbeaked sedge	*Carex simulata*
Slenderbeaked sedge	*Carex athrostackya*
Wooly sedge	*Carex lanuginosa*

Oleaster Family (Elaegnaceae)

Russet buffaloberry	*Shepherdia canadensis*

Horsetail Family (Equisetaceae)

Common horsetail	*Equisetum arvense*
Horsetail	*Equisetum laevigatum*
Northern scouring rush	*Equisetum variegatum nelsoni*

Heath Family (Ericaceae)

Bearberry	*Arctostaphylos uva-ursi*
Dwarf billberry	*Vaccinium caespitosum*
Low billberry	*Vaccinium myrtillus*
Grouse whortleberry	*Vaccinium scoparium*

Pea Family (Fabaceae = Leguminosae)
Alsike clover *Trifolium hybridium*
Long-stalked clover *Trifolium longipes*
Sweet clover *Melilotus officinalis*
White, dutch clover *Trifolium repens*
Silky crazyweed *Oxytropis sericea sericea*
Plains loco *Oxytropis campestris*
Tall locoweed *Oxytropis lamberii*
Big leaf lupine *Lupinus polyphyllus humicola*
Prairie lupine *Lupinus lepidus utahensis*
Silvery lupine *Lupinus argenteus argenteus*
Milkvetch, locoweed *Astragalus parryi*
Park milkvetch *Astragalus leptaleus*
Thistle milkvetch *Astragalus kentrophyta*
Silver-leaved milkvetch *Astragalus argophyllus*
Wooly-pod milkvetch *Astragalus purshii*
Plains orophaca *Astragalus gilyiflorus*
Yellow pea *Thermopsis rhombifolia*
American vetch *Vicia americana americana*

Gentian Family (Gentianaceae)
Gentian *Gentiana forwoodii*
Gentian *Gentiana parryi*
Pleated or prairie gentian *Gentiana affinis*
Moss gentian *Gentiana fremontii*
Northern gentian *Gentianella amarella*
Smaller fringed gentian *Gentiana thermalis*
Swertia *Swertia perennis*

Geranium Family (Geraniaceae)
Richardson's geranium *Geranium richardsonii*

Gooseberry Family (Grossulariaceae)
Swamp gooseberry *Ribes lacustre*
Whitestem gooseberry *Ribes inerme*

Waterleaf Family (Hydrophyllaceae)
North Park Phacelia *Phacelia formosula*

St. Johnswort Family (Hypericaceae)
St. Johnswort *Hypericum perforatum*

Iris Family (Iridaceae)
Blue-eyed grass *Sisyrinchium idahoense occidentale*
Blue-eyed grass *Sisyrinchium montanum*
Rocky mountain iris *Iris missouriensis*

Rush Family (Juncaceae)
Baltic rush *Juncus balticus*
Dagger-leaf rush *Juncus ensifolius*
Field woodrush *Luzula campestris*
Long-styled rush *Juncus lonistylis*
Smallflowered woodrush *Luzula parviflora*
Tuberous rush *Juncus nodosus*

Arrowgrass Family (Juncaginaceae)
Seaside arrowgrass *Triglochin maritimum*
Marsh arrowgrass *Triglochin palustre*

Mint Family (Lamiaceae)
Field mint *Mentha arvensis*
Common hemp nettle *Galeopsis tetrahit*
Marsh or willoweed skullcap *Scutellaria galericulata*

Lily Family (Liliaceae)
Chives *Allium schoenoprasum*
Cucumber root, clasping-leaved twisted stalk *Streptopus amplexifolius*
Panicled deathcams *Zigadenus paniculatus*
Fritillary *Fritillaria atropurpurea*
California false-hellebore *Veratrum californicum*
Sego lily *Calochortus nuttallii*
Red lily *Lilium umbellatum*
Onion *Allium geyeri*
Starry solomon plume *Smilacena stellata*

Mallow Family (Malvaceae)
Mallow *Malva crispa*
Checkermallow, false mallow *Sidalcea candida*
Scarlet globemallow *Sphaeralcea coccinea*

Evening Primrose Family (Onagraceae)
Fireweed, blooming sally *Epilobium angustifolium*
Common willow herb *Epitobium glandulosum tenue*
Willow herb *Epilobium glaberrimum fastigiatum*
Racemed ground smoke *Gayophytum racemosum*

Orchid Family (Orchidaceae)
Leafy white orchid *Habenaria dilatata*
Giant, western rattlesnake plantain *Goodyera oblongifolia*

Pine Family (Pinaceae)
Douglas fir *Pseudotsuga menziesii*
Subalpine fir *Abies lasiocarpa*
White fir *Abies concolor*
Limberpine *Pinus flexilis*
Lodgepole pine *Pinus contorta latifolia*
Blue spruce *Picea pungens*
Engleman spruce *Picea engelmannii*

Plantain Family (Plantaginaceae)
Nippleseed plantain *Plantago major*

Grass Family (Poaceae = *Gramineae)*
Nuttall alkaligrass *Puccinellia airoides*
Foxtail barley *Hordeum jubatum*
Meadow barley *Hordeum brachyantherum*
Thurber bentgrass *Agrostis thurburiana*
Winter bentgrass *Agrostis scabra*
Alkali bluegrass *Poa juncifolia*
Big bluegrass *Poa ampla*
Bog bluegrass *Poa leptocoma*
Canada bluegrass *Poa compressa*
Canby bluegrass *Poa canbyi*
Cusick bluegrass *Poa cusickii*
Kentucky bluegrass *Poa pratensis*
Nevada bluegrass *Poa nevadensis*
Sandberg bluegrass *Poa secunda*
Wheeler bluegrass *Poa nervosa*
Cheatgrass, downy brome *Bromus tectorum*
Fringed brome *Bromus ciliatus*
Mountain brome *Bromus marginatus*
Nodding brome *Bromus anomalus*
Smooth brome *Bromus inermis*
Arizona fescue *Festuca arizonica*
Idaho fescue *Festuca idahoensis*
Sheep fescue *Festuca ovina*
Thurber fescue *Festuca thurberi*
Fowl grass *Poa palustris*
Meadow foxtail *Alopecurus pratensis*

Blue grama	*Bouteloua gracilis*
Hairy grama	*Bouteloua hirsuta*
Tufted hairgrass	*Deschampsia cespitosa cespitosa*
Junegrass	*Koeleria pyramidata*
Mannagrass	*Glyceria borealis*
Mat muhly	*Muhlenbergia richardsonis*
Minute muhly	*Muhlenbergia minutissima*
Mountain muhly	*Muhlenbergia montana*
Mutton grass	*Poa fendleriana*
Needle and thread	*Stipa comata*
Columbia needlegrass	*Stipa columbiana*
Green needlegrass	*Stipa viridula*
Letterman's needlegrass	*Stipa lettermanii*
Pine needlegrass	*Stripa pinetorum*
Parry oatgrass	*Danthonia patryi*
Oniongrass	*Melica bulbosa*
Purple oniongrass	*Melica spectabilis*
Orchardgrass	*Dactylis glomerata*
Redtop	*Agrostis alba*
Common reed	*Phragmites australis*
Reed canary grass	*Phalaris arundinacea*
Bluejoint reedgrass	*Calamagrostis canadensis*
Narrow spiked reedgrass -	*Calamagrostis inexpansa inexpansa*
Plains reedgrass	*Calamagrostis montanensis*
Indian ricegrass	*Oryzopsis hymenoides*
Blue wild rye	*Elymus glaucus*
Saltgrass	*Distichlis stricta*
Prairie sandreed	*Calamovilfa longifolia*
Scratchgrass	*Muhlenbergia asperifolia*
Sleepy grass	*Stipa robusta*
Sloughgrass	*Beckmannia syzgachne*
Bottlebrush squirrel tail	*Sitanion hystrix*
Timothy	*Phleum pratense*
Spike trisetum downy oatgrass,	*Trisetum spicatum*
Sweetgrass	*Hierochloe odorata*
Baker's wheatgrass	*Agropyron bakeri*
Bearded wheatgrass	*Agropyron subsecundum*
Bluebunch wheatgrass	*Agropyron spicatum*
Crested wheatgrass	*Agropyron cristatum cristatum*
Elongate wheatgrass	*Agropyron elongatum*
Intermediate wheatgrass	*Agropyron intermedium*
Slender wheatgrass	*Agropyron trachycaulum*
Streambank wheatgrass	*Agropyron riparium*
Thickspiked wheatgrass	*Agropyron dasystachyum*
Western wheatgrass	*Agropyron smithii*
Brookgrass, water whorlwort	*Catabrosa aquatica*

Phlox Family (Polemoniaceae)

Narrow-leaf collomia	*Collomia linearis*
Scarlet gilia	*Gilia agregata*
Hood's phlox	*Phlox hoodii*
Long leaf phlox	*Phlox longifolia*
Phlox	*Phlox multiflora*
Prickly-leaved phlox	*Phlox aculeata*
Skunk or sticky polemonium	*Polemonium viscosum*

Buckwheat Family (Polygonaceae)

American bistort	*Polygonum bistortoides*
Sulphur buckwheat	*Eriogonum umbellatum dichrocephalum*
Wild buckwheat	*Eriogonum jamesii flavescens*
Curly dock	*Rumex crispus*
Heartweed, spotted ladysthumb	*Polygonum persicaria*
Douglas' knotweed	*Polygonum douglasii*

Purslane Family (Portulacaceae)

Least, dwarf, alpine lewisia	*Lewisia pygmeae*
Spring beauty	*Claytonia lanceolata lanceolata*

Primrose Family (Primulaceae)

Fairy candleabra, rock jasmine	*Androsace septentrionalis*
Few flowered or dark throat shooting star	*Dodecatheon pulchellum*

Wintergreen Family (Pyrolaceae)

Alpine pyrola	*Pyrola asarifolia*

Buttercup Family (Ranunculaceae)

Cliff anemone	*Anemone globosa*
Baneberry	*Actaea rubra*
Buttercup	*Ranunculus alismifolius*
Macoun's buttercup	*Ranunculus macounii*
Sagebrush buttercup	*Ranunculus glaberrimus ellipticus*
Sharp buttercup	*Ranunculus acriformis acriformis*
Columbine	*Aquilegia coerulea*
Globeflower	*Trollius laxus*
Larkspur	*Delphinium barbeyi*
Little larkspur	*Delphinium bicolor*
Slim or dwarf larkspur	*Delphinium depauperatum*
Tall larkspur	*Delphinium occidentale*
Marsh marigold	*Caltha leptosepala*
Veiny meadowrue	*Thalictrum venulsoum*
Monkshood	*Aconitum columbianum*
Pasqueflower	*Anemone patens multifida*

Buckthorn Family (Rhamnaceae)

Buckbrush	*Ceanothus velutinus*

Rose Family (Rosaceae)

Largeleaved avens	*Geum macrophyllum*
Bitterbrush	*Purshia tridentata*
Blackberry	*Rubus idaeus peramoenus*
Chokecherry	*Prunus virginiana*
Biennial cinquefoil	*Potentilla biennis*
Cinquefoil	*Potentilla diversifolia*
Cinquefoil	*Potentilla gracilis elmeri*
Cinquefoil	*Potentilla pucherrima*
Early cinquefoil	*Potentilla concinna*
Prairie cinquefoil	*Potentilla pensylvanica*
Shrubby cinquefoil, yellow rose	*Potentilla fruticosa*
Prairie smoke	*Geum triflorum*
Woods rose	*Rosa woodsii*
Common silverweed	*Potentilla anserina*
Serviceberry	*Amelanchier alnifolia*
Strawberry	*Fragaria virginiana*

Madder Family (Rubiaceae)

Northern bedstraw	*Galium boreale*
Small bedstraw	*Galium trifidum*

Willow Family (Salicaceae)

Quaking aspen	*Populus tremuloides*
Narrowleaf cottonwood	*Populus angustifolia*
Booth's willow	*Salix boothii*
Coyote willow	*Salix exigua melanopsis*
Drummond's willow	*Salix drummondiana*
Greyer's willow	*Salix geyeriana*
Mountain willow	*Salix monticola*
Planeleaf willow	*Salix planifolia planifolia*
Planeleaf willow	*Salix planifolia monica*

Scouler's willow	*Salix scouleriana*
Whiplash willow	*Salix lasiandra caudata*
Wolf's willow	*Salix wolfii*

Sandalwood Family (Santalaceae)

Bastard toadflax	*Comandra umbellata pallida*

Saxifrage Family (Saxifragaceae)

Alumroot	*Heuchera bracteata*
Alumroot	*Heuchera hallii*
Alumroot	*Heuchera parvifolia*
Slender fringecup, woodlandstar	*Lithophragma tenellum*
Brook saxifrage	*Saxifraga arguta*

Figwort Family (Scrophulariaceae)

Beardtongue	*Penstemon alpinus*
Beardtongue	*Penstemon cyathophorus*
Beardtongue	*Penstemon glaber*
Beardtongue	*Penstemon saxosorum*
American brooklime	*Veronica americana*
Yellow owl clover	*Orthocarpus luteus*
Elphant's head	*Pedicularis groenlandica*
Bracted lousewort	*Pedicularis bracteosa*
Leafy lousewort	*Pedicularis racemosa albe*
Lousewort	*Pedicularis crenulata*
Lousewort	*Pedicularis scopulorum*
Yellow monkey-flower	*Mimulus guttatus*
Desert paintbrush	*Castilleja chromosa*
Indian paintbrush	*Castilleja angustifolium chromosa*
Indian paintbrush	*Castilleja angustifolium puberula*
Yellow paintbrush	*Castilleja flava*
Yellow paintbrush	*Castilleja puberula*
Slender penstemom	*Penstemon gracilis*
Small-flowered penstemon	*Penstemon procerus*
Whipple's penstemon	*Penstemon whippleanus*
Speedwell	*Veronica arvensis*
Yellow toadflax	*Linaria vulgaris*

Spike Moss Family (Selaginellaceae)

Spike moss	*Selaginella densa*

Cattail Family (Typhaceae)

Common Cattail	*Typhia latifolia*

Nettle Family (Urticaceae)

Stinging nettle	*Urtica dioiea*

Valerian Family (Valerianaceae)

Valerian	*Valeriana occidentalis*

Violet Family (Violaceae)

Violet	*Viola canadensis*
Violet	*Viola nuttallii*

Appendix B. Glossary

Adaptive Management. Refers to a process in which policy decisions are implemented within a framework of scientifically driven experiments to test predictions and assumptions inherent in management plan. Analysis of results help managers determine whether current management should continue as is or whether it should be modified to achieve desired conditions.

Allelopathic. A plant that is able to suppress the growth of other plants by releasing toxic substances.

Alternative. 1. A reasonable way to fix the identified problem or satisfy the stated need (40 CFR 1500.2). 2. Alternatives are different means of accomplishing Refuge purposes and goals and contributing to the System mission (Draft Service Manual 602 FW 1.5).

Animal Unit Month. A measure of the quantity of livestock forage. Equivalent to the amount of forage needed to support a 1,000 pound animal (or 1 cow/calf pair) for 1 month.

Biological Diversity. The variety of life and its processes, including the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur (USFWS Manual 052 FW 1. 12B). The System's focus is on indigenous species, biotic communities and ecological processes. Also referred to as Biodiversity.

Biological Control. The use of organisms or viruses to control weeds or other pests.

Canopy. A layer of foliage; generally the upper-most layer, in a forest stand. Can be used to refer to mid- or understory vegetation in multi-layered stands. Canopy closure is an estimate of the amount of overhead tree cover (also canopy cover).

Categorical Exclusion (CE, CX, CATEX, CATX). A category of actions that do not individually or cumulatively have a significant effect on the human environment and have been found to have no such effect in procedures adopted by a Federal agency pursuant to the National Environmental Policy Act (40 CFR 1508.4).

CDOW SC. Colorado Division of Wildlife Species of Special Concern.

CFR Code of Federal Regulations.

Noxious Weed. Those noxious weeds not native to the state that are of limited distribution or are unrecorded in the state and that pose a serious threat to the state.

Noxious Weed. Those noxious weeds not native to the state that are of limited distribution or are unrecorded in a region of the state and that pose a serious threat to that region.

Designate. These are noxious weeds whose populations in a region or area are such that all seed production can be prevented within a calendar year.

Compatible Use. A wildlife-dependent recreational use or any other use of a Refuge that, in the sound professional judgment of the Director, will not materially interfere with or detract from the fulfilment of the Mission of the System or the purposes of the Refuge (Draft Service Manual 603 FW 3.6). A compatibility determination supports the selection of compatible uses and identified stipulations or limits necessary to ensure compatibility.

Comprehensive Conservation Plan (CCP). A document that describes the desired future conditions of the Refuge; and provides long-range guidance and management direction for the Refuge manager to accomplish the purposes of the Refuge, contribute to the mission of the System, and to meet other relevant mandates (Draft Service Manual 602 FW 1.5).

Concern. See definition of "Issue."

Cover Type. The present vegetation of an area.

Cultural Resources. The remains of sites, structures, or objects used by people in the past.

Cultural Resource Inventory. A professionally conducted study designed to locate and evaluate evidence of cultural resources present within a defined geographic area. Inventories may involve various levels, including background literature search, comprehensive field examination to identify all exposed physical manifestations of cultural resources, or sample inventory to project site distribution and density over a larger area. Evaluation of identified cultural resources to determine eligibility for the National Register follows the criteria found in .36 CFR 60.4 (Service Manual 614 FW 1.7).

Cultural Resource Overview. A comprehensive document prepared for a field office that discusses, among other things, its prehistory and cultural history, the nature and extent of known cultural resources, previous research, management objectives, resource management conflicts or issues, and a general statement on how program objectives should be met and conflicts resolved. An overview should reference or incorporate information from a field offices background or literature search described in Section VIII of the Cultural Resource Management Handbook (Service Manual 614 FW 1.7).

Depredation. Damage inflicted upon agricultural crops or ornamental plants by wildlife.

Demography. The quantitative analysis of population structure and trend.

Designated Wilderness Area. An area designated by the United States Congress to be managed as part of the National Wilderness Preservation System (Draft Service Manual 610 FW 1.5).

Disturbance. Significant alteration of habitat structure or composition. May be natural (e.g., fire) or human-caused events (e.g. timber harvest).

Dixie Harrow. A farming implement pulled behind a tractor that reduces sagebrush density by breaking off sagebrush plants. Typically one pass over sagebrush removes 60 to 70 percent of the live sagebrush plants.

Early Seral Stage. An area that is in the primary stages of ecological succession.

Ecological Succession. The orderly progression of an area through time from one vegetative community to another in the absence of disturbance. For example, an area may proceed from grass-forb through aspen forest to mixed-conifer forest.

Ecosystem. A dynamic and interrelating complex of plant and animal communities and their associated non-living environment.

Ecosystem Management. Management of natural resources using system wide concepts to ensure that all plants and animals in ecosystems are maintained at viable levels in native habitats and basic ecosystem processes are perpetuated indefinitely.

Endangered Species (Federal). A plant or animal species listed under the Endangered Species Act that is in danger of extinction throughout all or a significant portion of its range.

Endangered Species (State). A plant or animal species in danger of becoming extinct or extirpated in Colorado within the near future if factors contributing to its decline continue. Populations of these species are at critically low levels or their habitats have been degraded or depleted to a significant degree.

Endemic Species. Plants or animals that occur naturally in a certain region and whose distribution is relatively limited to a particular locality.

Environmental Assessment (EA). A concise public document, prepared in compliance with the National Environmental Policy Act, that briefly discusses the purpose and need for an action, alternatives to such action, and provides sufficient evidence and analysis of impacts to determine whether to prepare an environmental impact statement or finding of no significant impact (40 CFR 1508.9).

Environmental Impact Statement (EIS). A detailed written statement required by section 102(2)(C) of the National Environmental Policy Act, analyzing the environmental impacts of a proposed action, adverse effects of the project that cannot be avoided, alternative courses of action, short-term uses of the environment versus the maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitment of resources (40 CFR 1508.1 I).

Fauna. All the vertebrate and invertebrate animals of an area.

Federal Trust Resources. A trust is something managed by one entity for another who hold the ownership. The FWS hold in trust many natural resources for the people of the United States of America as a result of Federal Acts and treaties. Examples are species listed under the Endangered Species Act, migratory birds protected by international treaties, and native plant or wildlife species found on a National Wildlife Refuge.

Federal Trust Species. All species where the Federal government has primary jurisdiction including federally endangered or threatened species, migratory birds, anadromous fish, and certain marine mammals.

Finding of No Significant Impact (FONSI). A document prepared in compliance with the National Environmental Policy Act, supported by an environmental assessment, that briefly presents why a Federal action will have no significant effect on the human environment and for which an environmental impact statement, therefore, will not be prepared (40 CFR 1508.13).

Fire Regime. A description of the frequency, severity, and extent of fire that typically occurs in an area or vegetative type.

Flora. All the plant species of an area.

Floriferous. Flower bearing plant.

Forb. A broad-leaved, herbaceous plant; for example, a columbine.

Fragmentation. The process of reducing the size and connectivity of habitat patches.

Goal. Descriptive, open-ended, and often broad statement of desired future conditions that conveys a purpose but does not define measurable units (Draft Service Manual 620 FW 1.5).

Geographic Information System (GIS). A computer system capable of storing and manipulating spatial data.

Habitat. Suite of existing environmental condition required by an organism for survival and reproductions. The place where an organism typically lives.

Habitat Type. See Vegetation Type.

Habitat Restoration. Management emphasis designed to move ecosystems to desired conditions and processes, and/or to healthy forestlands, rangelands, and aquatic systems.

Historic Range of Variability (HRV). The natural fluctuation of components of healthy ecosystems over time. In this EIS, HRV refers to the range of conditions and processes that are Rely to have occurred prior to settlement of the project area by people of European descent (approximately the mid- I 800s), which would have varied within certain limits over time.

Historic range of variability is discussed in this document as a reference point to establish a baseline set of conditions for which sufficient scientific or historical information is available to enable comparison to current condition.

Indicator Species. A species of plant or animals that is assumed to be sensitive to habitat changes and represents the needs of a larger group of species. Also referred to as a key species.

Inholding. Privately owned land inside the boundary of a national Refuge.

Integrated Pest Management. Methods of managing undesirable species, such as weeds, including: education; prevention; physical or mechanical methods of control; biological control; responsible chemical use; and cultural methods.

Issue. Any unsettled matter that requires a management decision; e.g., a Service initiative, opportunity, resource management problem, a threat to the resources of the unit, conflict in uses, public concern, or the presence of an undesirable resource condition (Draft Service Manual 602 FW 1.5).

Inviolate. Not violated or profaned, pure.

Management Alternative. See Alternative.

Management Concern. See Issue.

Management Opportunity. See Issue.

Microhabitat. Habitat features at a fine scale; often identifies a unique set of local habitat features.

Migration. The seasonal movement from one area to another and back.

Mission Statement. Succinct statement of a unit's purpose and reason for being.

Mitigation. Measures designed to counteract environmental impacts or to make impacts less severe.

Monitoring. The process of collecting information to track changes of selected parameters over time.

National Environmental Policy Act of 1969 (NEPA). Requires all agencies, including the Service, to examine the environmental impacts of their actions, incorporate environmental information, and use public participation in the planning and implementation of all actions. Federal agencies must integrate NEPA with other planning requirements, and prepare appropriate NEPA documents to facilitate better environmental decision making (from 40 CFR 1500).

National Wildlife Refuge (NWR). A designated area of land, water, or an interest in land or water within the System.

National Wildlife Refuge System. Various categories of areas administered by the Secretary of the Interior for the conservation of fish and wildlife, including species threatened with extinction, all lands, waters, and interests therein administered by the Secretary as wildlife Refuges, areas for the protections and conservation of fish and wildlife that are threatened with extinction, wildlife ranges, games ranges, wildlife management areas, or waterfowl production areas.

National Wildlife Refuge System Mission. The mission is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

Native Species. Species that normally live and thrive in a particular ecosystem.

Neotropical Migratory Bird. A bird species that breeds north of the U.S.-- Mexican border and winters primarily south of this border.

Notice of Intent (NOI). In the case of a Federal action, such as analyzed in this documentation, an NOI is a notice that an environmental impact statement will be prepared and considered (40 CFR 1508.22). Published in the Federal Re&ter.

Noxious Weed. A plant species designated by Federal or state law as generally possessing one or more of the following characteristics: aggressive or difficult to manage; parasitic; a carrier or host of serious insect or disease; or non-native, new, or not common to the United States, according to the Federal Noxious Weed Act (PL 93-639), a noxious weed is one that causes disease or had adverse effects on man or his environment and therefore is detrimental to the agriculture and commerce of the Untied States and to the public health.

Objective. An objective is a concise target statement of what will be achieved, how much will be achieved, when and where it will be achieved, and who is responsible for the work. Objectives are derived from goals and provide the basis for determining management strategies. Objectives should be attainable and time-specific and should be stated quantitatively to the extent possible. If objectives cannot be stated quantitatively, they may be stated qualitatively (Draft Service Manual 602 FW 1.5).

Physiognomy. External aspect.

Planning Area. A planning area may include lands outside existing planning unit boundaries that are being studied for inclusion in the System and/or partnership planning efforts. It may also include watersheds or ecosystems that affect the planning area.

Planning Team. A planning team prepared the Comprehensive Conservation Plan. Planning teams are interdisciplinary in membership and function. Teams generally consist of a planning ream leader; Refuge manager and staff, biologists; staff specialists or other representatives of Service programs, ecosystems or regional offices; and other governmental agencies as appropriate.

Planning Unit. A single Refuge, an ecologically / administratively related complex of Refuges, or distinct unit of a Refuge.

Plant Association. A classification of plant communities based on the similarity in dominants of all layers of vascular species in a dimax community.

Plant Community. An assemblage of plant species unique in its composition; occurs in particular locations under particular influences; a reflection or integration of the environmental influences on the site -- such as soils, temperature, elevation, solar radiation, slope, aspect, and rainfall; denotes a general kind of climax plant community, i.e.,, ponderosa pine or bunchgrass.

Preferred Alternative. This is the alternative determined (by the decision maker] to best achieve the Refuge purpose, vision, and goals; contributes to the Refuge System mission, addresses the significant issues; and is consistent with principles of sound fish and wildlife management.

Prescribed Fire. The skillful application of fire to natural fuels under conditions of weather, fuel moisture, soil moisture, etc., that allow confinement of the fire to a predetermined area and produces the intensity of heat and rate of spread to accomplish planned benefits to one or more objectives of forest management, wildlife management, or hazard reduction.

Public. Individuals, organizations, and groups; officials of Federal, State, and local government agencies; Indian tribes; and foreign nations. It may include anyone outside the core planning team. It includes those who may or may not have indicated an interest in Service issues and those who do or do not realize that Service decisions may affect them.

Public Involvement. A process that offers affected and interested individuals and organizations an opportunity to become informed about, and to express their opinions on Service actions and policies. In the process, these views are studied thoroughly and thoughtful consideration of public views is given in shaping decisions for Refuge management.

Public Involvement Plan. Broad long-term guidance for involving the public in the comprehensive planning process.

Purpose(s) of the Refuge. The purpose of a Refuge is specified in or derived from the law, proclamation, executive order, agreement, public land order, donation document, or administrative memorandum establishing, authorization, or expanding a Refuge, Refuge unit, or Refuge subunit.

Refuge Operating Needs System (RONS). The Refuge Operating Needs System is a national database which contains the unfunded operational needs of each Refuge. Projects included are those required to implement approved plans, and meet goals, objectives, and legal mandates.

Refuge Use. Any activity on a Refuge, except administrative or law enforcement activity carried out by or under the direction of an authorized Service employee.

Record of Decision (ROD). A concise public record of decision prepared by the Federal agency, pursuant to NEPA, that contains a statement of the decision, identification of all alternatives considered, identification of the environmentally preferable alternative, a statement as to whether all practical means to avoid or minimize environmental harm from the alternative selected have been adopted (and if not, why they were not), and a summary of monitoring and enforcement where applicable for any mitigation (40 CFR 1505.2).

Refuge Goal. See Goal.

Refuge Purposes. The purposes specified in or derived from the law, proclamation, executive order, agreement, public land order, donation document, or administrative memorandum establishing, authorizing, or expanding a Refuge, a Refuge unit, or Refuge subunit (Draft Service Manual 602 FW 1.5).

Refuge Revenue Sharing. A 1978 Act (Public Law 95-469) which authorizes payments to counties in which Service-owned land is located. The amount of the payment is computed based on things such as the appraised value of Service fee land, number of acres of fee land, and net receipts collected by the Service for certain activities permitted on reserve lands (lands withdrawn from the public domain).

Rest, Refers to lands that are free from biological, mechanical or chemical manipulation.

Riparian. Refers to an area or habitat that is transitional from terrestrial to aquatic ecosystems; including streams, lakes wet areas, and adjacent plant communities and their associated soils which have free water at or near the surface; an area whose components are directly or indirectly attributed to the influence of water; of or relating to a river; specifically applied to ecology, “riparian” describes the land immediately adjoining and directly influenced by streams. For example, riparian vegetation includes any and all plant-life growing on the land adjoining a stream and directly influenced by the stream.

Seral Stage. Any plant community whose plant composition is changing in a predictable way; characterized by a group of species or plant community that will eventually be replaced by a different group of species or plant community, for example, an aspen community changing to a coniferous forest community.

Special Status Species. Plants or animals which have been identified through either Federal law, state law, or agency policy, as requiring special protection of monitoring. Examples include federally listed endangered, threatened, proposed, or candidate species; state liste endangered, threatened, candidate, or monitor species; U.S. Fish and Wildlife Service species of management concern and species identified by the Partners in flight program as being of extreme or moderately high conservation concern.

Species of Concern. Those plant and animal species, while not falling under the definition of special status species, that are of management interest by virtue of being Federal trust species such as migratory birds, important game species including white-tailed deer, furbearers such as American marten, important prey species including red-backed vole, or significant keystone species such as beaver.

Step-down Management Plans. Step-down management plans provide the details necessary to implement management strategies identified in the comprehensive conservation plan (Draft Service Manual 602 FW 1.5).

Sound Professional Judgement. A finding, determination, or decision that is consistent with principles of sound fish and wildlife management and administration, available science and resources, and adherence to the requirements of the Refuge Administration Act and other applicable laws.

Strategy. A specific action, tool, or technique or combination of actions, tools, and techniques used to meet unit objectives (Draft Service Manual 602 FW 1.5).

Thalweg. A line following the lowest part of a valley whether under water or not; the line of continuous maximum descent from any point on a land surface or one crossing all contour lines at right angles; subsurface water percolating beneath and in the same direction as a surface stream course.

Threatened Species (Federal). Species listed under the Endangered Species Act that are likely to become endangered within the foreseeable future throughout all or a significant portion of their range.

Threatened Species (State). A plant or animal species likely to become endangered in Colorado within the near future if factors contributing to population decline or habitat degradation or loss continue.

Tiering. The coverage of general matters in broader environmental impact statements with subsequent narrower statements of environmental analysis, incorporating by reference, the general discussions and concentrating on specific issues (40 CFR 1508.28).

Trust Species. Species for which the U.S. Fish and Wildlife Service has primary responsibility, including, most federally list threatened and endangered species, anadromous fish once they enter inland U.S. waterways, and migratory birds. Also see "Federal Trust Species".

Understory. Any vegetation whose canopy (foliage) is below, or closer to the ground than canopies of other plants.

Unit Objective. See Objective.

U.S. Fish and Wildlife Service Mission. The mission of the U.S. Fish and Wildlife Service is working with others to conserve, protect, and enhance fish and wildlife and their habitats for th continuing benefit of the American people.

Vegetation Type, Habitat Type, Forest Cover Type. A land classification system based upon the concept of distinct plant associations.

Vision Statement. A concise statement of the desired future condition of the planning unit, based primarily upon the System mission, specific Refuge purposes, and other relevant mandates (Draft Service Manual 602 FW 1.5).

Watershed. The region draining into a river, river system, or body of water.

Wilderness Study Areas. Lands and waters identified through inventory as meeting the definition of wilderness and undergoing evaluation for recommendation for inclusion in the Wilderness System. A study area must beet the following criteria: (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least 5,000 contiguous roadless acres or is sufficient in size as to make practicable its preservation and use in an unimpaired condition (Draft Service Manual 61 0 FW 1.5).

Wilderness. See Designated Wilderness Area.

Wildfire. A free-burning fire requiring a suppression response; all fire other than prescribed fire that occurs on wildlands (Service Manual 621 FW 1.7).

Wildland Fire. Every wildland fire is either a wildfire or a prescribed fire (Service Manual 621 FW 1.3).

Wildlife Corridor. A landscape feature that facilitates the biologically effective transport of animals between larger patches of habitat dedicated to conservation functions. Such corridors may facilitate several kinds of traffic, including frequent foraging movement, seasonal migration, or the once in a lifetime dispersal of juvenile animals., These are transition habitats and need not contain all the habitat elements required for long-term survival or reproduction of its migrants.

Wildlife-dependent Recreation. A use of a Refuge involving hunting, fishing, wildlife observation and photography, or environmental education and interpretation. The National Wildlife Refuge System Improvement Act of 1997 specifies that these are the six priority general public uses of the System.

Appendix C. Key Legislation/Policies

Antiquities Act (1906): Authorizes the scientific investigation of antiquities on Federal land and provides penalties for unauthorized removal of objects taken or collected without a permit.

Migratory Bird Treaty Act (1918): Designates the protection of migratory birds as a Federal responsibility. This Act enables the setting of seasons, and other regulations including the closing of areas, Federal or non-Federal, to the hunting of migratory birds.

Migratory Bird Conservation Act (1929): Establishes procedures for acquisition by purchase, rental, or gift of areas approved by the Migratory Bird Conservation Commission.

Migratory Bird Hunting and Conservation Stamp Act (1934): Authorized the opening of part of a Refuge to waterfowl hunting.

Fish and Wildlife Act (1956): Established a comprehensive national fish and wildlife policy and broadened the authority for acquisition and development of Refuges.

Fish and Wildlife Coordination Act (1958): Allows the Fish and Wildlife Service to enter into agreements with private landowners for wildlife management purposes.

Refuge Recreation Act (1962): Allows the use of Refuges for recreation when such uses are compatible with the Refuge's primary purposes and when sufficient funds are available to manage the uses.

National Wildlife Refuge System Administration Act of 1966 as amended by the National Wildlife Refuge System Improvement Act of 1997, 16 U.S.C. 668dd-668ee. (Refuge Administration Act): Defines the National Wildlife Refuge System and authorizes the Secretary to permit any use of a Refuge provided such use is compatible with the major purposes for which the Refuge was established. The Refuge Improvement Act clearly defines a unifying mission for the Refuge System; establishes the legitimacy and appropriateness of the six priority public uses (hunting, fishing, wildlife observation and photography, or environmental education and interpretation); establishes a formal process for determining compatibility; established the responsibilities of the Secretary of Interior for managing and protecting the System; and requires a Comprehensive Conservation Plan for each Refuge by the year 2012. This Act amended portions of the Refuge Recreation Act and National Wildlife Refuge System Administration Act of 1966.

National Historic Preservation Act (1966) as amended: Establishes as policy that the Federal Government is to provide leadership in the preservation of the nation's prehistoric and historic resources.

Architectural Barriers Act (1968): Requires federally owned, leased, or funded buildings and facilities to be accessible to persons with disabilities.

National Environmental Policy Act (1969): Requires the disclosure of the environmental impacts of any major Federal action significantly affecting the quality of the human environment.

Endangered Species Act (1973): Requires all Federal agencies to carry out programs for the conservation of endangered and threatened species.

Rehabilitation Act (1973): Requires programmatic accessibility in addition to physical accessibility for all facilities and programs funded by the Federal government to ensure that anybody can participate in any program.

Archaeological and Historic Preservation Act (1974): Directs the preservation of historic and archaeological data in Federal construction projects.

Clean Water Act (1977): Requires consultation with the Corps of Engineers (404 permits) for major wetland modifications.

Executive Order 11988 (1977): Each Federal agency shall provide leadership and take action to reduce the risk of flood loss and minimize the impact of floods on human safety, and preserve the natural and beneficial values served by the floodplains.

American Indian Religious Freedom Act (1978): Directs agencies to consult with native traditional religious leaders to determine appropriate policy changes necessary to protect and preserve Native American religious cultural rights and practices.

Archaeological Resources Protection Act (1979) as amended: Protects materials of archaeological interest from unauthorized removal or destruction and requires Federal managers to develop plans and schedules to locate archaeological resources.

Emergency Wetlands Resources Act (1986): The purpose of the Act is "To promote the conservation of migratory waterfowl and to offset or prevent the serious loss of wetlands by the acquisition of wetlands and other essential habitat, and for other purposes."

Federal Noxious Weed Act (1990): Requires the use of integrated management systems to control or contain undesirable plant species; and an interdisciplinary approach with the cooperation of other Federal and State agencies.

Native American Graves Protection and Repatriation Act (1990): Requires Federal agencies and museums to inventory, determine ownership of, and repatriate cultural items under their control or possession.

Americans With Disabilities Act (1992): Prohibits discrimination in public accommodations and services.

Executive Order 12996 Management and General Public Use of the National Wildlife Refuge System (1996): Defines the mission, purpose, and priority public uses of the National Wildlife Refuge System. It also presents four principles to guide management of the System.

Executive Order 13007 Indian Sacred Sites (1996): Directs Federal land management agencies to accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners, avoid adversely affecting the physical integrity of such sacred sites, and where appropriate, maintain the confidentiality of sacred sites.

Volunteer and Partnership Enhancement Act of 1998: To amend the Fish and Wildlife Act of 1956 to promote volunteer programs and community partnerships for the benefit of national wildlife refuges, and for other purposes. October 5, 1998

Executive Order 13287 Preserve America (2003): It is the policy of the Federal Government to provide leadership in preserving America's heritage by actively advancing the protection, enhancement, and contemporary use of the historic properties owned by the Federal Government, and by promoting intergovernmental cooperation and partnerships for the preservation and use of historic properties (March 3, 2003).

Appendix D. RONS Projects

RONS #	Goal or Objective (See MMS table for key to abbrev)	Project Description	Construction Funding	First Year Need ($1,000)	Recurring Annual Need ($1,000)	FTE*
03001	PUF1, P1, R1, R2, RI1-7	Conduct a Riparian study		195	10	
97011	PUH1, PUH3, OU1, P1, P2	Implement the CCP and associated step-down plans		128	70	1.0
00002	U1-3, W1-4, RI1-5, M1-4	Improve irrigation and fence maintenance		100	50	0.5
98002	P1-2, R1-2, U4	Conduct a life history study of the endangered North Park Phacelia		38		
97017	PUF1, PUH1, P1, P2, R1-2, W1-4, RI1-7, M1-6	Platte River Water Conservation, and improving Refuge water use efficiency		98		
98001	PUF2, PUH2, P1, P2, R1-2,U1-4, W1-5, RI1-7, M1-6	Improve Refuge and ecosystem management capabilities		128	70	1.0
03002	P1, R1, U1-4, W1-4, RI1-5, M1-3	Improve Refuge GIS use and capabilities		128	70	1.0
97002	PUE2, PUF2, PUH2, PUO2, OU2,P2,U4,W5, RI6-7,M5-6	Interagency coordination		22	22	
03003	U1-4, W1-5, RI1-7, M1-6	Improve administrative functions with increased staff and responsibilities as identified in the CCP		70	40	1.0
03004	PUE1-3, PUO1, OU1	Construct a multi-use trail from Walden to the Brocker overlook		150		
03005	C1-2, PUE1-3, PUO1	Install a trail and interpretation from the Brocker overlook to the old Brocker homestead		25		
03006	PUF1, PUH1, P1, P2, R1-2, RI1-5	Survey the Illinois River and develop a channel restoration plan		150		
03007	PUH1, PUH3, OU1	Create 5 parking areas for hunters		60		
03008	PUO1	Construct a moose and/or elk viewing platform		30		
97006	U1-4, W1-5, RI1-5, M1-4	Maintain Refuge riparian areas, wetlands and associated habitat		110	60	1.0
03009	U1-4, W1-5, RI1-5, M1-4	Install a 6 stall garage at the office		125		
03010	U1-4, W1-5, RI1-5, M1-4	Construct a pole barn for Refuge equipment storage		100		
98003	PUE1-3, PUF1-2, PUO1, PUH1, OU1-2, R1-2	Improve Refuge environmental education and interpretation programs		128	70	1.0
01003	W1-5, RI1-7, M1-6	Provide annual funding for Platte River Depletion payments		14	14	
97005	U1-3	Develop wells on Hampton property		81		
97009	PUH1, P1-2, R1-2, U1-2, W1-5, RI1-5, M1-6	Prescribed fire for wildlife habitat management		28		
		TOTAL		1,908	476	6.5

Appendix E. MMS Projects

MMS #	Goal or Objective (see below for key)	Description	Cost
00003	W1-5, RI1, RI6, M1-3	Replace wornout hydraulic excavator	$177,000
95011	PUE1-3, PUO1, OU1	Regravel auto tour route	$798,000
93004	W1-4	Replace deteriorated water control structures	$62,000
01021	P1-2	Replace 1986 Ford 4X4 pickup	$25,000
99002	U1-3	Replace deteriorated boundary fence	$79,000
98017	PUE1-3, PUO1	Replace visitor center interpretive displays	$99,000
95007	W1-4, RI1-5, M1-4	Replace deteriorated river headgates	$84,000
95010	PUE1-3, PUO1	Replace public use and education signs	$40,000
02006	PUE1, PUF1, PUH1, PUO1	Rehabilitate Allard backroad and Fishermans parking lot road.	$1,419,000
00012	PUE1, PUF1, PUO1	Replace outhouse and parking area at Fishermans parking lot	$87,000
96002	U1-3, W1-4, M1-4	Replace interior fence on Case tract	$45,000
01002	U1-3, W1-4, RI1-5, M1-4	Replace 1997 Polaris 6X6 All Terrain Vehicle	$12,000
01016	U1-3, W1-4, RI1-5, M1-4	Replace 1993 Chevy 4X4 pickup	$35,000
90010	U1-3, W1-4, RI1-5, M1-4	Replace 1980 Case tracked crawler/bulldozer	$241,000
01006	U1-3, W1-4, RI1-5, M1-4	Replace 1984 International Dump Truck	$101,000
03001	PUE1-3, PUF1, PUH1, PUO1, OU1	Rehabilitate Allard Kiosk and overlook	$50,000
00007	U1-4, W1-5, RI1-5, M1-4	Replace quarters #4, and two outbuildings with a bunkhouse.	$250,000
00004	C1-2, PUE1-3	Rehabilitate the historic barn on the Case tract	$266,000
		Total	$3,870,000

RI = Riparian Habitat
W = Wetland Habitat
M = Meadow Habitat
U = Upland Habitat
PUH = Public Use Hunting
PUF = Public Use Fishing
PUO = Public Use Wildlife Observation/Photography
PUE = Environmental Education/Interpretation
OU = Other Public Uses
C = Cultural Resources
R = Research
P = Partnerships

Appendix F. Compatibility Determinations

Refuge Name: Arapaho National Wildlife Refuge. Established September 26, 1967.

Establishing and Acquisition Authority(ies): Migratory Bird Conservation Act and Fish and Wildlife Act of 1956.

Refuge Purpose(s): For use as an inviolate sanctuary, or for any other management purpose, for migratory birds. For the development, advancement, management, conservation, and protection of fish and wildlife resources for the benefit of the United States Fish and Wildlife Service in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude.

National Wildlife Refuge System Mission: The Mission of the National Wildlife Refuge System is "to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."

This goose, designed by J.N. "Ding" Darling, has become the symbol of the National Wildlife Refuge System

Description of Proposed Use: Recreational Hunting

Arapaho NWR is open to hunting of mourning dove, snipe, rail, American coot, waterfowl, sage grouse, cottontail and jackrabbit, and pronghorn antelope. Hunting seasons are in accordance with State seasons and regulations established for this area. Visitation for these activities is estimated at 500 hunter use days. Species are hunted according to Federal and State laws.

Arapaho NWR is divided into three management units: A, B, and C. Unit A consists of 4,536 acres and is closed to all hunting. This area contains the auto tour route and also a large wetland complex which provides resting areas for migratory birds. Unit B is 8,260 acres and is open for small game, migratory birds, and pronghorn antelope. The remaining 9,415 acres, Unit C is closed to migratory bird hunting but open to small game and pronghorn antelope hunting.

Hunting pressure of all species is approximately 450 to 550 hunter visits annually. During waterfowl, big game, and small game seasons most pressure is concentrated around the opening weekend, with hunter use dropping significantly during the rest of the seasons.

The CCP proposes to continue with the above uses and add or change the following to improve the hunting experience and better protect Refuge resources:

- Develop a hunting step-down management plan which will address existing species as well as elk and furbearer hunting opportunities depending on Refuge habitat objectives and/or population objectives North Park wide.
- Develop 5 parking areas and 3 permanent gates to minimize resource damage.
- Update hunting signs to reflect changes in new hunting step-down management plan.
- Include hunting opportunities on Pole Mountain in Title 50 Code of Federal Regulations.
- Add limited elk hunting to the list of big game hunting opportunities and submit a modification to Title 50 Code of Federal Regulations.

Availability of resources:
Currently, sufficient resources are available to continue the existing recreational hunting. Implementing the new improvements for hunting will be addressed by funding requests in the form of MMS and RONS projects (Appendices D and E).

Anticipated impacts of the use:
No detrimental impact is anticipated with the hunting program. Recreational hunting will remove individual animals from the wildlife populations which may help ensure that carrying capacity (especially for big game species) is not exceeded (possibly impacting Refuge habitat objectives). Closed areas will provide some sanctuary for target and non-target species and minimize conflicts between hunters and other visitors. Travel on non-designated roads may be a problem but development of parking areas and gates should minimize this impact.

Determination:
Recreational hunting is compatible.

Stipulations necessary to ensure compatibility:

- ✓ Only non-toxic shot is permitted on the Refuge when hunting with a shotgun. This restriction minimizes the exposure of waterfowl and other wildlife to lead.
- ✓ Hunting must be in accordance with Federal and State regulations.
- ✓ All hunting will be coordinated with the Colorado Division of Wildlife to meet Refuge and State goals and objectives.
- ✓ Sound hunting practices will be promoted for safety of visitor/hunter and minimal wildlife disturbance.
- ✓ Vehicle travel is limited to established roads and parking areas.
- ✓ Hunting programs will be conducted to provide a quality hunting experience as defined in the Refuge Manual.

Justification:
Hunting is a legitimate wildlife management tool that can be used to manage populations. Small game hunting is biologically sound on the basis of limited hunter interest and because populations of small game species fluctuate moderately regardless of whether they are hunted or protected. Migratory bird hunting uses a small portion of the available resource on the Refuge. Hunting on the Refuge harvests a small percentage of the renewable resources which is in accordance with wildlife management objectives and principles.

Based upon biological impacts anticipated above and in the Environmental Assessment, it is determined that recreational hunting at Arapaho NWR will not materially interfere with or detract from the purposes for which this Refuge was established or the habitat goals and objectives.

One of the secondary goals of the National Wildlife Refuge System is to provide opportunities for public hunting when it is found to be compatible and it is identified as a priority public use in the National Wildlife Refuge System Improvement Act of 1997.

Description of Proposed Use: Wildlife Observation/Photography and Environmental Education and Interpretation

The Refuge strives to provide opportunities that support wildlife-dependent recreation, education, and outreach to the public. Approximately 8,000 visitors come to Arapaho NWR annually for wildlife observation, photography, and interpretation/education. The majority of the use is focused on the auto tour route, interpretive nature trail, and visitor contact stations. The auto tour route is a 6-mile self-guided wildlife tour, while the interpretive nature trail is half-mile walk. The are 3 information kiosks, 2 scenic overlooks, and a visitor center.

Interpretation and environmental education opportunities are provided on demand and include talks, tours, and environmental games for school groups, scouts, and special interest groups.

The Comprehensive Conservation Plan proposes to continue with the above uses and add the following to improve wildlife viewing, interpretation, and access for visitors:

- Develop new interpretive displays for visitor center that reflect Refuge habitat and water management.
- Rebuild the Brocker Overlook including new interpretive signs depicting the history of North Park and the Refuge.
- Construct a moose observation platform.
- Develop new Refuge brochures and signs and update old brochures to reflect current management.
- Work with partners to develop specific environmental education programs concerning habitat management, natural history of North Park, and water issues.
- Rehabilitate the Case Barn and provide interpretation of the site.
- Develop new interpretive material involving land management in North Park.
- Continue participation in natural resource events like 'Day in the Woods' and 'Water Carnival.'
- Complete Interpretive Nature Trail boardwalk.

Availability of resources:
Currently, resources are stretched to continue the existing wildlife-dependent recreation. An outdoor recreation planner is required to meet the Refuge's current demands. The additional items to be added from the Comprehensive Conservation Plan are tied to funding requests in the form of RONS and MMS projects (Appendices D and E).

Anticipated impacts of the use:
Some disturbance of wildlife will occur in areas of the Refuge frequented by visitors. The main areas used are the auto tour route, visitor contact points, and interpretive nature trail. Primary species disturbed by vehicles and hikers are waterfowl, moose, raptors, prairie dogs, and shorebirds.

Construction of a moose observation platform, rebuilding the Brocker Overlook, and development of the Case Barn interpretive site will result in the loss of a small portion of wildlife habitat. It is anticipated that all uses will increase, particularly with new interpretation sites.

With an increase in use, the potential for problems with trash will increase; a slight increase in wildlife disturbance may occur.

Determination:
Wildlife Observation/Photography and Environmental Education and Interpretation are compatible.

Stipulations necessary to ensure compatibility:

- ✓ Vehicles will be restricted to designated Refuge roads.
- ✓ Enforce Refuge regulations.
- ✓ Improve signing and update Refuge information brochures.
- ✓ Monitor use, regulate access, and maintain necessary facilities to prevent habitat degradation.
- ✓ Develop a wildlife observation/photography and environmental education/interpretation step-down plan.

Justification:
Based upon anticipated biological impacts above and in the Environmental Assessment, it is determined that wildlife observation/photography and environmental education / interpretation on Arapaho NWR will not interfere with the Refuge habitat goals and objectives or purposes for which it was established. Limited access and monitoring use can help limit any adverse impacts.

One of the secondary goals of the National Wildlife Refuge System is to provide opportunities for the public to develop an understanding and appreciation for wildlife when it is found compatible. The above uses are identified as priority public uses in the National Wildlife Refuge System Improvement Act of 1997 and will help meet the above secondary goal with only minimal conflicts.

Description of Proposed Use: Recreational Fishing

Arapaho NWR is open to recreational fishing in the Illinois River from August 1 to May 31 each year. Fishing is in accordance with State regulations. Game fish include brown trout and limited numbers of rainbow trout. Visitors participating in this use on the Refuge are estimated at 50 to 100 anglers annually. Two parking and access fishing sites are developed and are available on the Refuge with a variety of non-developed access sites also available.

The Comprehensive Conservation Plan proposes to continue with the above uses and add the following to improve fishing opportunities and access for visitors:

- Work with the Colorado Division of Wildlife to create a fishery step-down management plan.
- Improve fishery habitats on private lands through the Services' Partners for Fish and Wildlife Program.
- Assist the Colorado Division of Wildlife with fishery law enforcement, management, and projects in North Park as requested.
- Monitor river gauges on the upstream and downstream ends of the Refuge to evaluate flows and effects on the Illinois River fishery resources.
- Evaluate angler impacts on Refuge goals and objectives.

Availability of resources: Currently, sufficient resources are available for existing recreational fishing. With the addition of projects from the Comprehensive Conservation Plan, additional resources will be needed. These are addressed as funding requests in the RONS and MMS projects (Appendices D and E).

Anticipated impacts of the use:
Fishing can cause disturbance to wildlife and the habitat but at the current levels of use on the Refuge, disturbance impacts will be minimal. The presence of anglers along the River may deny waterfowl and other water birds use of that portion of the River. However, the majority of the fishing pressure on the Illinois River occurs on the southern half of the Refuge, which makes up approximately 10 percent of the riparian and wetland habitats and is closed during two months of the summer. The poisoning of migratory birds due to ingestion of lead sinkers may also occur, but less than 10 percent of the anglers utilize bait in a given year according to creel census information.

Determination:
Recreational fishing is compatible.

Stipulations necessary to ensure compatibility:

- ✓ The Refuge will be closed to fishing from June 1 through July 31 each year.
- ✓ Fishing must be in accordance with State regulations.
- ✓ Parking and access areas will be maintained to prevent habitat damage.
- ✓ Only the Illinois River will be open to fishing.
- ✓ Monitor existing use to ensure that facilities are adequate and disturbance to wildlife continues to be minimal.
- ✓ Improve and/or replace existing signage.

Justification:
Based on the biological impacts addressed above and in the Environmental Assessment, it is determined that recreational fishing will not materially interfere with the Refuge habitat goals and objectives or purposes for establishment. The fishing closure minimizes disturbance during sensitive nesting seasons for migratory birds.

Description of Proposed Use: Use of Grazing as a Management Tool

The Refuge currently uses livestock grazing as the most common management tool to manipulate the riparian, meadow, and upland habitats. Grazing by livestock has been the preferred management tool because the effect on the habitat is controllable and predictable. Livestock grazing is used in a variety of ways including: high intensity short duration, rest rotation, light annual, and complete rest. In general, the meadows and riparian habitats are not grazed until August 1 to minimize disturbance to nesting birds. The upland habitats are grazed earlier but most grazing does not start before June 1 on the Refuge. Grazing rates range from .52 to .71 AUMs per acre with an average of 8,470 AUMs used annually. Actual rates per field vary significantly depending on the site, with some upland areas being as low as 0.01 AUMs per acre and some meadow fields as high as 2.18 AUMs per acre. The Refuge is divided into over 100 fields by barbed wire and electric fences. Maintenance of the fences is a constant effort with weather, water, animals, and human impacts.

The CCP proposes to continue with the proposed use and add/or change the following to improve habitat management:

- Grazing rates will average .4 to 1.0 AUMs per acre for the riparian and meadow habitats and .05 to .15 AUMs per acre for the upland habitat to meet new Refuge objectives.
- Initiate a vegetation and wildlife monitoring program to assess habitat response to the grazing management program.
- Complete an upland habitat inventory by 2008 to gain a better understanding of the existing habitat for future grazing management.

Availability of resources:
Current resources are stressed in an effort to monitor habitats to understand if objectives are being met. Another wildlife biologist is needed to meet current and future Refuge demands. The additional items to be added from the Comprehensive Conservation Plan are tied to funding requests in the form of RONS and MMS projects (Appendices D and E).

Anticipated impacts of the use:
This use is intended to maintain and enhance the habitat for the benefit of migratory birds and other wildlife. Minimal negative impacts are expected through the use of this tool. Some trampling of areas may occur around watering holes or mineral licks. Overgrazing may occur if problems exist with fences, which would negatively impact the habitat. Grazing will be in a mosaic pattern with some plants grazed harder than others. The presence of livestock may be disturbing to some wildlife species and some of our public users. The benefits of this use as a habitat manipulation tool is felt to outweigh these minimal negative impacts. The endangered North Park Phacelia plant does occur in grazed areas of the Case tract. However, plant monitoring data from the past 6 years indicates a stable or slightly expanding population of plants. Therefore, the Refuge proposes to continue grazing these areas until more information is available on North Park Phacelia life history.

Determination:
Using grazing as a habitat management tool is compatible.

Stipulations necessary to ensure compatibility:

- ✓ Monitor the vegetation and wildlife to assess the effects of grazing.
- ✓ Fences will be monitored and maintained.
- ✓ Annually evaluate AUMs per acre used in relation to habitat conditions.
- ✓ Permittees will be issued a special use permit each year with AUMs to be used specified and all other regulations listed.
- ✓ Continue to monitor North Park Phacelia plant populations to ensure grazing program is not negatively impacting plant survival.

Justification:
In order to maintain and enhance the habitat for migratory birds and other wildlife, some habitat manipulation needs to occur. Grazing by livestock is one option that can be used to achieve these desired habitat changes. Because grazing by livestock is controllable and predictable, it is a useful management tool.

Description of Proposed Use: Plowing of Snow Fences by the Colorado State Highway Department

The Colorado State Highway Department plows snow on the Refuge along Highway 125 to make "snow" fences. The snow fences are constructed by a dozer or front-end loader just on the inside of the Refuge boundary fence along Highway 125. The heavy equipment creates two to four parallel strips, of varying heights of snow, approximately 20 feet apart. Snow fences minimize snow drifting across Highway 125 and increase safety for highway travelers.

Availability of resources:
Currently, this use does not utilize any Refuge resources.

Anticipated impacts of the use:
Plowing of snow along the Refuge boundary to create snow fences has very little impact on the Refuge habitat. These areas are primarily upland habitat. In general, the equipment blade is not lowered to dig into the soil but just skim the surface. Some brush plants may be eliminated in the process but most grasses and forbs are not effected. This leaves strips of land without brush species. The snow fences do provide more water to these areas, with the melting of the built up snow in the spring, possibly promoting the growth of grasses and forbs.

Determination:
Plowing snow to create snow fences along Highway 125 is a compatible use.

Stipulations necessary to ensure compatibility:
- ✓ Any fence damage done will be repaired by the State Highway Department.
- ✓ Soil disturbance is kept to a minimum.

Justification:
Plowing snow fences is necessary to help prevent snow from drifting on Highway 125, helping the highway department maintain this road in the winter for the safety of the general public.

Description of Proposed Use: Providing a Water Line From a Refuge Spring to a BLM Grazing Allotment

In 1991, the Refuge issued a special use permit to a private landowner to construct and maintain a water line across the Refuge. This water line runs from a spring outlet on the Refuge fish hatchery tract to a BLM grazing allotment. The permit allows for the use of the spring water to fill a water trough for livestock on the BLM allotment for approximately 30 days during the grazing season. It also allows access to maintain the water line on the Refuge. This use has continued to date with the special use permit being renewed every 2 years.

This use corresponds with the goals of the CCP of working with partners to promote sound habitat management.

Availability of resources:
Currently, the spring that feeds this water line flows enough water to fulfill livestock watering and Refuge needs.

Anticipated impacts of the use:
Impacts of the water line are minimal; if the line were to break, some erosion could occur along the line in the upland habitat if the leak was not observed right away. Potentially, in an extremely dry year, the spring could dry up if the use continued.

Determination:
Use of the water line to take water from the fish hatchery spring is compatible.

Stipulations necessary to ensure compatibility:
- ✓ A new special use permit will be issued every 2 years.
- ✓ The private landowner is responsible for upkeep of the water line.
- ✓ In extremely dry years, the spring will be evaluated for flow production.

Justification:
The Refuge is working with the BLM to promote land health improvements. The grazing allotment this water line feeds is large with little water. The position of the water trough helps to promote the movement of the livestock over the whole allotment and to help eliminate over-grazing of certain areas.

Description of Proposed Use: Providing a Right-of-Way for a Water Pipeline and Dissipater

In 1986, the Refuge issued a right-of-way permit to Walden Reservoir Company to construct a pipeline to divert water from a Michigan River irrigation ditch through the Refuge to the Illinois River. The underground pipeline and dissipater were installed in the spring of 1990. Water flows from the Michigan River irrigation ditch down off the hill through the pipeline to the dissipater at the base of the hill. This water then flows through a Refuge irrigation ditch and pond to the Illinois River, giving the Refuge temporary use of the water. Just north of the Refuge, the water is picked up out of the Illinois River in a ditch that feeds Walden Reservoir. The Walden Reservoir Company has used this right-of-way intermittently over the years. This use is not specifically addressed in the CCP but does promote a partnership which is beneficial to wildlife and the habitat.

Availability of resources:
Currently, sufficient resources are available to continue this use.

Anticipated impacts of the use:
Water flows from the Michigan River irrigation ditch have the potential to be substantial and may impact the smaller Refuge ditch, causing blow-outs or erosion of the ditch bank.

Determination:
Use of the right-of-way pipeline and dissipater is compatible.

Stipulations necessary to ensure compatibility:
- ✓ Refuge continues to have temporary use of the water.

Justification:
In permitting this right-of-way, the Refuge benefits from the temporary use of the water flowing across the area. This water can supplement the existing Refuge irrigation water in the spring, if flowing. The water also helps keep Home Pond water fresh with the constant flow, especially when the flows are in the fall, a time the Refuge usually does not have water in its irrigation ditches. A more regional benefit is that of supplementing Walden Reservoir water. This large reservoir is an irrigation storage reservoir but it provides habitat (nesting, brood-rearing, foraging, and molting) for a large number of waterfowl and water birds. Keeping some water in this large reservoir is very important for these birds.

Description of Proposed Use: Construction of Multi-Use Trail on Refuge Boundary

The CCP proposes the construction and use of a multi-use trail along Highway 14 just inside the Refuge boundary. This area is along the northeast edge of the Refuge. The trail would be a 3-mile, 8-foot wide gravel trail. It would be designed to minimize disturbance to wildlife and the environment. This trail would be a partnership with Jackson County, Town of Walden, and the Colorado Scenic Byways. Use would be limited to non-motorized vehicles, walking, and horses. The trail would be fenced to eliminate potential for further excursions onto the Refuge. This 3-mile trail may be too short for purely biking enthusiasts.

Availability of resources:
Currently, no Refuge resources are available for the construction and use of the multi-use trail. Funding requests for this use are in the RONS projects (Appendix D). Other funding would come from partnerships with interested parties.

Anticipated impacts of the use:
Construction of the trail would cause some short-term disturbance to wildlife in the area. The multi-use trail will result in a small amount of habitat loss. This multi-use trail may cause disturbance to wildlife and increase litter problems. Expected level of use should not interfere with Refuge purposes, goals, and objectives. Monitoring of the activity and its impacts will help maintain the use at an acceptable level.

Determination:
Creation and maintenance of a multi-use trail along Highway 14 is compatible.

Stipulations necessary to ensure compatibility:
- ✓ Area is restricted to non-motorized use only.
- ✓ Area will be signed for compliance of use and Refuge regulations.
- ✓ Monitoring will be done to assess the impact of the use on wildlife and the environment.
- ✓ A fence will be constructed between the trail and Refuge to limit further disturbance.
- ✓ Cultural resource clearance would be confirmed before construction.
- ✓ Trail is located on the Refuge boundary to facilitate wildlife viewing, but minimize disturbance to wildlife on the Refuge.

Justification:
This multi-use trail does not appear to create any special problems and biking is associated with wildlife viewing and photography. The trail will also promote partnerships.

Description of Proposed Use:
Shooting Range

The Refuge currently maintains a shooting range just northeast of the Headquarters. The range is used by Refuge, county, and Colorado Division of Wildlife officers to requalify with firearms several times during the year to maintain their law enforcement status. The estimated use is 25 officers requalifying twice during a year. The range is uniquely configured to accommodate pistol, rifle, and shotgun courses required by Refuge law enforcement policy. The CCP supports the continued use of this range. The area encompasses approximately 2 acres of cleared upland with posts and target fastening boards.

Availability of resources:
Currently, sufficient resources are available to continue with this use.

Anticipated impacts of the use:
This shooting range results in a small amount of habitat loss in an upland site. Wildlife may be disturbed during firearms requalification but use is limited to several times a year. Litter of brass is a potential problem. Use of Refuge equipment and materials to maintain the shooting range will be an annual need. Lead contamination of the soil immediately behind the eight target fastening boards may be of concern.

Determination:
Continued use of shooting range is compatible.

Stipulations necessary to ensure compatibility:

- ✓ Users of the site will be required to pick up all brass and any litter.
- ✓ Monitor the area for heavy wildlife use before deciding to requalifying that day to minimize disturbance especially in the winter.
- ✓ The public will not be allowed to use the range as the BLM provides a public range near Walden, Colorado.
- ✓ Lead deposition is currently monitored by the USFWS Safety Office. Because the lead collection berm is small, and the lead is underground and useage is low, we feel the exposure to wildlife is limited.

Justification:
The shooting range is needed to facilitate the firearms requalification of Refuge and Colorado Division of Wildlife law enforcement officers.

Signatures:

_____ _____ _____
Project Leader Date

Concurrence:

_____ _____ _____
Refuge Supervisor Date

_____ _____ _____
Regional Chief
National Wildlife Refuge System Date

Appendix G. Economic Analysis

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Introduction

The National Wildlife Refuge System Improvement Act of 1997 requires all units of the National Wildlife Refuge System to be managed under a Comprehensive Conservation Plan (CCP). The CCP must describe the desired future conditions of a Refuge and provide long range guidance and management direction to achieve Refuge purposes. Arapaho National Wildlife Refuge (NWR), located in the high mountain basin in north-central Colorado known as North Park, is in the process of developing a range of management goals, objectives, and strategies for the CCP. The CCP for Arapaho NWR must contain an analysis of expected effects associated with current and proposed Refuge management strategies.

Special interest groups and local residents often criticize a change in Refuge management, especially if there is a perceived negative impact to the local economy. Having objective data on income and employment impacts may show that these economic fears are drastically overstated. Quite often, residents do not realize the extent of economic benefits a Refuge provides to a local community, yet at the same time overestimate the impact of negative changes. Spending associated with Refuge recreational activities such as wildlife viewing and hunting can generate considerable tourism activity for the regional economy. Refuge personnel typically spend considerable amounts of money purchasing supplies in the local lumber and hardware stores, repairing equipment and purchasing fuel at the local service stations, as well as reside and spend their salaries in the community.

The purpose of this study was to provide the economic analysis needed for the Arapaho NWR CCP by evaluating the regional economic impacts associated with the Arapaho NWR Draft CCP management strategies. For Refuge CCP planning, an economic impact analysis describes how current (No Action Alternative) and proposed management activities (alternatives) affect the local economy. This type of analysis provides two critical pieces of information: 1) it illustrates a refuge's true value to the local community; and 2) it can help in determining whether local economic effects are or are not a real concern in choosing among management alternatives.

There are four alternatives evaluated in the draft CCP. Alternative A, the No Action alternative, would continue Refuge management at current levels. Alternative B focuses on the role of the Refuge in the North Park "sub-ecosystem." This alternative gives consideration to the idea that Arapaho NWR can provide recreational, educational, and economic opportunities in addition to providing quality habitat for migratory birds and other wildlife. Alternative C represents achieving the goals, vision, and purposes of the Refuge by manipulating Refuge habitats in order to reach the apogee of biological potential, and thus support a well balanced and diverse flora and fauna representative of the North Park region. Alternative D is the proposed action. This alternative encompasses most of the objectives and strategies of Alternative B, with some additions from alternative A and C. Alternative D places great importance in the role that Arapaho NWR has in the North Park "sub-ecosystem," both for the environment and the residents of North Park.

This report first provides a description of the local community and economy near the Refuge. An analysis of current and proposed management strategies that could affect the local economy is then presented. The Refuge management activities of economic concern in this analysis are Refuge personnel staffing and Refuge spending within the local community, livestock grazing activities on the Refuge, and spending in the local community by Refuge visitors.

Regional Economic Setting

Arapaho NWR is located in central Jackson County, directly south of Walden, the county seat. Jackson County is a high mountain basin in north-central Colorado with a total area of 1,613 square miles (1,036,800 acres). The basin is approximately 30 miles wide and 45 miles long. Since it is the most northern of three such "parks" in Colorado, it is known locally as "North Park."

Walden is an historic mountain town established in the 1800s with a strong ranching heritage. The Walden business community provides most of the essential goods and services; however, county residents must travel to cities such as Laramie, Wyoming (65 miles northeast of Walden) to purchase larger durable goods (e.g., cars and major appliances) and specialty items. For the purposes of an economic impact analysis, a region (and its economy) is typically defined as all counties within a 30 to 60 mile radius of the impact area. Only spending that takes place within this local area is included as stimulating the changes in economic activity. The size of the region influences both the amount of spending captured and the multiplier effects. Based on the relative self-containment in terms of retail trade and distance of Walden, Jackson County was assumed to comprise the economic region for this analysis.

Population, Employment, and Income

The 2000 Census estimated Jackson County's population at 1,577 persons (US Census Bureau). More than 900 of the county's residents reside in Walden, leaving more than a million acres to be inhabited by less than 700 people (Town of Walden 2001). While the State of Colorado experienced a 30.6 percent population increase from 1990 to 2000, Jackson County's population decreased 1.7 percent over the same time frame. In 2000, Jackson County averaged one person per square mile, the State average was 41.5 persons per square mile.

The 2000 Census reported 6.5 percent of the county population consisting of persons of Hispanic or Latino origin, 92.1 percent of white persons not of Hispanic/Latino origin, 0.3 percent of Black or African American persons, 0.8 percent of American Indian and Alaska Native Persons, and 0.1 percent of Asian persons. Fifty-seven percent of the county population 25 years and older were high school graduates, 11 percent were college graduates (US Census Bureau).

According to the Town of Walden (2001), employment in Jackson County is starting to rebound since the closure of the Lumber Mill in 1994. Ranching, retail trade, government, timbering, mining, support services, and recreation are major employers and major exports include livestock, native mountain hay, timber, oil and carbon dioxide (Town of Walden 2001). Local and State employment is shown in Table 1. In 2000, 60.6 percent of county jobs were in private wage and salary employment (people who work for someone else) as compared to 85.6 percent for the State of Colorado. Self-employment in Jackson County accounted for the remaining 39 percent of county jobs and grew by 92 percent from 1970 to 1997 (Morton 2000).

Table 1. Industry Breakdown of Full-time and Part-time Employment for 2000

	Jackson County		State of Colorado	
Industry	# Jobs	% of County Total	# Jobs	% of State Total
Total farm	245	21.6%	44,406	1.5%
Total nonfarm	889	78.4%	2,916,514	98.5%
Private	687	60.6%	2,534,168	85.6%
Ag. Services, forestry, & fishing	(D)	---	39,364	1.3%
Mining	(D)	---	22,634	0.8%
Construction	108	9.5%	226,475	7.6%
Manufacturing	56	4.9%	217,473	7.3%
Transport/utilities	57	5.0%	162,241	5.5%
Wholesale trade	(D)	---	121,306	4.1%
Retail trade	148	13.1%	493,168	16.7%
Insurance/real estate	(D)	---	304,660	10.3%
Services	192	16.9%	946,847	32.0%
Government	202	17.8%	382,346	12.9%
Total full-time and part-time employment	1,134		2,960,920	

Source: U.S. Dept. of commerce, Bureau of Economic Analysis, Regional Economic Information System, 2002.
(D) not shown to avoid disclosure of confidential information, but the estimates for these are induded in the totals.

As shown in Table 2, county per capita personal income was $20,612 in 2000, which was $11,822 lower than the State average (U.S. Dept. of Commerce 2001). Total personal income was $32.57 million for Jackson County in 2000 (Table 2). County non-farm personal income totaled $32.71 million, farm related income was -$146,000 in 2000. According to the Town of Walden (2001), while over two-thirds of the employment is in agriculture, only one-fifth of the county's income is generated by agriculture. Agricultural-related income (includes farming and agricultural services) fell from 35 percent of total county personal income in 1973 to just 8 of total personal income in 1997 (Morton 2000).

Table 2. Personal Income for Jackson County and Colorado, 2000

	Jackson County	State of Colorado
Personal Income	$32,567,000	$140,224,394,000
Nonfarm personal income	$32,713,000	$139,579,510,000
Farm Income	-$146,000	$664,884,000
Per capita personal income	$20,612	$32,434

Source: U.S. Dept. of Commerce, Bureau of Economic Analysis, Regional Economic Information System, 2002.

Tourism and construction have started to play larger roles in the county economy (Town of Walden 2001). Most jobs pertaining to the recreation and tourism industry are found in the retail trade (spending on supplies, souvenirs, restaurants, and grocery stores) and service (spending on hotels, gas stations, amusement, and recreation activities) sectors in an economy. In 1999, tourism related jobs (mostly hunting) provided almost 17 percent of county employment and 12 percent of total income (Seidl and Garner 2001). According to Colorado Department of Local Affairs (2001), traditional tourism is transitioning to second home tourism where more affluent visitors and retirees are purchasing seasonal homes in Colorado mountain communities. County land use policies and zoning plans have been revised to encourage recreational and second home development (Town of Walden 2001). In 1999, retirees and tourism combined provided almost 30 percent of county employment and more than 50 percent of total base income (Seidl and Garner 2001).

Economic Impacts of Current and Proposed Management Activities

Economic impacts are typically measured in terms of number of jobs lost or gained, and the associated result on income. Economic input-output models are commonly used to determine how economic sectors will and will not be affected by demographic, economic, and policy changes. The economic impacts of the management alternatives for Arapaho NWR were estimated using IMPLAN, a regional input-output modeling system developed by the USDA Forest Service (Olson and Lindall, 1996).

IMPLAN is a computerized database and modeling system that provides a regional input-output analysis of economic activity in terms of 10 industrial groups involving as many as 528 sectors (Olson and Lindall, 1996). The year 2000 Jackson County IMPLAN data profile was used in this study. IMPLAN estimates for employment include both full-time and part-time workers which are measured in total jobs. The IMPLAN county level employment data estimates were comparable to the US Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System data at the 1 digit Standard Industrial Code level for the year 2000.

Refuge Staffing and Budgeting

For the current conditions, (Alternative A) staffing at the Refuge consists of 6 permanent and 4 seasonal employees. The current staff accounted for an annual payroll (including salaries and benefits) of $392,543 in 2002. In addition to providing salaries and benefits, the Refuge purchased goods and services totaling $105,207 in 2002, approximately 60 percent of which was spent locally in the Jackson County economy.

Table 3 shows the proposed staff for Alternatives B, C, and D. The staffing needs are the same for all alternatives except Alternative C would not include the Private Lands Refuge Operations Specialist or the Outdoor Recreation Planner.

Table 3. Proposed Staffing Needs for Alternatives B, C[1], and D

Management Staff	
	Complex Project Leader, GS-13
	Supervisory Refuge operations Specialist, GS-12
	Refuge Operations Specialist, GS-9/11*
	Private Lands Refuge Operations Specialist, GS 9/11
Biological Staff	
	Complex Wildlife Biologist, GS-11
	Wildlife Biologist, GS-9*
	Career Seasonal Wildlife Biological Technician, GS-6
	Seasonal Biological Technicians, GS-3 to GS-5 (4-5)*
	GIS Coordinator/Data Manager, GS-9/11
Public Use Staff	Outdoor Recreation Planner, GS-9/11*
Administrative Staff	
	Administrative Officer, GS-9*
	Administrative Assistant, GS-5/6*
Maintenance Staff	
	Equipment Operator, WG-10
	Career Seasonal Maintenance Worker, WG-8 (Irrigator)
	Career Seasonal Maintenance Worker, WG-8

[1] Alternative C would not include the Private Lands Refuge Operations Specialist or the Outdoor Recreation Planner
*Shared with other stations in Wyoming under Arapaho's Complex Management

Additional annual funding needed for the proposed personnel/staffing is anticipated to cost $430,000 for Alternatives B and D and $323,000 for Alternative C (Table 4). Additional annual non-salary expenditures are anticipated to cost $46,000 annually ($36,000 for habitat projects and $10,000 for research/studies) for Alternatives B, C, and D. For each alternative, it is assumed that approximately 60 percent of non-salary expenditures will still be spent locally in the Jackson County economy. Table 4 summarizes the anticipated annual expenditures by management alternative.

Table 4. Refuge Staffing and Budgeting Expenditures by Management Alternative

	Annual Expenditures by Alternative			
	A	B	C	D
Salary	$392,543	$822,453	$712,543	$822,543
Non-salary	$105,207	$151,207	$151,207	$151,207
Total	$497,750	$973,750	$863,750	$973,750

Because of the way industries interact in an economy, a change in the activity of one industry affects activity levels in several other industries. For example, an increase in funding could allow the Refuge to start new projects or hire additional staff members. This added revenue will directly flow to the businesses from which the Refuge purchases goods and services and to the new Refuge employees. As additional supplies are purchased or as new staff members spend their salaries within the community, local businesses will purchase extra labor and supplies to meet the increase in demand for additional services. The income and employment resulting from Refuge purchases and Refuge employees' spending of salaries locally represents the *direct* effects of Refuge management activities within Jackson County. In order to increase supplies to local businesses, input suppliers must also increase their purchases of inputs from other industries. The income and employment resulting from these secondary purchases by input suppliers are the *indirect* effects of Refuge management activities within the county. The input supplier's new employees use their incomes to purchase goods and services. The resulting increased economic activity from new employee income is the *induced* effect of visitor spending. The sums of the direct, indirect and induced effects describe the total economic effect of Refuge management activities in Jackson County.

Table 5 shows the economic impacts associated with current and proposed management staffing. IMPLAN estimates for employment include both full-time and part-time workers which are measured in total jobs. The current level (Alternative A) of Refuge personnel directly accounts for 7.5 jobs and $331,023 in personal income. The associated indirect and induced effects generate an additional 1.8 jobs and $31,575 in personal income throughout the Jackson County economy for a total economic impact of 9.3 jobs and $362,598 associated with the current level of Refuge personnel. Due to the increased staffing levels for Alternatives B, C, and D (Table 3), the associated economic effects generate more jobs and income than Alternative A.

Table 5. Local Economic Impacts of Refuge Staffing Expenditures

Jackson County	Alternative			
	A C	B		D
Salary Impacts *(excludes benefits)*				
Direct Effects *(Federal Government Sector)*				
Income ($/year)	$331,023	$693,633	$600,872	$693,633
Jobs	7.5	15.8	13.7	15.8
Indirect and Induced Effects *(in Jackson County Economy)*				
Income ($/year)	$31,575	$66,163	$57,315	$66,163
Jobs	1.8	3.7	3.2	3.7
Total Effects				
Income ($/year)	$362,598	$759,796	$658,187	$759,796
Jobs	9.3	19.5	16.9	19.5

Table 6 shows the economic impacts associated with current and proposed management non-salary spending in Jackson County. For each alternative, it is assumed that 60 percent of the non-salary expenditures reported in Table 4 are spent locally in the Jackson County economy. The current level (Alternative A) of Refuge non-salary expenditures directly accounts for 1.4 jobs and $26,955 in personal income. The associated indirect and induced effects generate an additional one-third of a job (0.3) and $6,328 in personal income throughout the Jackson County economy for a total economic impact of 2 jobs and $36,241 associated with the current level of Refuge non-salary spending in the local economy. Due to the increased non-salary spending levels for Alternatives B, C, and D (Table 3), the associated economic effects generate more jobs and income than Alternative A.

Table 6. Economic Impacts of Refuge Non-salary Expenditures in Jackson County

Jackson County	Alternative			
	A	B	C	D
Non-salary Impacts *(60% of total non-salary expenditures spent locally)*				
Direct Effects *(Federal Government Sector)*				
Income ($/year)	$29,913	$42,992	$42,992	$42,992
Jobs	1.7	2.4	2.4	2.4
Indirect and Induced Effects *(in Jackson County Economy)*				
Income ($/year)	$6,328	$9,095	$9,095	$9,095
Jobs	0.3	0.5	0.5	0.5
Total Effects				
Income ($/year)	$36,241	$52,087	$52,087	$52,087
Jobs	2.0	2.9	2.9	2.9

Table 7 presents the combined economic impacts associated with refuge staffing and non-salary spending in Jackson County. Refuge management activities currently generate 11.3 jobs and $398,839 in personal income in Jackson County and account for 1 percent of total employment in Jackson County. Alternatives B, C, and D would generate more jobs and income than Alternative A.

Table 7. Combined Refuge Staffing and Non-salary Expenditures in Jackson County

	Alternative			
Jackson County	A	B	C	D
Total Refuge Staffing and Budgeting Impacts *(salary and non-salary)*				
Direct Effects				
Income ($/year)	$360,936	$736,625	$643,864	$736,625
Jobs	9.2	18.2	16.1	18.2
Indirect and Induced Effects *(in Jackson County Economy)*				
Income ($/year)	$37,903	$75,258	$66,410	$75,258
Jobs	2.1	4.2	3.7	4.2
Total Effects				
Income ($/year)	$398,839	$811,883	$710,274	$811,883
Jobs	11.3	22.4	19.8	22.4
% of Total County Employment	*1.0%*	*2.0%*	*1.8%*	*2.0%*

Livestock Grazing Activities

According to the 1997 Census of Agriculture (U.S. Census Bureau), Jackson County had 126 ranches, totaling 477,063 acres (46 percent of total county acreage). Jackson County's cattle and calf inventory numbered 47,683, with 26,549 cattle and calves sold in 1997 (U.S. Census Bureau). Seventy percent of the operators listed ranching as principal occupation, while 30 percent listed ranching as a secondary occupation. Livestock production accounted for $12.3 million in sales (88 percent of all ranch product sales) in Jackson County in 1997 (U.S. Census Bureau). For 1997 operations, 75 ranches reported net gains, averaging $48,999 per ranch while 51 ranches reported net losses, averaging $19,341 per ranch (U.S. Census Bureau).

According to US Census Bureau, Jackson County had 364,255 acres of total pastureland in 1997. Of the 126 ranches in the county in 1997, 69 ranches (55 percent of all county ranches) held public grazing permits with at least one Federal agency, the Bureau of Land Management accounting for most of these permits followed by the USDA Forest Service (U.S. Census Bureau). Pastures on Arapaho NWR are currently leased for cattle grazing to seven local permittees. From 1991 to 2001, 46 to 74 percent (10,692 to 17,200 acres) of Arapaho NWR lands were grazed annually. Thus Arapaho NWR accounts for 2.9 to 4.7 percent of the total grazing capacity in the county.

In order to estimate the local economic impact associated with grazing on Refuge lands, the current level (Alternative A) of AUMs was set as the base level of production. Estimated base level grazing numbers are based on the 1996 to 2001 annual average AUMs of 8,470. This range was used because 1996 was the first year of grazing on the current Refuge acreage of 23,243 acres, following the purchase of the Stelbar tract. The figures for 2002 were not included as they were considered an anomaly since one of the worst droughts on record significantly decreased use.

Generally the Refuge uplands are grazed in the spring after there has been sufficient new plant growth. The cattle are then removed prior to the end of the growing season, allowing grazed plants to recover. Most of the meadows are not grazed until after August 1, or after the majority of the waterfowl and other migratory birds have completed their nesting activities. Most permittees remove all of their cattle prior to, or during, the month of October as heavy snowstorms accompanied by strong winds may develop in North Park at that time. Refuge personnel estimate that the typical grazing season averages 4.5 months.

To determine economic impacts associated with Refuge grazing, the number of head associated with the allotted AUMs must be estimated for each alternative. The USFWS grazing permit records for Arapaho NWR indicate that of the annual average 8,470 AUMs, on average approximately 75 percent are cow/calf pairs, 22 percent are yearlings, and 3 percent are mature bulls or cows. USFWS monthly forage stocking rates equate cow/calf pairs as 1.25 AUM, yearlings as .75 AUM, and mature bulls and cows as 1 AUM. As shown in Table 8, for the average 4.5 month grazing season, the annual AUMs convert to an average of 1,738 head (each cow/calf pair is counted as one head) per month (1,129 pairs, 552 yearlings, and 56 bulls) grazing on Refuge lands.

Table 8. Estimated Number of Head Associated with Annual Average AUMs

Total AUMs (1996-2001 annual average)	8,470
% AUMs	
Pairs (75% of total)	6,352.50
Yearlings (22% of total)	1,863.40
Bulls/Mature Cows (3% of total)	254.1
Average Monthly Number Head (4.5 months)	
Pairs (1.25 AUM)	1,129
Yearlings (.75 AUM)	552
Bulls/Mature Cows (1 AUM)	56
Total	1,738

For the purposes of this analysis, the gross revenue and net revenue associated with the head grazing on the Refuge will be calculated to show the economic value. Gross revenue is the value or sales price of the head at market. Net revenue is the gross revenue minus permittee operational costs, this is the permittee profit.

The 1998-99 Colorado Livestock Enterprise Budget (Colorado State University Cooperative Extension 2000) was used to determine the gross and net revenue from cow/calf operations. For a beef cow/calf enterprise with an average herd size of 250 head, the Colorado Livestock Enterprise Budget estimates total gross revenue at $366.67 per pair. Total gross revenue from a yearling/stocker operation is estimated at $250 per yearling (Koontz).

The 1998-99 Colorado Livestock Enterprise Budget (Colorado State University Cooperative Extension 2000) estimated total direct expenses for a cow/calf operation at $373.27 per pair for an overall net loss of $6.60 per pair. Because not all operating expenses incurred by a permittee will change directly with the number of cattle grazed on the Refuge, we used a partial budgeting analysis. The Colorado Livestock Enterprise Budget reports cost in terms of animal expenses ($196.69 per pair), machine and equipment expense ($25.94 per pair), labor expense ($8.60 per pair), land expense ($47.11 per pair), and finance expense ($94.92 per pair). This analysis excludes costs associated with the land expense ($47.11 per pair), a portion of finance interests associated with real estate ($65.82 per pair) and a portion of the livestock feeding expense to account for Refuge forage ($50.22 per pair). With this more restrictive accounting, operating expenses for a cow/calf operation are estimated at $210 per pair for a net profit (excluding Refuge grazing fees) of $156 per pair. The net profit for a yearling/stocker operation is estimated at $100 per yearling (Koontz).

While the average monthly number of head is used for the economic analysis, it is important to point out that the 7 permittees do not have the same allotted number of AUMs. During the 2000 grazing season, permittee allotments ranged from 90 AUMs to over 2,600 AUMs. A review of the grazing permit records indicate that typically 4 of the 7 permittees annually graze over 1,300 AUMs spanning most of the grazing season while the other 3 permittees graze less than 250 AUMs for only part of the season. Thus, the economic gains and losses associated with current and proposed changes to grazing on the Refuge will have varying impacts on each permittee.

Refuge grazing rate fees are based on the USDA Statistics Board publication for "Grazing Fee Rates for Cattle by Selected States and Regions" for 2002. The USFWS plans to use the USDA yearly published rates as the base rate of charge, but will increase their yearly fee by $1.00/AUM (current policy allows for this increase) until the base rate is reached. The USDA base rate and yearly Refuge grazing fees are shown in Table 9. Once the USDA base rate is reached, the rate will then be based on the USDA annual rate reported. For the 2000 grazing season, average private land livestock grazing fees for the Jackson County area averaged $10/AUM for yearlings and $13/AUM for cow/calf pairs (Colorado State University Cooperative Extension 2001). The USDA reported year 2000 base rate fee of $11.80/AUM for Colorado was consistent with the range of private land grazing fees in Jackson County. Therefore, it is assumed that once the USDA base rate is reached in 2005, grazing fees for Arapaho NWR will be equivalent to private land grazing fees.

Table 9. Refuge Grazing Fees

	Grazing Fees Charged		
Base Rate for 2003 (USDA reported for 2002)	2001	2002	2003
$12.60/AUM	$9.05/AUM	$10.05/AUM	$11.05/AUM

Alternative A

The current average grazing level of 8,470 AUMs converts to an average of 1,738 head per month (1,129 pairs, 552 yearlings, and 56 bulls) for the average 4.5 month grazing season) on Refuge lands. Using the estimated gross revenue of $366.67 per pair and $250 per yearling, annual revenue associated with current grazing levels is $282,333 for pairs and $202,445 for yearlings for total annual revenue of $484,779 associated with permittees that use the Refuge as part of their operation (Table 10). Using the IMPLAN model for Jackson County, the sales associated with the current level of head grazed on the Refuge account for an estimated 3.4 jobs and $67,780 in labor income in the Range Fed Cattle Industry and a total of 6.9 jobs (0.61 percent of total County employment) and $131,959 in labor income throughout the Jackson County economy (Table 10). It is important to note that the permittees use the Refuge as part of their overall grazing operation, the economic values presented in this analysis represent the value of the overall operation not just the value of grazing on the Refuge.

Table 10. Economic Impacts Associated with the Current Level of Refuge Grazing

	Alternative A
Gross revenue (sales) associated with Refuge grazing	$484,779
Direct Effects in Range Fed Cattle Industry	
Personal Income ($/year)	$67,780
Employment (Jobs)	3.4
Total Effects in Jackson County	
Personal Income ($/year)	$131,959
Employment (Jobs)	6.9
% of Total County Employment	0.61%
Annual Net Permittee Profit (Gross revenue minus operational costs and grazing fees)	$146,264

While the net sales in the Range Fed Cattle industry shows the countywide income and employment effects, it does not account for permittee operational costs incurred per head or grazing fee charged per AUM. Using the Refuge grazing fee of $10.05/AUM for 2002, seasonal grazing costs for 8,470 AUMs associated with Refuge grazing total $85,123.50. Subtracting the operational costs ($156 per pair and $100 per yearling) and Refuge grazing fee costs from the net revenue gives an annual net profit of $146,264 associated with the head grazing on the Refuge. Costs associated with Refuge grazing will continue to decrease annual net profit as Refuge grazing fees increase by $1/AUM each year until USDA base is reached.

Alternatives B, C, and D

Alternatives B, C, and D all propose the same range in grazing number reductions from the 1996-2001 average base level. Alternatives B, C, and D anticipate a range of grazing numbers from 3,050 to 7,650 AUMs annually, representing approximately a 10-64 percent reduction from 1996-2001 average. Because there is such a large range in the anticipated decrease of AUMs for each proposed alternative, an exact economic loss per alternative cannot be calculated. Therefore, the economic analysis will present the range of anticipated economic losses for a 10 percent and a 64 percent reduction in grazing.

Table 11 shows the associated number of AUMs and head allowed for a 10 percent and a 64 percent reduction from base level Refuge grazing. For a 10 percent reduction in Refuge grazing, 7,650 AUMs would be allowed on Refuge lands supporting 1,570 head for 4.5 months. For a 64 percent reduction in Refuge grazing, 3,050 AUMs would be allowed on Refuge lands supporting 626 head for 4.5 months.

Table 11. Herd and AUM Reductions Associated with Alternatives B, C, and D

Reduction from Base	10%	64%
Annual AUMs	7,650	3,050
% AUMS		
Pairs (75% of total)	5,738	2,288
Yearlings (22% of total)	1,683	671
Bulls/Mature Cows (3% of total)	230	92
Average Monthly Number Head (4.5 months)		
Pairs (1.25 AUM)	1,020	407
Yearlings (.75 AUM)	499	199
Bulls/Mature Cows (1 AUM)	51	20
Total	1,570	626

Table 12 shows the number of head allowed for a 10 percent and 64 percent reduction in Refuge grazing AUMs. A 10 percent AUM reduction in Refuge grazing translates into a reduction of 168 head (109 pairs, 53 yearlings, and 5 bulls/mature cows) allowed on refuge lands. A 64 percent AUM reduction in Refuge grazing translates into a reduction of 1,112 head (723 pairs, 353 yearlings, and 36 bulls/mature cows) allowed to graze on refuge lands.

Table 12. Number of Head by Alternative

	Alternative		
	A	B, C, & D	
AUMs	1996-2001 Annual Average 8,470	10% Reduction 7,650	64% Reduction 3,050
Monthly number of head on Refuge			
Pairs	1129	1020	407
Yearlings	552	499	199
Bulls	56	51	20
Total	1738	1570	626
Change in number of head from Alt. A			
Pairs		-109	-723
Yearlings		-53	-353
Bulls		-5	-36
Total		-168	-1112

For reduced Refuge grazing below the levels identified in Alternative A, the key issue is to identify how permittees will respond to being able to graze fewer head on the Refuge. Several options are available including transferring to private land, purchasing additional hay, or reducing the number of animals in their operation. Because it is not known how each permittee will respond, this analysis will encompass the best and worst case scenarios to frame the possible impact range. Therefore, permittees are expected to change their operations in one of two ways:

> Option 1) permitees will transfer to private pasture for the 4.5 months of grazing provided by Arapaho NWR under alternative A (best case scenario); or
>
> Option 2) all permittees will cut back local production by the associated reduction in AUMs (worst case scenario).

Which option a permittee chooses will depend on their level of dependence on the Refuge for their overall operation. Although option 2 is unlikely for all permittees, an economic analysis of reducing head production was undertaken since this option represents the worst case scenario associated with cuts to the Refuge grazing program.

Option 1: Transfer to Private Land

The availability of grazing opportunities on private lands will play a key role in determining whether permittees can make arrangements to transfer over to private pasture. According to Seidl and Garner (2001), agricultural land in Jackson County is either dedicated rangeland or pastureland or is planted in hay to feed cattle. According to Refuge personnel, it is reasonable to assume there is currently enough private land grazing available to accommodate the anticipated decrease in AUMs for each alternative. However, if local ranching operations change, the assumption that private pasture is available to substitute for AUM losses on Refuge pasture might not hold true in future years.

As previously discussed, the FWS grazing fee will continue to increase by $1/AUM per year until the USDA base rate is reached. The grazing fee for Arapaho NWR is expected to be equivalent to private land grazing fees by 2005. Because implementation of the CCP will not happen until after 2005, an increase in the cost of grazing fees associated with transferring from Refuge lands to private lands is not expected.

For a 10 percent reduction in Refuge grazing AUMs, permittees would have to transfer 168 head to private land. A total of 1,112 head would have to be transferred to private land for a 64 percent reduction in Refuge grazing AUMs. Transferring from Refuge land to private land could increase or decrease the hauling costs and labor requirements for each permittee. The increase in costs from switching from Refuge land to private land is not expected to significantly impact total operational costs.

Option 2: Decrease Livestock Production

Under this option it is assumed that permittees would cut back numbers in their operation. As shown in Table 12, a 10 percent AUM reduction in Refuge grazing would cut 168 head (109 pairs, 53 yearlings, and 5 bulls/mature cows), and a 64 percent AUM reduction in Refuge grazing would cut 1,112 head (723 pairs, 353 yearlings, and 36 bulls/mature cows). Using the estimated gross revenue of $366.67 per pair and $250 per yearling, for 7,650 AUMs (10 percent reduction from base) associated annual revenue is $437,846 for permittees that use the Refuge as part of their operations. Total annual revenue associated with 3,050 AUMs (64 percent reduction from base) is $174,566. Table 13 shows the associated direct and total economic effects associated with the number of AUMs allowed. The economic losses associated with Refuge grazing reductions from the 1996 to 2001 base level (Alternative A) are presented in Table 14.

Table 13. Economic Effects of Refuge Grazing by Alternative

	Alternatives B, C, & D Head Associated with a . . .	
	10% Reduction	64% Reduction
AUMs	7,650	3,050
Gross revenue associated with Refuge grazing	$437,846	$174,566
Direct Effects in Range Fed Cattle Industry		
Personal Income ($/year)	$61,218	$24,407
Employment (Jobs)	3.1	1.2
Total Effects in Jackson County		
Personal Income ($/year)	$119,184	$47,518
Employment (Jobs)	6.3	2.5
Annual Net Permittee Profit (Gross revenue minus operational costs and grazing fees)	$132,104	$52,669

A cut in permittee production by the indicated number of head for a 10 percent and a 64 percent AUM reduction from the current level (Alternative A), would result in a revenue loss of $46,933 for a 10 percent reduction, and a loss of $310,213 for a 64 percent reduction (Table 14). As shown in Table 10, the sales associated with a 10 percent reduction from the current level of head grazed on the Refuge would result in a decrease of less than one job (0.3) and $6,562 in labor income in the Range Fed Cattle Industry and would have an impact of less than one job (0.6) and a decrease of $12,775 in labor income throughout the Jackson County economy (IMPLAN estimates for employment include both full time and part time workers which are measured in total jobs). The sales associated with a 64 percent reduction from the current level would result in a decrease of 2.2 jobs and $43,373 in labor income in the Range Fed Cattle Industry and would decrease countywide employment by 4.4 jobs (-0.39 percent of total County employment) and labor income by $84,441 (Table 14).

Table 14. Economic Losses Associated with Refuge Grazing Reductions

	Alternatives B, C, & D	
	10% Reduction	64% Reduction
Change in gross revenue	-$46,933	-$310,213
Change in Direct Effects in Range Fed Cattle Industry		
Employment (Jobs)	-0.3	-2.2
Personal Income ($/year)	-$6,562	-$43,373
Change in Total Effects in Jackson County		
Employment (Jobs)	-0.6	-4.4
Personal Income ($/year)	-$12,775	-$84,441
% Change in Total County Employment	0%	-0.39%
Annual Net Permittee Profit (Gross revenue minus operational costs and grazing fees)	-$14,160	-$93,595

While the gross revenue (sales) in the Range Fed Cattle industry shows the countywide income and employment effects, it does not account for permittee operational costs incurred per head or grazing fee charged per AUM. Using the Refuge grazing fee of $10.05/AUM for 2002, seasonal grazing costs associated with Refuge grazing would total $76,882.50 for a 10 percent reduction in AUMs and $30,652.50 for a 64 percent reduction in AUMs. Subtracting the operational costs ($156 per pair and $100 per yearling) and Refuge grazing fee costs from the net revenue, would give an annual net profit of $132,104 (for a 10 percent AUM reduction) and $52,669 (for a 64 percent AUM reduction) associated with the head grazing on the Refuge. A 64 percent reduction from the base Refuge grazing level would equate to an annual net profit loss of $93,595, a 10 percent reduction would equate to a $14,160 annual profit loss for Refuge grazing permittees. However, since costs associated with Refuge grazing will continue to decrease annual net profit as Refuge grazing fees increase by $1/AUM each year until USDA base is reached, the losses in profit associated with Refuge grazing reductions will decline over the years. While all proposed alternatives have the same range of AUMs, the methods for determining the annual number of AUMs and flexibility for meeting permittee operational needs will vary significantly under each alternative. This will affect the economic viability of using the Refuge as part of permittee grazing operations. Under Alternative B, it is assumed that some grazing will likely occur every year and the Refuge personnel will work closely with permittees to combine Refuge needs and permittee operational needs together as much as possible as far as timing, areas, and to a certain extent, numbers. Alternative C requires tighter decisions based solely on predicted habitat needs therefore creating a higher likelihood of significant variability in AUMs from year-to-year, and an increased possibility of no grazing under certain circumstances. Alternative D anticipates continuing working with existing permittees, and to adjust use to Refuge goals using attrition and across the board cuts in AUMs if needed. Under Alternative D, if all permittees are interested in continued use in two years, all permits will be decreased annually approximately 5 to 10 percent from 1996-2001 averages until objectives levels are met.

Which option (transfer to private land or cut production) a permittee chooses will depend on their level of dependence on the Refuge for their overall operation and the way the Refuge actually reduces AUMs. For alternative B and D, it is anticipated the permittees will still be able to depend on the Refuge for a portion of their operation. Because Alternative C has a high uncertainty in AUMs from year-to-year, a combination of options 1 and 2 may result. While most of the permittees transfer to private land, it may be that permittees with high dependence on the Refuge as part of their operation would have to cut production.

Recreation Activities

Besides Arapaho NWR, Jackson County is home to the Mount Zirkel, Never Summer, Rawah, and North Platte River Wilderness Areas; Sand Hills Recreation Area; Routt National Forest; Colorado State Forest; over 180,000 acres managed by the Bureau of Land Management; and numerous State Wildlife Areas, including one of two Gold Medal trout lakes in the state. These lands have many diverse uses including, recreation, wildlife management, livestock grazing, woodland products, and mineral resources. In all, the Federal and State government manage sixty four percent of Jackson County's total land area (Table 15). Arapaho NWR accounts for 2.4 percent of Jackson County's total land area and 4.6 percent of the County land managed by the federal government. The abundance of recreational opportunities on federal and state lands makes Jackson County a popular recreation and tourism destination.

Table 15. Area Land Management

	Jackson County	Colorado Total
Total Land Area (acres)	1,036,497	66,614,080
State Land (acres)	124,765	3,318,346
Federal Land (acres)	541,073	24,615,790
Private Land (acres)	370,659	38,679,945
State & Federal Land (%)	64	42
Private Land (%)	36	58

Source: Seidl and Garner 2001.

Arapaho NWR offers visitors a variety of recreation opportunities including wildlife observation and photography, hunting, fishing, environmental education, and interpretation. For the purposes of this analysis, Arapaho NWR annual visitation was estimated based on the 1997 to 2001 annual average estimate of 7,106 visits. Visitation estimates from the year 2002 were not included as they were considered an abnormality since one of the worst droughts on record significantly decreased waterfowl hunting. The Refuge bases visitation estimates on a traffic counter on the auto tour route, visitors entering the Visitor Center/Office, and general observation. Table 16 summarizes estimated visits based on visitor activities.

Table 16. Estimated Annual Arapaho NWR Visitors

	Total # of Visitors
Total Estimated Visitors	7,106
Non-Consumptive Users	
Interpretation/Observation	6,593
Environmental Education	141
Hunting	
Waterfowl	280
Big Game	15
Small Game	18
Fishing	59

To determine the local economic impacts of visitor spending, only spending by persons living outside the local area is included in the analysis. The rational for excluding local visitor spending is twofold. First, money flowing into Jackson County from visitors living outside is considered new money injected into the Jackson County economy. Second, if Jackson County residents visit Arapaho NWR more or less due to the management changes, they will correspondingly change their spending of their money elsewhere in Jackson County, resulting in no net change to the local economy. These are standard assumptions made in most regional economic analyses at the local level. Refuge personnel estimate that 5 percent of Refuge visitors (across all activities) are local Jackson County residents and 95 percent are nonlocal visitors.

A tourist usually buys a wide range of goods and services while visiting an area. Major expenditure categories include lodging, food, and supplies. A key step in estimating total visitor spending is the development of visitor spending profiles. Average daily travel related expenditure profiles for various recreation activities derived from the 1996 National Survey of Hunting, Fishing and Wildlife Related Recreation (U.S. Dept. of Interior 1996) by the U.S. Forest Service (Niccolucci and Winter 2002) were used in this analysis. For each type of visitor activity, the Survey reports trip related spending of state residents and nonresidents for several different recreational activities.

Refuge personnel estimate that nonlocal visitors participating in hunting, fishing, and environmental education activities on the Refuge are state residents that live along the front range of Colorado (Fort Collins, Denver, and Colorado Springs). Therefore, state resident spending profiles for big game hunting, small game hunting, migratory bird hunting, and fresh water fishing were used for the Arapaho NWR hunting and fishing related visitor activities. The state resident spending profile for non-consumptive wildlife recreation (observing, feeding, or photographing fish and wildlife) was used for environmental education visitors at Arapaho NWR. Refuge personnel estimate that of the nonlocal interpretation/observation visitors, approximately 40 percent are state residents from the front range area and 60 percent are nonresident visitors. The state resident and nonresident spending profiles for non-consumptive wildlife recreation (observing, feeding, or photographing fish and wildlife) were used for nonlocal interpretation/observation visitors at Arapaho NWR. For each visitor activity, spending is reported in the categories of lodging, food and drink, transportation, and other expenses. Total spending per day for each visitor activity is reported in Table 17.

Table 17. Spending per Day for Each Visitor Activity

	Average Spending per Day
Interpretation/Observation (Nonresidents)	$100
Interpretation/Observation (State Residents)	$15
Environmental Education (State Residents)	$15
Hunting (State Residents)	
Waterfowl	$21
Big Game	$39
Small Game	$42
Fishing (State Residents)	$28

Visitor spending is typically estimated on an average per day (8 hours) or average per trip basis. In order to properly account for the amount of spending associated with each type of Refuge visitor, it is important to determine the average length of trip. Refuge personnel estimate that visitors participating in environmental education activities typically spend 2 hours or less on the Refuge. It is estimated that approximately half of the nonlocal state resident and nonresident interpretation / observation visitors spend about 4 hours at the Refuge observing wildlife, the other half tour the Refuge in 2 hours or less. Visitors participating in fishing activities and waterfowl hunting usually spend a half day (4 hours) and big and small game hunters spend a day (8 hours) on the Refuge. Because the visitor spending profiles are for an 8 hour visitor day, the number of 8 hour visitor days for each visitor activity must be calculated. The current number of visitor days per activity is shown in Table 18.

Table 18. Annual Number of Nonlocal Visitor Days per Activity and Total Spending in Jackson County for Alternative A

	Nonlocal Visitors*	Estimated time spent at Arapaho NWR	Number of Visitor Days (1 day = 8 hours)	Total Visitor Spending in Jackson County
Total Estimated Visitors	6,751			
Interpretation/Observation Visitors (40% are state residents, 60% nonresidents)	6,263			
State Resident Interpretation/Observation Visitors	2,505	50% spend 4 hours (1,253 visitors)	626	$9,390
		50% spend 2 hours (1,253 visitors)	313	$4,695
Nonresident Interpretation/Observation Visitors	3,758	50% spend 4 hours (1,879 visitors)	940	$94,000
		50% spend 2 hours (1,879 visitors)	470	$47,000
Environmental Education	134	2 hours	34	$510
Hunting				
Waterfowl	266	4 hours	133	$2,793
Big Game	14	8 hours	14	$546
Small Game	17	8 hours	17	$714
Fishing	56	4 hours	28	$784
Total			2,575	$160,432

*Note: Nonlocal visitors account for 95 percent of total Refuge visitors

Total visitor spending is determined by multiplying the total spending per day (Table 17) by the number of nonlocal visitor days for each visitor activity. As shown in Table 18, current Refuge visitors spend about $160,500 annually in the Jackson County economy. Table 19 shows the results of the IMPLAN modeling impacts of visitor spending in Jackson County. The current level of visitor spending directly generates $29,918 in personal income and 2.1 jobs for local businesses accommodating visitors (hotels, restaurants, supply stores, and gas stations) and generates a total of $39,308 in personal income and 2.5 jobs (0.2 percent of total county employment) throughout the local economy.

Table 19. Economic Impacts of Visitor Spending Associated with Alternative A

Jackson County	Alternative A
Direct Effects	
Income ($/year)	$29,918
Jobs	2.1
Indirect and Induced Effects	
Income ($/year)	$9,390
Jobs	0.4
Total Effects	
Income ($/year)	$39,308
Jobs	2.5
% Total County Employment	0.2%

Although the economic impacts associated with current Refuge visitation are somewhat limited in terms of overall tourism activities in the area, Arapaho NWR plays an important part in the overall recreational opportunities and scenic open space that makes North Park a popular tourist destination. Any decrease in visitation associated with a change in Refuge management will not have a significant economic effect. An increase in the amount of time current visitors spend on the Refuge will increase the amount of daily spending that can be attributed to visiting the Refuge. An increase in both the length of stay on the Refuge (and in the local economy) and the number of people visiting the Refuge could have a considerable impact on increasing the role Refuge visitors play in the local economy.

Summary and Conclusions

Table 20 summarizes the direct and total economic impacts for all Refuge management activities by management alternative. Under current Refuge management (Alternative A), economic activity directly related to all Refuge operations would generate an estimated 14.7 jobs and $458,634 in Jackson County. Including direct, indirect, and induced effects, all Refuge activities would account for 20.7 jobs and $570,106 in personal income in Jackson County. Current Refuge management activities account for 1.8 percent of total County employment.

Table 20. Summary of all Refuge Management Activities by Alternative.

Jackson County	Alternative A	Alternative B	Alternative C	Alternative D
Total Refuge Staffing and Budgeting Impacts				
Direct Effects				
Income ($/year)	$360,936	$736,625	$643,864	$736,625
Jobs	9.2	18.2	16.1	18.2
Total Effects				
Income ($/year)	$398,839	$811,883	$710,274	$811,883
Jobs	11.3	22.4	19.8	22.4
Refuge Grazing Activities				
Direct Effects		*Range from a 64% reduction in AUMs (option 2) to no impact expected (Option 1)*		
Income ($/year)	$67,780	$24,407 to $67,780	$24,407 to $67,780	$24,407 to $67,780
Jobs	3.4	1.2 to 3.4	1.2 to 3.4	1.2 to 3.4
Total Effects				
Income ($/year)	$131,959	$47,518 to $131,959	$47,518 to $131,959	$47,518 to $131,959
Jobs	6.9	2.5 to 6.9	2.5 to 6.9	2.5 to 6.9
Recreation Activities				
Direct Effects		*No change in visitation expected across alternatives*		
Income ($/year)	$29,918	$29,918	$29,918	$29,918
Jobs	2.1	2.1	2.1	2.1
Total Effects				
Income ($/year)	$39,308	$39,308	$39,308	$39,308
Jobs	2.5	2.5	2.5	2.5
Aggregate Impacts				
Direct Effects				
Income ($/year)	$458,634	$790,950 to $834,323	$698,189 to $741,562	$790,950 to $834,323
Jobs	14.7	21.5 to 23.7	19.4 to 21.6	21.5 to 23.7
Total Effects				
Income ($/year)	$570,106	$898,709 to $983,150	$797,100 to $881,541	$898,709 to $983,150
Jobs	20.7	27.4 to 31.8	24.8 to 29.2	27.4 to 31.8
% of Total County Employment	*1.8%*	*2.4% to 2.8%*	*2.2% to 2.6%*	*2.4% to 2.8%*

For alternatives B, C, and D two options were used to estimate the impacts on a reduction in grazing AUMs by alternative. Table 20 presents the range of anticipated economic impacts for the associated cut in permittee operations by the associated reduction in AUMs (the anticipated reduction is 10 percent to 64 percent, the 64 percent reduction impacts are reported to represent the worst case scenario). The other end of the range represents the best case scenario of no economic impacts associated with transferring to private land (Option 1).

For Refuge recreation activities, at this time no significant change is expected in current visitation levels for Alternatives B, C, and D. Therefore, the economic impacts reported in Table 20 are the same across all alternatives.

Table 21 summarizes the economic effects associated with management changes from Alternative A. All proposed alternatives will increase employment and personal income in Jackson County because of proposed increases in staffing and non-salary expenditures.

Table 21. Economic Effects Associated with Changing from Alternative A

Sector and Type of Effect	Alternative B	Alternative C	Alternative D
Total Refuge Staffing and Budgeting Impacts			
Direct Effects			
Income ($/year)	+$375,689	+$282,928	+$375,689
Jobs	+9.0	+6.9	+9.0
Total Effects			
Income ($/year)	+$413,044	+$311,435	+$413,044
Jobs	+11.1	+8.5	+11.1
Grazing Activities			
Direct Effects	*Range from a 64% reduction in AUMs (option 2) to no impact expected (Option 1)*		
Income ($/year)	$0 to -$43,373	$0 to -$43,373	$0 to -$43,373
Jobs	0 to -2.2	0 to -2.2	0 to -2.2
Total Effects			
Income ($/year)	$0 to -$84,441	$0 to -$84,441	$0 to -$84,441
Jobs	0 to -4.4	0 to -4.4	0 to -4.4
Aggregate Impacts			
Direct Effects			
Income ($/year)	+$332,316 to +$375,689	+$239,555 to +$282,928	+$332,316 to +$375,689
Jobs	+6.8 to +9.0	+4.7 to +9.6	+6.8 to +9.0
Total Effects			
Income ($/year)	+$328,603 to $413,044	+$226,994 to +$311,435	+$328,603 to $413,044
Jobs	+6.7 to +11.1	+4.1 to +8.5	+6.7 to +11.1

Appendix H. Habitat Write-ups

Riparian Habitat

The riparian habitat (4,374 acres) on Arapaho NWR is composed of the channel, floodplain, and transitional upland fringe along portions of the Illinois River and Spring Creek. Historically, the Refuge staff has considered the floodplain and transitional fringe collectively as irrigated meadow. However, we have chosen to use channel, floodplain, and transitional fringe in this document because these components more appropriately represent the collective functions and processes of riparian habitats, and such a designation allows management potential of the entire area to be more thoroughly evaluated.

Although the channel is well-defined as the portion of the riparian zone with flowing surface water (The Federal Interagency Stream Restoration Working Group 1998), delineation of the floodplain and the transitional upland fringe is more difficult because characteristics used to separate these two components are temporally dynamic. The floodplain is a highly variable area on one or both sides of the stream channel that is inundated by floodwaters at some interval. Two methods describe the floodplain: hydrological and topographical. The hydrological floodplain is the land adjacent to the baseflow channel residing below bankfull elevation that is inundated about 2 years out of 3 (The Federal Interagency Stream Restoration Working Group 1998). In contrast, the topographical floodplain is the land adjacent to the channel (including the hydrologic floodplain) up to an elevation reached by a flood peak of a given frequency (e.g., 100-year floodplain) (The Federal Interagency Stream Restoration Working Group 1998). In some cases, these two metrics can result in the same delineation of the floodplain.

The transitional upland fringe is the zone between the floodplain and the surrounding upland landscape. This zone can incorporate numerous landscape features and vegetation communities (e.g., forests and prairies). However, all transitional upland fringes have one common attribute: they are distinguishable from uplands by their greater connection to the floodplain and stream (The Federal Interagency Stream Restoration Working Group 1998). Objective #4 contains further discussion of Illinois River form and function.

Assumptions that were used during the decision-making process included (1) channel incision has occurred (See Objective #4), (2) the width of the floodplain has been reduced [conservative estimate of 137 m on each side of channel], and (3) width of transitional upland fringe has increased [137 m from channel to base of hillslope]. Obviously, these assumptions form the basis for fundamental decisions that have been made; thus, they pervade the entire decision-making framework. Although acceptable at the current time, such assumptions should be validated in the near future. This is particularly critical when considering management options within riparian systems because hydroperiod is a primary function that determines vegetation composition and productivity (Cooper 1986). In some cases, such as restoration of the willow community, validation of these assumptions must occur prior to initiating management activities. Otherwise, the probability of success will be reduced greatly, staff time will be wasted, and funding will not be used efficiently. Information necessary to make decisions regarding future management of the riparian system will likely include magnitude and duration of peak and low flows, bankfull discharge, stage vs. discharge relationships, and seasonal groundwater changes. More detail on the information and equipment necessary to validate assumptions occurs later in this section.

Goal:
Provide a riparian community representative of the historic flora and fauna in a high valley of the southern Rocky Mountains to provide habitat for migratory birds, large mammals, and river-dependent species.

Explanation:
Wetlands are among the most productive ecosystems (Mitsch and Gosselink 1993). In the western United States, this is particularly true with respect to riparian systems (Johnson et al. 1977). In general, riparian habitats often support a higher diversity of plant species, higher density, and more variable structure than associated uplands (American Fisheries Society 1980). Current information indicates that riparian habitat along the Illinois River supports a diverse assemblage of rushes, sedges, grasses, and numerous species of willows (Refuge files). Although birch (*Betula spp.*) and alder (*Alnus spp.*) are common along the Michigan River, another tributary of the North Platte River in North Park, these species currently are not present along the Illinois River, and they were not mentioned in the historical documents located. Historically, the distribution of vegetation communities was highly variable because dynamic river fluctuations, herbivory, and local climatic changes resulted in a constantly changing plant mosaic.

The ability of riparian systems to support a diverse assemblage of vertebrates is also well-documented (Pashley et al. 2000). In fact, riparian habitats are disproportionately more important for support of wildlife than any other type of ecological habitat (Cooper 1986). For example, floodplain vegetation provides habitats for more species of birds than other vegetation associations in western North America (Stanley and Knopf 2000), and in northern Colorado, 82 percent of breeding bird species use riparian vegetation (Knopf 1985). Collectively, the components (channel, floodplain, transitional upland fringe) comprising this system provide habitat for fishes, large and small mammals, amphibians, reptiles, wetland-dependent birds (waterfowl, shorebirds, wading birds), and a large diversity of passerines including neotropical migrants and grassland birds. Species of primary management interest on the Refuge include migratory birds (neotropical migrants, grassland birds, waterfowl, shorebirds), whereas large mammals and channel dependent vertebrates (river otter, fishes) are a secondary focus.

The potential for the Refuge to manage for historic flora remains high because seedbanks and budbanks are resilient (Fredrickson and Taylor 1982; Leck 1989). Rather, the greatest challenge will be the ability to manage hydroperiods and herbivory in a manner necessary to (1) stimulate establishment and ensure survival of some plant species (e.g., willows), (2) mimic the structural variability required by different vertebrates, and (3) provide vegetation communities in a spatial configuration required by certain area-sensitive vertebrates. The ability to successfully manage for this diverse array of plant communities will ultimately determine the populations of vertebrates that will inhabit the riparian corridor. Although the Refuge staff believes that the majority of fauna that historically occurred within the corridor will be supported by the following objectives, populations of some species will likely be lower than historic levels due to constraints on area available and management potential.

Objectives:
1) Restore (50 to 100 acres) of dense (40 to 100 percent) willow in patches >.2 ha and 20 m wide in the central third of the Illinois River (from the north end of the island to the confluence with Spring Creek) to connect existing willow patches and maintain 535 acres of dense willow in patches in the lower third of the Illinois River to benefit nesting neotropical migrant songbirds (yellow warbler, willow flycatcher) and resident moose and beaver.

Rationale:
Woody vegetation is a common component on the Illinois River floodplain. Although cottonwood (*Populus spp.*) is native to this region and some individual trees currently exist on the Refuge, this species occurs primarily at historic homesites and the staff does not consider reestablishment a priority. Rather, willow (*Salix spp.*) is the primary genera composing the woody component along the river. Based on available information, as many as eight willow species are known to occur on the Refuge, including sandbar willow (*S. exigua*), geyer willow (*S. geyeriana*), Wolf's willow *(S. wolfii*), diamondleaf willow (*S. planifolia*), bebb willow (*S. bebbiana*), mountain willow (*S. monitcola*), whiplash willow (*S. caudata*), and blueberry willow (*S. pseudocordata*) (Refuge records; Canon and Knopf 1984). Additional shrub species that represent minor components include interior rose (*Rosa woodsii*) and golden currant (*Ribes aureum*) (Stanley and Knopf 2000).

Several reasons exist for restoring and maintaining the willow community. First, the National Wildlife Refuge System Improvement Act (NWRSIA) of 1997 requires the Refuge System to preserve unique or historic habitats if it is compatible with the purpose of the Refuge (16 U.S.C. 668d). Estimates of riparian habitat loss in the United States range from 70 to 90 percent (Council on Environmental Quality 1978, Swift 1984); thus protection of this habitat type is critical (Cooper 1986). At the current time, the extent and width of the woody component of the riparian community on Arapaho NWR is completely absent along several reaches in the northern 33 percent of the Refuge. Second, riparian plant communities (including willow) play an important role in the maintenance of water quality and aquatic habitat, support distinct vegetation communities, and afford high-quality terrestrial wildlife habitat (Thomas et al. 1979; Windell et al. 1986; Naiman et al. 1993; Stocek 1994). Finally, the purpose for Refuge establishment was to provide habitat for migratory species (16 U.S.C. 715d). Among this large assemblage are species (referred to as neotropical migrants) that migrate between South and North America. Neotropical migratory species account for 45 percent of 58 area-sensitive bird species in riparian habitats (Freemark et al. 1995). Further, many members of this species group currently are declining throughout much of their range (DeGraaf and Rappole 1995) and some species (e.g., southwestern willow flycatcher) are listed as threatened or endangered (U.S. Fish & Wildlife Service 1995). Approximately 50 percent of the neotropical migrants reported as declining are dependent on woody vegetation for foraging and nesting (DeGraaf and Rappole 1995). In arid climates such as Colorado, riparian habitats represent obligate or preferred nesting sites and support higher densities and diversities of migrating and nesting birds (Carothers and Johnson 1975; Stevens et al. 1977; Knopf 1985).

The Refuge currently supports some neotropical migrants that nest in woody vegetation. Research conducted on the Refuge indicate that yellow warblers, American robins, song sparrows, savannah sparrows, red-winged blackbirds, brown-headed cowbirds, willow flycatchers, Lincoln's sparrows, and white-crowned sparrows represent >90 percent of the breeding individuals within the local avifauna (Knopf et al. 1988). However, abundance of some species is low and certain species known to occur in North Park have not been observed on the Refuge (Knopf, unpublished data, Refuge files). Although the causes for the lack of occurrence are unknown, a potential reason may be area size and/or isolation of willows. Past research on the requirements of breeding bird communities suggests that area, in combination with isolation of woodland, is one of the most important considerations in maintaining natural diversity of breeding bird populations (Robbins 1979; Whitcomb et al. 1981; Askins et al. 1987; Blake and Karr 1987; Lynch 1987). In general, species richness increases with the area or width of riparian forests (Stauffer and Best 1980; Dobkin and Wilcox 1986; Keller et al. 1993; Freemark et al. 1995). Further, the abundance of migrants typically is higher in the interior of riparian habitats (Szaro and Jakle 1985). However, the types of species and amount of use are often influenced by geographic orientation and the type of adjacent habitats. For example, species abundance can differ depending on slope (Dobkin and Wilcox 1986) and surrounding habitat types (Carothers et al. 1974), and nest density can differ depending on orientation of habitat relative to migration pathways (Gutzwiller and Anderson 1992).

Thus, the Refuge staff has decided to restore additional areas of willow along the central portion of the Illinois River and maintain/improve the willow community along the southern extent of the Refuge. A primary reason for restoring willows along the central portion of the Refuge is that research conducted in many areas of North America has suggested that habitat configuration (size, shape, geographical orientation) influences the relative importance of riparian habitats (Freemark et al. 1995); either by affecting presence or abundance (Askins and Philbrick 1987; Villard et al. 1995) and movements (Sutcliffe and Thomas 1996) of species. In this context, increasing the extent of willow to the north would reduce the distance between

willow communities on the Illinois and Michigan River and potentially provide benefits to a wider range of passerines by providing breeding habitat, travel corridors to larger patches of woody habitat, and migratory stopover habitat (Winker et al. 1992; Haas 1995; Thurmond et al. 1995; Machtans et al. 1996; Kilgo et al. 1998; Hagar 1999).

The parameters used to determine the amount and structural characteristics of willow were based on available information. However, much of this research was conducted in riparian areas outside of Colorado; thus, applicability to riparian habitats on the Refuge may not be direct because a given species, patterns in habitat use can vary from one geographic area to another (Hutto 1992), within and among years (Karr and Freemark 1985), and diurnally (Stacier 1992). However, a lack of perfect or even moderate knowledge cannot be an impediment to conservation action (Pashley et al. 2000).

The exact dimensions (width, length) of the woody riparian community necessary to benefit the most birds has received much discussion (Darveau et al. 1993; Spackman and Hughes 1995). Several studies have indicated that widths >100 m are required to support an unaltered bird assemblage (Keller et al. 1993; Hodges and Krementz 1996; Kilgo et al. 1998; but see Gates and Gysel 1978 for potential of areas to function as ecological traps). For example, riparian widths of 40 to 50 m supported densities <50 percent of that observed in interior balsam fir forests (Whitaker and Montevecchi 1999). However, they did indicate that widths >20 m would provide benefits to a relatively diverse bird assemblage. Similar results have been reported in other regions of the United States. Higher bird densities but fewer species were documented in narrow (16-20 m) versus wide (40-60 m) riparian zones in Georgia (Thurmond et al. 1995), Quebec (Darveau et al. 1995), Rocky Mountains (Kinley and Newhouse 1997), and Oregon (Hagar 1999). Based on this information, the Refuge staff will attempt to establish willows in a minimum of 20 m wide zones along the Illinois River. However, the extent to which this objective can be accomplished is currently unknown because the width of the current floodplain must first be defined.

Length, in addition to width, must also be considered in determining the optimum shape of riparian zones because proximity to edge influences use by many neotropical migratory species (Whitcomb et al. 1981). We searched published information on breeding habitat requirements of neotropical migratory birds occurring in Jackson County, Colorado to estimate the minimum area required. Of the species for which information was located, veery was the species with the largest area requirement (20 ha in Maryland; Robbins et al. 1989). Based on an average width of 20 m, the riparian zone would have to exceed 500 m in length to support breeding veery. Riparian areas with these dimensions would provide potential breeding habitat for other neotropical species, including but not limited to house wren, warbling vireo, orange-crowned warblers, northern waterthrush, yellow-billed cuckoo, yellow warbler, willow flycatcher, hairy woodpecker, downy woodpecker, white-breasted nuthatch, and western wood pewee (Galli et al. 1976, Robbins et al. 1989, Hagar 1999; Table 7). However, based on the estimated area requirement (225 ha) of red-shouldered hawk, these areas will not support breeding raptors (Robbins et al. 1989). Although willow restoration at this scale may be ideal, the ability to accomplish an objective of this magnitude is unknown because critical information on the functions of the river. Therefore, the Refuge will restore 50 to 100 acres of dense willows, in smaller patch sizes of .5 acres for the 15-year Plan, which will provide habitat for many edge and interior edge neotropical species (Table 6).

In addition to area, structure is also an important component determining the types and abundance of species using wooded riparian habitats (Fleming and Giuliano 1998, Dieni and Anderson 1999). Bird species numbers typically increase with the density and distribution of foliage among vertical strata (Martin 1988). This is not surprising since birds are known to actively select habitat on the basis of such proximate factors as landscape features, terrain, substrate, vegetative structure, or arrangement of vegetation (Wiens 1969). In general, a more heterogeneous habitat allows co-occurrence of more species (May 1986) because species-specific habitat requirements are met (Karr 1982) and because species may be spatially segregated (Martin 1986). In addition, some studies using artificial nests have found an inverse relation between predation rates and vegetation complexity in nesting habitat (Bowman and Harris 1980, Ratti and Reese 1988). Therefore, the Refuge has established guidelines to promote multiple shrub layers by managing for variable heights ranging from 1 to 10 m within the woody riparian zone.

Of all structural components that potentially influence habitat use by woodland passerines, most studies have identified nesting and foraging substrate as the two most important. If these components are classified according to general groups (i.e., foraging = ground, low foliage, high foilage; nesting = cavity, ground, low foliage, high foliage), comparisons indicate that a high percentage of variation in species numbers and species richness among areas are explained by viewing structure at this level of complexity (Martin 1988). For example, the number of species observed often is correlated with increasing foliage diversity (height, density). Although this relationship is often explained as a function of increasing foraging niche space or food abundance (MacArthur and MacArthur 1961; Willson 1974; Martin 1984), information also exists that observed relationships result from correlation with suitable nest sites (Oniki 1985; Martin 1988). Regardless, such a relationship indicates that greater structural diversity will support a greater number of species. Although the upper limits of vertical diversity along the Illinois River is somewhat constrained because the woody component is almost exclusively shrubs (willow), management can be directed toward increasing horizontal diversity and vertical diversity <10 m. However, objectives for habitat management must be relatively broad because riparian systems are dynamic and many habitat management practices (e.g., fire, hydrology) cannot be controlled at the finite levels necessary to affect a minute change in conditions (e.g., 40 to 45 percent canopy closure).

The Refuge established structural requirements of the woody riparian community based on the breeding requirements of birds because (1) breeding requirements are more narrow than migratory requirements, and (2) birds distribute among different layers of vegetation (Anderson and Shugart 1974; Willson 1974; Martin 1984). Some information on the specific habitat requirements of species

occurring in North Park was available, but most information was of a general nature that provided undefined descriptions (e.g., dense/sparse, tall/short). We constructed a table (Table 7) using this type of information for individual bird species for the purpose of identifying broad structural components that would be managed within the woody riparian component. We then used available quantifiable information available for several species to define these broad terms.

Research conducted on Arapaho NWR indicates that yellow warblers select nest sites characterized by the horizontal arrangement of willow, including average distance to nearest willow (0.16 m), average distance to farthest willow (0.4 m), and the average distance to the nearest willow in each of 4 quadrants (0.16 m) (Knopf and Sedgwick 1992). This information suggests yellow warblers require clumps of uniform-sized bushes characterized by moderate canopy closure. In a similar study conducted on willow flycatchers, nest sites were characterized by smaller distances between willow (0.8 $\pm$ 0.2 m [mean $\pm$ standard error]) and greater willow densities (not interpretable) within an area defined by the nest tree and 4 nearest trees in each quadrant; larger willow patches and smaller gaps (0.4 $\pm$ 0.5 m) in 0.07-ha circular plots around nest sites, and greater willow coverage (49.3 $\pm$ 2.3 percent) and less non-willow coverage (50.7 $\pm$ 12.4 percent) in 0.32-ha circular plots surrounding the nest site (Sedgwick and Knopf 1992).

In the Wind River Range of Wyoming, the abundance of western wood-pewees and warbling vireos was greater in unburned Aspen forests because of greater canopy cover (46.9 percent) and canopy depth (4.6) compared to burned aspen forests (18.3 percent canopy cover; 4.1-m canopy depth) (Dieni and Anderson 1999). In addition, orange-crowned warblers and dusky flycatchers were observed more in areas of unburned sites; presumably because of greater shrub cover (19.6 percent in unburned sites and 8.6 percent in burned sites). However, overall species richness did not differ between unburned and burned sites suggesting these species are tolerant of relatively wide ranges of habitat structure.

A comparison of forest/field edges and forest/shrub edges in Pennsylvania suggest that the abundance of song sparrows, chipping sparrows, common yellowthroats, and brown-headed cowbirds were greater, and rose-breasted grosbeaks were lower, in forest/shrub edges (Fleming and Giuliano 1998). Comparison of structural features indicated that shrub canopy cover (76.3 percent between 0-2 m) and vertical cover (68.8 percent) were greater and sapling height (5.0 m maximum) was lower in forest/shrub edges compared to forest/field edges (57.4 percent shrub cover; 17.4 percent vertical cover, 14.7 m shrub height). In western Oregon, the abundance of orange-crowned warblers, MacGillivray's warblers, white-crowned sparrows, house wrens, northern flickers, and Stellar's jays were greatest in logged sites, whereas Hammond's flycatcher abundance was greatest in unlogged sites (Hagar 1999). Of the habitat variables quantified in this study, the number of live stems, stems $\geq$50 cm dbh, and snags >30 cm dbh were lower ($P < 0.05$) in logged (90.1 $\pm$ 18.6 live stems, 14.6 $\pm$ 3.4 stems >50 cm, and 11.2 $\pm$ 1.8 snags) compared to unlogged sites (139.3 $\pm$ 15.5 live stems, 51.2 $\pm$ 10.7 stems >50 cm, 18.3 $\pm$ 3.2 snags), suggesting that species abundances are related to structural characteristics effected by tree density (e.g., canopy closure, canopy depth) and cavity availability.

Achieving the conditions stated in this objective should ensure some suitable habitat for the range of neotropical bird species that occur in North Park, including species that require dense, shrubby habitats and those species that require more open, widely-spaced woody cover. Regardless of area requirements, however, the ability of the Refuge to provide breeding habitat for the complete assemblage of birds potentially occurring on the Refuge will not be possible. For example, many species considered (Table 7) require cavities for nesting, but potential cavity sites are limited on the Refuge because willow is the dominant woody vegetation. Therefore, accomplishing this objective will not provide habitat for the entire assemblage of birds known to occur in this habitat type. However, it may provide potential breeding habitat for several neotropical species that currently do not breed on the Refuge.

Although based on breeding requirements of neotropical birds, numerous other species will also benefit from increasing the willow community on the Refuge. For example, the target dimensions of woody riparian habitat will also provide migratory habitat for numerous passerines, forage and cover for large mammals (e.g., moose, elk, mule deer) (Allen et al. 1987; Snyder 1991), and migratory and breeding habitat for several species of waterfowl (e.g., mallard, gadwall, and teal) (Colorado Breeding Bird Atlas 1998). Further, riparian buffers along small headwater streams (e.g., Illinois River) may be instrumental in maintaining populations of amphibians associated with riparian habitat in closed-canopy forests (Vesely 1997).

Strategies:
Numerous strategies have been used to successfully reintroduce willows, including establishment from seed, planting slims or bare-root stock, and excavation and movement of existing willows (Svejcar et al. 1991; Friedman et al. 1995; Houle and Babeux 1998; Pezeshki et al. 1998). The viability and costs of each method varies depending on local environmental conditions and availability of a plant source. Information necessary to decide on the best strategy of restoration includes data on dates of seed fall, area that can be expected to receive seed, area that experiences surface flooding, groundwater fluctuations (including peaks, seasonal fluctuations, etc.) at different elevations within the floodplain and transitional fringe, current vegetation conditions, and water management capabilities (surface and groundwater).

1) In general, germination of willow seed requires bare, moist substrates, that are free of shade (Johnson et al. 1976; Bradley and Smith 1986; Rood and Mahoney 1990; Scott et al. 1993). Appropriate conditions can be created using several combinations of strategies, including fire, herbicides, scraping sod, and water management (Friedman et al. 1995). During the initial establishment phase, however, soil moisture conditions are critical to ensure survival (Pezeshki et al. 1998). Seedlings of most cottonwood and willow species are intolerant of low moisture (McLeod and McPherson 1973; Krasny et al. 1988). Numerous studies have indicated that rainfall alone is insufficient to support seed germination and seedling establishment on alluvial sands on sites that are not susceptible to mechanical damage by flooding and

rain (Moss 1938; Engstrom 1948; Segelquist et al. 1993). Therefore, even if slims and bare-root stock are used, success will be dependent largely on the ability to control groundwater fluctuations, particularly rate, duration, and depth of groundwater decline (Segelquist et al. 1993). Results of some studies indicate that a gradually declining water table promotes root growth to a greater depth than a static water table (Fenner et al. 1984; Segelquist et al. 1993). Thus, minor groundwater fluctuations can be advantageous, but extreme fluctuations will tend to result in mortality. For cottonwood (*P. deltoides*), available information suggests that rates of decline exceeding 2 cm/day (Segelquist et al. 1993) and 4 cm/d (Mahoney and Rood 1991) result in significant mortality. Results of these studies provide useful information for estimating the level of groundwater control necessary. However, if established from seed, willow may be more sensitive to groundwater fluctuations the first month following germination; willow seeds obtain moisture from a smaller volume of sediment (Friedman et al. 1995). Another consideration that must be accounted for is the possibility of mortality following establishment. Although willow seedlings are capable of withstanding floods for two growing season (Walters et al. 1980), they also are susceptible to mortality through scouring during subsequent high flows (Everitt 1968; Segelquist et al. 1993; Friedman 1993). Such events are common within the channel and on the floodplain during certain portions of the year. Once established, various other factors (e.g., herbivory, fire) can potentially cause significant mortality. Although strategies (e.g., sleeves, exclosures, fire breaks) exist for reducing the impact of these mortality factors, the best solution(s) will likely vary depending on site conditions and location. Therefore, the Refuge staff will evaluate options and make decisions on a site-by-site basis.

2) Provide 3,630 to 3,845 acres, over a 5-year average, of a grass:forb (75:25) plant community composed primarily of native plants (rushes, sedges, grasses, forbs) characterized by 10-30 cm VOR, 0-10 cm duff layer and minimal (<5 percent) bare ground and less than 40 percent (canopy closure) willow to benefit nesting waterfowl (pintail, shoveler, gadwall, green-winged teal) and sage grouse broods.

3) Provide 210 to 700 acres, over a 5-year average, of a grass:forb (75:25) plant community composed primarily of native species (grasses, sedges, forbs, and rushes) characterized by >30 cm VOR, 10-20 cm duff layer and minimal (<5 percent) bare ground, and less than 40 percent (canopy closure) willow from mid-April through August to benefit nesting waterfowl (mallard, gadwall, pintail, scaup), songbirds (savannah sparrow, meadowlark), and foraging shorebirds if flooded (snipe, phalarope, white-faced ibis, sora, curlew, willet).

Rationale:
Herbaceous vegetation is a component of riparian systems nationwide. The dominant herbaceous species within the Illinois River corridor are primarily perennial species classified as obligate or facultative wetland plants that are tolerant of temporary surface flooding and seasonally high groundwater tables. These species, including rushes, sedges, grasses, and forbs are adapted to the short growing season (<40 days), low annual precipitation (<10 inches), and high annual evapotranspiration rates characteristic of North Park. The species composition has been modified by the introduction of additional grasses, but invasive, nonnative species currently occupy <5 percent of the land base and current floristics do not appear to be reducing the value of the area to wildlife (Refuge files).

The primary species of management concern in the grassland-dominated portion of the riparian zone are nesting waterfowl and grassland-dependent passerines. Both groups represent trust resources for the Refuge. The enabling legislation for the Refuge specifically identifies waterfowl production as a purpose of the Refuge. Grassland birds, although not specifically mentioned, are migratory and currently declining in many areas of North America (Herkert 1995). The most abundant duck species nesting on Arapaho NWR are blue-winged teal, gadwall, scaup, wigeon, mallard, and pintail (Refuge files). Based on Refuge banding records, Monitoring Avian Productivity and Survivorship (MAPS) station data (Refuge files), Partners in Flight (PIF) scores (Pashley et al. 2000), and regional species of concern (Refuge files), grassland birds of management interest are savannah sparrow, western meadowlark, vesper sparrow, bobolink, upland sandpiper, and Wilson's phalarope.

Numerous studies have demonstrated that grassland size is an important factor determining avian use of grasslands for both foraging and nesting (Wiens 1969; Herkert 1991; Madden 1996; Greenwood et al. 1995; Clark 1977; Herkert et al. 1993; Vickery et al. 1994). Therefore, as with the willow community, size and dimension of the area must be considered. Some species typically do not nest in small grassland fragments (Samson 1980; Herkert 1994; Vickery et al. 1994) or near grassland edges (Johnson and Temple 1986; Delisle 1995; Helzer 1996) because nest depredation and parasitism are often higher (Johnson and Temple 1986; Johnson and Temple 1990; Burger et al. 1994). A literature review of species known to nest in this region suggests that most are found on grasslands greater than 5 ha, but nest densities of these species are much higher if the grassland is greater than 30-50 ha (Helzer 1996; Herkert 1994; Johnson and Temple 1990; Martin and Gavin 1995). Currently, the size of grass-dominated habitats is not limiting, but the size of areas conforming to each of the objectives is currently unknown. The Refuge staff will evaluate current conditions based on the parameters in each objective and ensure that blocks of sufficient size are provided in each category.

In addition, species that use floodplain grasslands have varying requirements with regards to foods and structural requirements for nesting and brood-rearing. The Refuge established requirements for vegetation structure based primarily on the breeding requirements of grassland nesting ducks and ground-nesting grassland birds. Most of the information used to establish requirements for these species was from studies in other geographic areas and some of the studies used undefined terms (e.g., dense, tall, thick) rather than numeric values. However, it was the best information available and future monitoring will help determine the extent to which the information is applicable to Arapaho NWR. Table 8 summarizes the information used to identify grassland requirements.

The most important structural characteristics are vegetation height and density, residual cover (duff), and

shrub density. Differences in grass cover required by breeding birds can be separated into two broad groups based on nesting requirements. Species, including mallard, scaup, and gadwall require taller, denser cover to conceal nests (Holm 1984; Livezey 1981; Lokemoen et al. 1984; Austin et al. 1998; LeSchack et al. 1997), whereas other species, such as pintail, teal, western meadowlark, Savannah and vesper sparrows, bobolink, and upland sandpiper prefer shorter, less dense cover (Madden 1996; Skinner et al. 1984; Lanyon 1994; Wheelwright and Rising 1993; Livezey 1981; Austin and Miller 1995; Kantrud and Higgins 1992). The cover requirements for both groups are provided by a combination of new growth and residual vegetation often referred to as duff or litter. Most waterfowl and gallinaceous birds depend on residual vegetation for initial nesting attempts and duff is an extremely important factor in nest site selection by dabbling ducks and ground-nesting grassland birds (Wiens 1969; Clark 1977; Kirsch et al. 1978; Leopold 1933). Ground-nesting grassland birds and dabbling ducks preferring shorter, less dense cover (e.g. pintail, teal) are typically found where duff layers are less than 10 cm (Swanson 1998; Wiens 1969; Madden 1996). In contrast, dabbling ducks nesting in the San Luis Valley of Colorado use denser cover characterized by duff layers that exceed 10 cm (Laubhan and Gammonley, unpublished data).

The effects of these characteristics on avian grassland use are most obvious in grasslands subject to different management practices. For example, a study at Malheur National Wildlife Refuge (Clark 1977) showed that duck nest densities were highest where grazing and mowing were prohibited the previous season, intermediate where partial mowing but no grazing were allowed, and lowest where grazing and mowing were unrestricted the previous season. Higher residual cover on the ungrazed and unmowed units was the single best parameter explaining the higher nest densities (Clark 1977). Other duck nesting studies have shown similar results (Reeves 1954; Salyer 1962; Martz 1967; Oetting and Cassell 1971). Structural changes have more varied consequences for nongame birds. For example, studies in Alberta and Saskatchewan found that some species preferred the structural conditions in ungrazed and unmowed grasslands (Savannah sparrow, Baird's sparrow, Sprague's pipit), other species preferred grazed or mowed grasslands (horned lark, McCown's longspur, chestnut collared longspur), while some species were unaffected by grazing or mowing (western meadowlark, clay-colored sparrow) (Owens and Myres 1973; Maher 1973; Karuziak et al. 1977).

In addition, some species of management interest are dependent on the presence of forbs in grasslands either as a nesting site for females or as song perches for males. Based on the requirements of western meadowlark, Savannah sparrow, vesper sparrow, and bobolink, the literature indicates that a minimum composition of 10 percent forbs is required (Wiens 1969; Skinner et al. 1984; Madden 1996; Dechant et al. 1999). Although currently unknown, the Refuge will determine the forb composition of grassland-dominated habitats through monitoring and use various strategies to either maintain or improve the forb community.

Based on a review of the literature, the species of management interest are tolerant of scattered woody vegetation. In fact, some nesting dabbling ducks (e.g., mallard, green-winged teal, gadwall) will build nests at the base of shrubs (Austin et al. 1998; Kingery 1998; LeSchack et al. 1997). Ground-nesting grassland birds are somewhat less tolerant of woody vegetation but many are found in grasslands with 10 to 40 percent shrub cover (Madden 1996, Schaid et al. 1983). Although scattered willows are likely to become established within the grasslands, no attempt will be made to reduce willows until canopy closure exceeds 40 percent because many species are tolerant of such conditions.

The Refuge used the above information to establish the two grassland objectives. Management to achieve these objectives will occur in the portion of the floodplain that will not be restored to willows. The relative proportion of habitat in each objective is not equal; however, Objective #3 (10-30 cm vor) is being weighted more heavily. This decision was based largely on the capability to manage the riparian corridor for both habitat types. Past modifications limit the ability of the Refuge to manage some areas for dense cover. For example, the highest elevations that are thought to be only minimally impacted by groundwater, and are known to be difficult to irrigate, are best suited for Objective #3, whereas the areas nearest the river are likely to be easier to obtain conditions stated in Objective #2.

Strategies

Because extensive areas of grasslands currently exist within the riparian habitat, management will be directed primarily toward maintaining existing areas. This will be accomplished by numerous methods, including but not limited to water management, prescribed fire, grazing management, and haying. These management practices affect vegetation height, density, grass:forb ratio, and duff layer and thus avian use of grasslands (Clark 1977; Mundinger 1976; Oetting and Cassel 1971; Salyer 1962; Enright 1971; Kaiser 1976; Kirsch and Higgins 1976; Owens 1971; Owens and Myres 1973; Maher 1973; Dambach 1944; Madden 1996). Initially grasslands will be monitored to assess current structural conditions, forb distribution, and nonnative distribution. In areas of low (<10 percent) forb composition, attempts will be made to increase this component by seeding in combination with the above listed activities. Areas that contain >10 percent nonnative species (i.e., <90 percent natives) will be identified and attempts made to reduce the composition of these plants using herbicides, biological control, water level management, or other management practices that have proven useful in other areas.

Given the altered river flow regime, provide a properly functioning river channel characterized by a well defined thalweg, outside river edges that are deeper than inside edges, a river sinuosity of 2.0 to 2.5, pool spacing every 7 to 9 channel widths, active point bar formation, and gradients in riffles that are higher than in pools to benefit willow establishment for neotropical migrants, and indirectly provide suitable habitat for native and nonnative fishes.

Rosgen (1996) developed a stream classification system that provided guidelines for identification of stream channel types. This stream classification system utilizes the following criteria: channel gradient, sinuosity, width/ratio, dominate particle size of bed and bank material, channel entrenchment, channel confinement, landform features and

stream bank stability. Utilizing this stream classification system, the Illinois River on the Refuge is classified as a C-channel. The preferred, and most stable channel, is an E-channel (narrower and deeper). Rosgen (1996) describes an E-channel as low gradient, meandering riffle/pool morphology stream with low width to depth ratio and little deposition occurring. E-channels are considered to be the most stable channel types and will encourage willow development; they provide the best habitat for trout. These are very efficient and stable streams found in broad valley/meadows over alluvial materials and characterized by well vegetated banks. Minimizing disturbance to stream banks will facilitate E-channel development.

A thalweg is the deepest point on a stream channel cross section, and typically the deepest point on the valley floor. Functioning streams exhibit well defined thalwegs that move side to side as a stream meanders. Sinuosity is the ratio of the valley slope to the stream slope. E-channels exhibit sinuosity of >1.2, but 2.0 - 2.5 is preferred. Pool spacing for E-channels is generally every 4 to 7 channel widths. Point bar formation is another characteristic of streams that transport water and sediment efficiently. Stream gradients are defined as the rise/run along the longitudinal profile of the stream. Functioning streams exhibit higher gradients over riffle areas (Rosgen 1996).

Rationale:
This objective recognizes the altered Illinois River condition. The Refuge will strive to produce a naturally functioning channel, given flow and irrigation shortcomings. Understanding the location and functional processes of the floodplain and transitional fringe are crucial to improving management on the Refuge because these processes determine the potential composition and structure of vegetation and, therefore, the associated wildlife benefits (Pashley et al. 2000). In addition, a greater understanding of these processes will allow the Refuge staff to identify potential management strategies that have a high probability of success. However, delineation of the floodplain and transitional upland fringe along the Illinois River that traverses the Refuge is difficult. First, the hydrology of the river in North Park has been altered greatly; thus, it is not possible to assume that historic indicators (e.g., location of landforms) can be used to define these components. This statement is based on the fact that an extensive irrigation and water storage system has been developed within the riparian system. However, the impacts of these developments are difficult to quantify because the historic gauge station on the Refuge has been removed. Second, even if existing gauges were still in place, many of the original alterations leading to water diversions occurred prior to the establishment of USGS gauge stations. This is supported by conversations with the state water engineer and local ranchers who have stated that water management has not changed appreciably in the last 100 years and 50 years, respectively. The Refuge attempted to confirm these statements by comparing USGS data from 1935-1939 and 1995-1999 that was collected at Rand, Colorado (URL: http://nwis-colo.cr.usgs.gov and http://co.water.usgs.gov/nwis/). Several diversions (e.g., McFarland Reservoir, landowner ditches) occur between the gauge and the Refuge boundary; thus, the usefulness of this information for purposes of Refuge management is poor. Regardless, the data confirms that the hydrology of the river, at least at this location, has not changed appreciably during the past 40 years based on comparisons of peak discharge, flow duration curves and seven day minimum flows. In general, the Illinois River at Rand is characterized by (1) peak flows (500-600 cfs) in spring that are of short duration, (2) 90 percent of flows do not exceed five cubic feet per second (cfs), and (3) minimum daily flows are about two cfs. Further, a spatial comparison of the river channel on the Refuge indicates the river has not undergone appreciable lateral migration during this period.

Although it is not possible to mathematically derive the location and extent of the floodplain and transitional fringe because both current and pre-development information is unavailable, the Refuge staff has evaluated the riparian system within the limits of their ability and have concluded the channel is in a state of change even though management has remained relatively static during the past few decades. This conclusion is supported by several subjective assessments. First, an October 2000 evaluation of several river reaches using the Rosgen method (Rosgen 1996) suggests the river is functional-at-risk. Specific factors identified during the evaluation included evidence of channel incision, reduction in fine sediment load, and occasional mass failure of banks (i.e., sloughing). Further, indications of the direction of change can be assessed by placing these observations in the context of the channel equilibrium equation (Lane 1955).

$$Q_s \bullet D_{50} \propto Q_w \bullet S, \text{ where}$$

Q_s = sediment discharge, D_{50} is sediment particle size, Q_w is streamflow, and S = stream slope

Channel equilibrium occurs when all four of the above variables are in balance. If one variable changes, one or more of the other variables must increase or decrease proportionally (The Federal Interagency Stream Restoration Working Group 1998). In the case of the Illinois River on the Refuge, channel incision suggests stream slope may be increasing, whereas the small amount of fine sediment suggests that sedimentation size or discharge may have been reduced compared to historical. This latter observation is supported by (1) dominance of large substrates (e.g., cobble) in the river channel, (2) increased sedimentation in palustrine basins that have been developed within the riparian corridor, and (3) lack of significant point-bar formation within the channel. Irrigation practices may remove the peak water flows, alter sediment loads, and change the duration of water events critical to stream function. Collectively, this information suggests that the equilibrium equation is currently unbalanced. During a December 2000 workshop, these factors were considered in relation to a channel evolution diagram that depicts the current stage of disequilibrium and theoretically may help predict future changes in habitat or stream morphology (The Federal Interagency Stream Restoration Working Group 1998). Based on the diagram produced by Simon (1989), the staff classified the channel as either degrading or degrading-and-widening. Characteristics associated with this classification include large scallops and bank retreat, reduction or flattening in bank angles, a flow line that is low relative to the top of the bank, and a prediction that a new floodplain will be developed (Simon 1989).

Despite the fact that the Refuge currently lacks detailed information necessary to quantify current and predict future

channel changes, available information suggests that the elevation of the channel is lower than historic conditions. Because the intensity and frequency of flooding is important in determining community structure and system functions (Odum 1978), this directional change affects not only the channel, but also the floodplain and associated fringe (Baxter 1977; Lillehammer and Saltveit 1984). For example, lower channel elevation, coupled with lower peak flows, reduces the frequency, duration, and extent of overbank flooding. Consequently, the current width of the floodplain, as defined by hydrologic parameters, is narrower than the historic floodplain. Although the current extent of the floodplain has not been quantified, staff observations during the past 15 years indicate that the maximum extent surface water extends onto the floodplain is about 137 m (150 yds). Consequently, the transitional upland fringe has encroached toward the channel during the past four decades.

More information must be obtained on the current hydrology of the riparian zone prior to initiating restoration efforts. Data on bankfull discharge, seasonal and peak flows, and stage vs discharge relationships must be developed. This will require establishing gauge stations to monitor river flows, placement of peizometers (or other equipment) perpendicular to the channel at various locations to monitor groundwater fluctuations, and obtaining elevation data at several points along the channel. In combination, this information will allow areas with highest potential for restoration to be selected, identify the best method of restoration (e.g., seeds, slims), and allow development of the most appropriate water management strategies at different sites within the riparian zone.

Efforts to restore the Illinois River channel will most likely improve the Refuge fishery resource. Fish are primarily found only in the Illinois River and other aquatic sites, including Potter Creek, Spring Creek and Refuge ponds, represent poor fishery habitat. Water depth and winter survival is the limiting factor in most of these systems. Winter-kill is a common problem with many of the lakes on the Refuge and throughout North Park. Fish species found in the other aquatic sites include longness dace, creek chub, white sucker, long-nosed sucker, fathead minnow, and johnny darter (Kehmeier 2001). The Illinois River is a transition stream, beginning as a trout stream in the headwaters and transitioning to a native species stream by the time it meets the Michigan River. This transition appears to occur as the river crosses the Refuge. The lower flows experienced at the north end of the Refuge may be responsible for the trout giving way to the more tolerate native species. Trout are not native to North Park streams. Sampling in 1998 found that upstream from the Refuge, the fishery is dominated by brook and brown trout at or near carrying capacity of 114 kg/ha of biomass. Sampling near the Allard bridge found a high diversity of habitats, and the highest species count (6 native species and 1 nonnative). Brown trout are reproducing and demonstrate recruitment in the Illinois River. Rainbow trout were not sampled in 1998; however, they may exist because of previous Colorado Division of Wildlife stocking efforts. Sampling downstream of the Ward Ditch #1 found mostly native species mentioned above.

Instream structure is limited to willow root balls, aquatic vegetation (*Elodia*, Potamogeton, and *filamentous algae*) and small woody debris. Beaver dams, common on the upstream end of the system, help the system become more dynamic and provide excellent angling opportunities. Continued stream bank protection is critical to sustaining the fishery resource. Degraded stream banks exhibit shallow water spread over a wide stream channel. Deep water pools are critical to sustain healthy fish populations. Fishery habitat efforts must focus restoring natural structure and function to the Illinois river and will result in better fishery habitat. A Fishery Management Step-Down Management Plan will be prepared by 2005.

General Consideration of Areas Specified:
The area of each habitat component (defined by objectives) will vary over time depending on annual and seasonal conditions (e.g., river flow, precipitation, etc.). In addition, it is likely that some areas originally meeting the conditions of one objective will develop conditions that meet another objective. For example, grasslands with less cover (Objective# 3) may develop more cover (Objective #2). Such changes (succession) are natural and have many benefits (e.g., nutrient cycling, soil stabilization) other than providing wildlife habitat. Therefore, the Refuge has established broad tolerances in the area (ha) of each habitat that will be provided. This is based on the concept that disturbance-driven spatial and temporal variability is a vital attribute of nearly all ecological systems (Landres et al. 1999). Further, managing within the constraints of site variability and history is easier, requires fewer external subsidies, and is more cost effective than attempting to achieve management goals that are outside the bounds of the system (Allen and Hoekstra 1992). Conditions that collectively fall within the established ranges will be sufficient to provide some habitat for species of interest in most, if not all, years.

Table 7. General Breeding Habitat Requirements of Selected Woodland Birds in North Park, Colorado							
	Breed[a]		Nest[e]		Forage[f]		
Species	Type	Minimum patch (ha)	Type	Ht (m)	Type	Ht (m)	General habitat characteristics[k]
American redstart	I	118.0	F	4-12	A,F	3-6	open, moist, deciduous woods w/ good undergrowth of shrubs/young trees
Blackbird, Red-winged	E	24.0	F	<3	F	<3	
Bluebird, Mountain	E		C				prefer forest edges and open habitats;
Chickadee			C		F	>3 - >15	aspen/cottonwood preferred
Black-capped	IE	4.7					
Mountain			C		F	>3 - >15	
Common Yellowthroat	IE	2.3	F	<3;<0.5	F,G	<3;<5.5	prefer cattail or low streamside thickets; require open water
Cowbird, Brown-headed	E	2.3					
Cuckoo, Yellow-billed	IE	2.3	F	<3; 0.5-6			old growth w/ dense understory
Dove, Mourning	E	2.3					
Flicker, Northern	IE	1.8	C		G		
Flycatcher							
Dusky			F	<3			dense shrubby understory
Hammond's				3-31	F	6-12	mature conifer with little ground cover; limited understory; some occur in shrubs
Olive-sided	E[b]		F	4.5-21	A		conifers w/ snags and clearings; early post-fire communities; nearby water
Willow	E			1.2	F	0.6-18[h]	2-3 layers of shrubs preferred; presence of water; dense shrub patches with openings for nesting; nest in areas with trees 3-15 m w/ or w/o distinct overstory and very dense <2 m; forage in areas <10 m wide; shrub patches with canopy cover 40-100% and foliage density 50-70% in nesting shrub layer [h]
Grosbeak, Rose-breasted	IE	24.0					
Horned lark			G		G		shortgrass w/ considerable bare ground and grasses <3 cm; widely spaced shrubs <25 cm tall
Jay, Stellar's			F	>3	F	>3	
Kingfisher, Belted			G		W		requires clear, slow-moving water; nest w/i 800 m of water; perching/nest sites limiting
Nuthatch							
White-breasted	I	4.7	C		B		prefer conifers/aspen over riparian
Red-breasted	I[b]		C		B		
Robin, American	E	1.8	F	>3	G		
Solitaire, Townsends			G		F,G	<3	forage in open areas of understory
Sparrow							
Field	E	28.0					
Fox			G		G		dense/shrubby understory associated with water
Lincoln's[b]	E		G		G		boggy areas w/willows/sedges/aspen; wet ground for foraging; nest in dense sedges; associated w/ warblers (Yellow, Wilson's), sparrows (Song, Fox, White-crowned), and Dusky Flycatcher
Savannah		>10[g]					avoid areas with extensive tree cover; prefer intermediate vegetation height and density, sparse or low (<3 m) shrubs; forb:grass (25:75)
White-crowned	E[b]		G		G		requires grasslands, bare ground for foraging, and dense shrubs for nesting; associated w/ Wilson's Warbler and sparrows (Fox, Lincoln's)

Table 7. General Breeding Habitat Requirements of Selected Woodland Birds in North Park, Colorado							
	Breed[a]		Nest[e]		Forage[f]		
Species	Type	Minimum patch (ha)	Type	Ht (m)	Type	Ht (m)	General habitat characteristics[k]
Swallow, violet-green			C		A		
Thrush							
Hermit			F	1-3	F,G	<2	prefer conifer/hardwood; leaf litter for foraging; drier than Swainson's thrush
Swainson's			F	1-1.5	A		similar to veery but less dense understory and larger willows growing in larger patches; associated with sparrows(Fox, Song, Lincoln's White-crowned), warblers (Yellow, Wilson's), and flycatchers (Dusky, Willow)
Towhee, Green-tailed			F,G	<3	G		dry brushy areas w/ open spaces between shrubs
Veery[b]	I	28.0	G	G; <1.5			thick/dense understory
Vireo, Warbling		7.0[d]	F	>3	F	>3-16	widely spaced trees w/ little undergrowth and open canopy
Warbler							
MacGillivray's			F	<3	F	<3	large shrubs; similar to orange-crowned warblers
Orange-crowned			F,G		F	>3; ALL	dense willows; associated with Virginia's and MacGillivray's warblers
Virginia's			G				dense understory;
Wilson's							dense willows
Yellow	E	0.05-0.45[j]	F	0-15[h]	A,F	0-16[i]	require tall singing posts and open space; breeding primarily in willows 1-2 m; shrub densities 60-80% optimal; avoid widely spaced shrubs and forests w/closed canopies; [i]
Yellow-rumped			F	1.2-15	F,G		prefer conifer/aspen;
Waterthrush, Northern							thick/dense willows
Woodpecker							
Downy	IE	16.2	C	1.2-12			small/young trees w/ low canopy
Hairy	I	1.8	C	1.5-18	B		mature forests w/ dense canopy; snags
Wood Pewee, Western			F	2-24		6-23	nests in shrubs (low density); requires trees with exposed branches;
Wren, House	E	2.3	C		F	<3	prefer aspen/cottonwood

[a] From Blake and Karr (1987). Patches sampled ranged from 1.8-600 ha. Habitat classification (I = interior; IE = interior and edge; I = interior) based on literature (Kendeigh 1982, Bohlen 1978, Whitcomb et al. 1981) and authors experience in Illinois.
[b] From Whitaker and Montevecchi (1999).
[c] Robbins et al. (1989) report 20 ha as minimum.
[d] Maximum territory size according to Colorado Breeding Bird Atlas (1998).
[e] From Colorado Breeding Bird Atlas (1998) and Martin (1988); C = cavity, F = foliage, G = ground.
[f] From Colorado Breeding Bird Atlas (1998) and Martin (1988); A = air, B = bark, F = foliage, G = ground, W = water.
[g] From Illinois (Herkert et al. 1993).
[h] From Sogge et al. (1997).
[i] From Morse (1966), Hutto (1981), Schroeder (1982), Knopf and Sedgwick (1992), Stevenson and Anderson (1994), Briskie (1995), Dunn and Garrett (1997), Lowther et al. (1999).
[j] Territory size, which is not equivalent to minimum patch size. From Fryendall (1967) and Lowther et al. (1999).
[k] From Colorado Breeding Bird Atlas (1998) unless otherwise noted.

Table 8. General Breeding Habitat Requirements of Selected Grassland Birds in North Park, Colorado									
Species	Nest Type	Territory (ha)	Patch (ha)	Grass (%)	Forbs (%)	Shrubs (%)	Duff (cm)	VOR (cm)	General habitat characteristics
western meadow-lark	G	2-13[b]	>5[c]; mod. sensitive[c] depredation less on >130[aa]	32-52[m] high[b]	35[a] high[b] 24-41[m]	10-22[m] little or no[b]	0-3[a] low-mod.[b] 2.9-5.3[m]	1.2-2.0[m]	nest in dense vegetation with thick litter cover[s,t]
Savannah sparrow	G	.05-1.25[d]	sensitive[d] may occur <5[g] >10 in Ill.[c] >40 for 50% occurrence[l]	0-20[n] 21-42[m]	2-7[n] 27[a] little[d] 25:75 forbs: grass[i] 16-30[m]	very sparse[e] shrubless[f] 15-40[m]	0-4 territory[a] 1-6 nest[a] well-developed[d] 2.5-5.7[m]	1.4-2.4[m]	open country with short vegetation, moist grassy meadow[s,u]
vesper sparrow				0-7[n]	30[a] 0-10[n]		0-3[a]		sparsely or patchily distributed shrubs with good grass cover[u]
bobolink	G	.45-2.0[r]	>50 for 50% occurrence[l] much higher densities >30 than <10[r]	32-48[m]	28[a] 18-31[m]	12-30[m]	0-4 territory[a] 1-6 nest[a] 1.1-5.3[m]		grassy meadows with nearby forbs and high litter cover[s]
mallard	G			48-50 and 43-49 cm tall[p]				14.7[o] >20[q]	
scaup	G							16[o]	tall vegetation cover in native prairie, meadow, or sparse shrub[w]
blue-winged teal	G			22-24 and 37-39 cm tall[p]				15.1[o]	dense, tall cover[s]
pintail	G			sparse				11.7[o]	open sites with low vegetation, residual cover of short grasses[x]
gadwall	G			48-60 cm tall[p] 25 and >30 cm tall[y]				17.3[o] >20[q]	dense grasses, forbs, or shrubs[y]
common snipe	G	2-12[z]		low, sparse[k]					low grass/sedge or fairly dense low woody growth with open terrain nearby[s]
upland sandpiper	G			0-15 and <30 cm tall[n]	0-8[n]				thick, mid-height grasslands[s]
Wilson's phalarope	G			sparse to mod. dense[j]				<20[j]	moist sedge/rush meadows with low vegetation and adjacent open water[s]

[a] Wiens (1969)
[b] Dechant et al. (1999)
[c] Helzer (1996)
[d] Swanson (1998)
[e] Wheelwright and Rising (1993)
[f] Arnold and Higgins (1986)
[g] Potter (1972)
[h] Herkert (1991)
[I] Herkert et al. (1993)
[j] Kantrud and Higgins (1992)
[k] Arnold (1994)
[l] Herkert (1994)
[m] Madden (1996)
[n] Skinner et al. (1984)
[o] Holm (1984)
[p] Livezey (1981)
[q] Lokemoen et al. (1984)
[r] Martin and Gavin (1995)
[s] Colorado Breeding Bird Atlas (1998)
[t] Lanyon (1994)
[u] Schaid et al. (1983)
[v] Mueller (1999)
[w] Austin et al. (1998)
[x] Austin and Miller (1995)
[y] LeSchack et al. (1997)
[z] Williamson (1960)
[aa] Johnson and Temple (1990)

Wetland

To facilitate discussion and future management planning, the Refuge staff defined wetland habitat as all natural and created ponds and lakes up to the high water mark, excluding the surrounding meadows and riparian corridor. This habitat, henceforth referred to as basins or wetlands, composes 824 acres based on National Wetland Inventory (NWI) land coverage for the Refuge. Three wetland complexes were identified for management purposes, mainly based on location: Case, Illinois River, and Soap Creek. Meadow habitat is defined as the grasslands/old hay meadows on all areas of the Refuge except those along the riparian corridor (which are considered part of the riparian habitat) and consist of 2,683 acres.

Of the wetlands on the Refuge, about 10 percent are natural freshwater basins and about 90 percent are created freshwater basins. Meadows characteristically occur adjacent to wetland basins in lowland sites and in the more upland areas that are irrigated. The Illinois River, Spring Creek, Soap Creek, and Potter Creek flow through the Refuge and are the major source of water to basins and meadows through natural subsurface and surface flows and via a complex ditch irrigation system. Origination of the ditches occurs both on- and off-Refuge with the Illinois River as the major water source. Other surface and groundwater resources also affect the timing, duration, frequency, and depth of flooding among sites.

Goals

Wetland Goal

Provide and manage natural and man-made permanent and semipermanent wetlands (in three wetland complexes) to provide habitat for migratory waterfowl, shorebirds, wading birds, and associated wetland-dependent wildlife.

Meadow Goal

Provide and manage irrigated, grass-dominated meadows historically developed for hay production, to support sage grouse broods, waterfowl nesting, and meadow-dependent migratory birds.

Justification

Water resources are limited in the west and a variety of wetland types (e.g., permanently flooded wetlands, seasonally flooded meadow) are needed to provide the required life resources of migratory birds and other wildlife. Wetland systems are characterized by their flooding patterns (e.g., timing, frequency, duration, depth) (Mitsch and Gosselink 1993) that directly and indirectly determine plant productivity and wildlife use. Wetland complexes (proximate wetlands with different hydrologic regimes) often favor the availability of resources for wetland-dependent wildlife in dry and wet years.

Wetland and meadow on Arapaho NWR have been altered by various artificial disturbances. Because North Park is a cold mountain desert, we assume that historically, aside from the river, most of the water sources likely were temporal and/or seasonal. Early (circa 1900) settlers of Colorado created grassland meadows and dry-land crops in river bottomlands and adjacent sagebrush habitat where soils were suitable and irrigation was possible (Rogers 1964). With the intent of maximizing cattle production, previous landowners presumably used seeps, springs, natural contours, and areas with high water tables to create much of the meadows and perhaps a few of the artificial basins. These areas were used as watering holes, productive range sites, and irrigated hay meadows. Reports indicate that irrigated hay meadows were common in Jackson County before Refuge establishment (Rogers 1964). Historical records show that at least five selected wells on the Refuge were drilled around 1956 by private landowners mostly for domestic and stock use (Voegeli 1965). Three major reservoirs (Case 1,2, and 3), germ and the fish hatchery ponds were created prior to Refuge establishment. However, the majority of semipermanent/permanent basins were created by the Refuge. Largely due to past ranching practices and the construction of various water control structures (including ditches), the extent of sagebrush habitat has declined and the structure and composition of many of the sagebrush and wetland systems have changed. Because the historic conditions of these sites are largely unknown, a complete and accurate description of the structural and functional modifications that have occurred is not possible. Nonetheless, the complex of roads and ditches on the Refuge has invariably altered historic hydrologic regimes by impounding more water for longer periods in some areas and less water for shorter periods in other areas.

Differences among wetlands and meadows on Arapaho NWR vary largely due to: (1) Refuge infrastructure (e.g., roads and ditches that affect water flow, control structures); (2) management (e.g., flooding, burning, grazing, no action); (3) position in the landscape (e.g., degree of slope in and around basin or meadow, size of depression, aspect/solar exposure, horizontal and vertical proximity to the river and water table, juxtaposition of habitat types); and (4) soil characteristics (water-holding capacity, organic/mineral content). Collectively, these characteristics of basins and meadows affect water quality and the availability of moisture and nutrients that influence plant composition and productivity (Mitsch and Gosselink 1993). Different types, abundances, and distributions of plants creates varied habitat conditions that, in turn, support a diversity of wildlife.

Plants in and around wetlands characteristically are distributed in zones largely based on differences in soil and moisture (Castelli et al. 2000). Plants in wetland habitat on Arapaho NWR include species that are adapted to semipermanent/permanent flooding regimes (standing water), a short growing season (33 days), high daily and annual temperature fluctuations (25-40°F, -49-96°F, respectively), and cold mean annual temperatures (36.5°F) (climate data from various sources in Kuhn et al. 1983). Species in wetland habitat are dominated by perennials, including submergents (e.g., sago pondweed, wigeongrass), tall emergents (e.g., cattail and bulrush), and short emergents (a mix of grasses, rushes, sedges, and forbs). The short emergent sites occurring within the high water mark likely are a result of fluctuating water levels among dry and wet years and, therefore, are limited in size and relatively short-lived when high water levels persist. These short emergent areas within wetland habitat are a continuum into meadow habitat (e.g., Windell et al. 1986). Thus, while the boundary defining the margins of wetland and meadow sites remains the same (i.e., defined by the high water mark), the habitat conditions within each habitat type may vary within seasons and among years. Nonetheless, periodic

disturbances (e.g., flooding/drying) are necessary to continually provide diverse habitat conditions and to maintain system productivity.

The ability for the Refuge to provide (1) wetland habitat for migratory waterfowl, shorebirds, wading birds, and associated wildlife and (2) meadow habitat for sage grouse broods, waterfowl nesting, and meadow-dependent migratory birds has been achieved in past and recent years (refuge files). Regardless, adaptive management practices will be implemented to improve the quality and quantity of those resources and to increase management efficiency (cost vs. benefit). In this process, changes on- and off-Refuge that potentially influence management are considered. The relative importance of a particular habitat or wildlife species often changes or new information (e.g., species-habitat relationships or management strategies) influences management approach. For example, sage grouse has become a species of concern in North Park, and we are evaluating how we can best support the species throughout the annual cycle (nesting, brooding, and wintering).

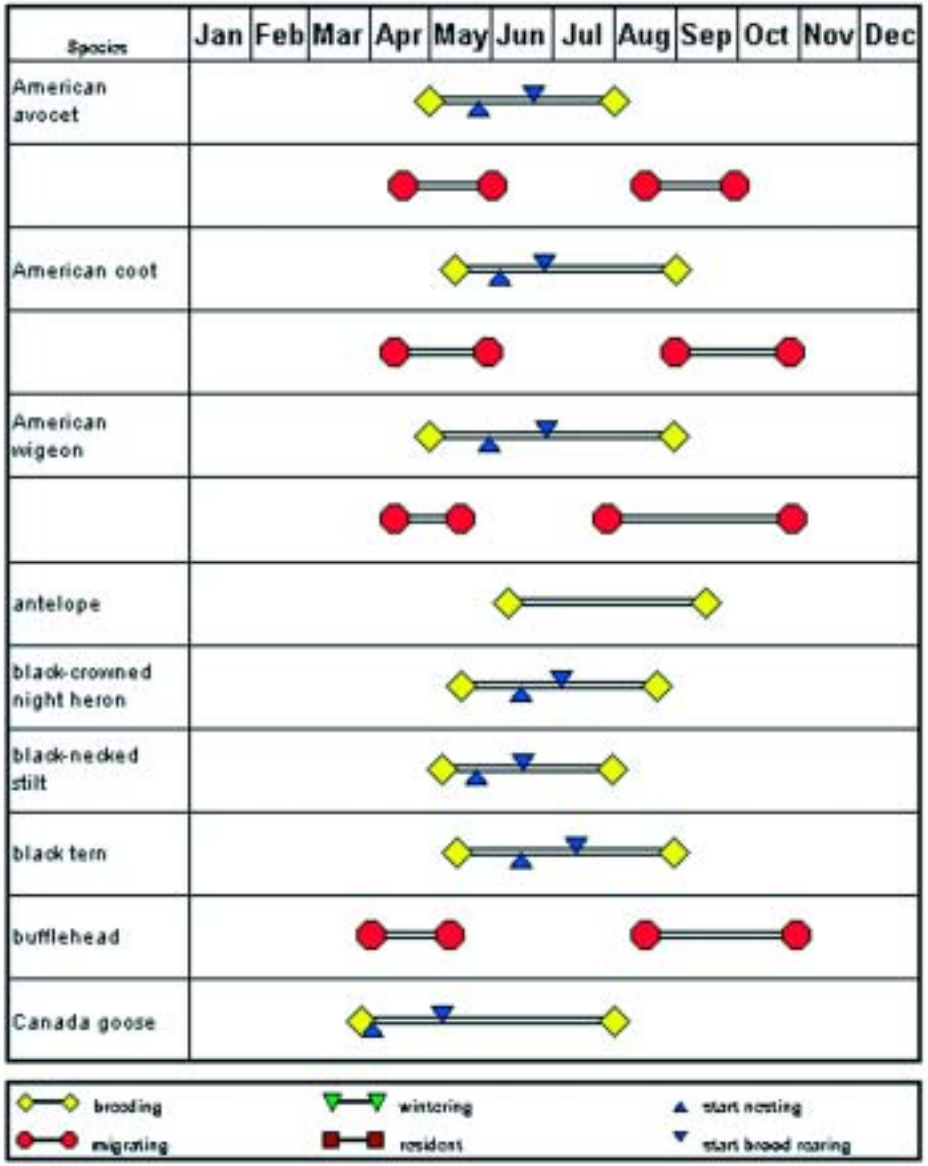
Wetland and Meadow Objectives

Rationale

Because the habitat characteristics (e.g., vegetation composition and structure) on Arapaho NWR are not currently quantified, we used the known habitat requirements of a select group of wildlife species to facilitate the process of writing habitat-based objectives. Required resources of the selected species effectively represent the range of potential habitat conditions that naturally may have occurred in wetland and meadow habitat on Arapaho NWR. As stated in the goal, wetland habitat on the Refuge will be managed for migratory waterfowl, shorebirds, wading birds, and associated wetland-dependent wildlife. Thus, particular attention was paid to wetland-dependent species and species of Refuge concern and consideration was given to multiple bird conservation plans/lists (e.g., State and Federal threatened and endangered species, Partners in Flight, Bird Conservation Regions). Further, species habitat requirements typically vary among life cycle events (e.g., migrating, nesting, brood-rearing) and, therefore, the chronologies of these species events were identified with respect to Refuge use periods to maximize resource availability (See Chronology Charts starting on next page). Because the life requisites of plants and wildlife vary temporally and among species, different types of conditions (e.g., height, density, composition, water depth) must be provided within each of the habitat types (i.e., upland, riparian, wetland, meadow) at particular times in the year (e.g., nesting, migration). Each objective describes a range of habitat conditions that is within the management capabilities of the Refuge. Collectively, these objectives support a high diversity of wildlife species.

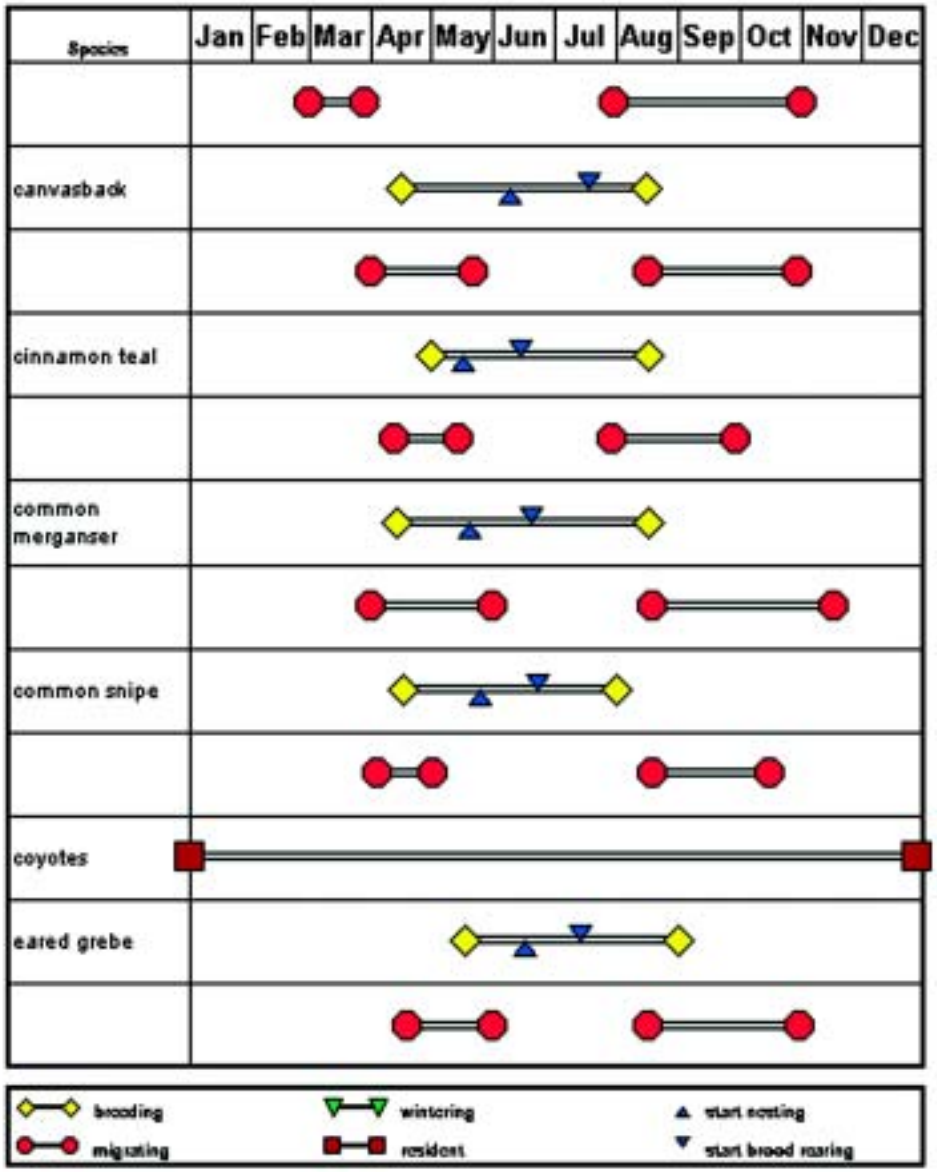
Habitat Use Chronology
Arapaho National Wildlife Refuge

Chronology Chart #1



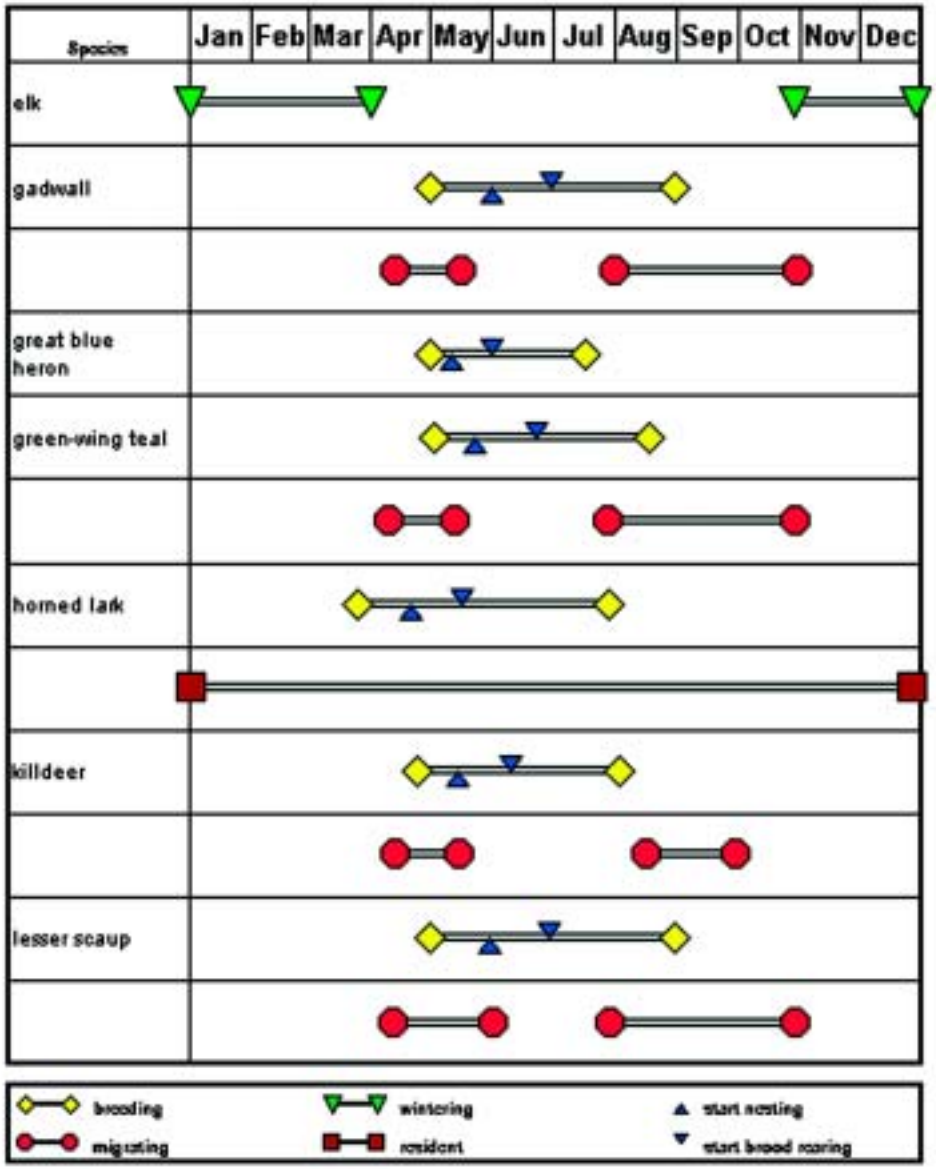
Habitat Use Chronology
Arapaho National Wildlife Refuge

Chronology Chart #2



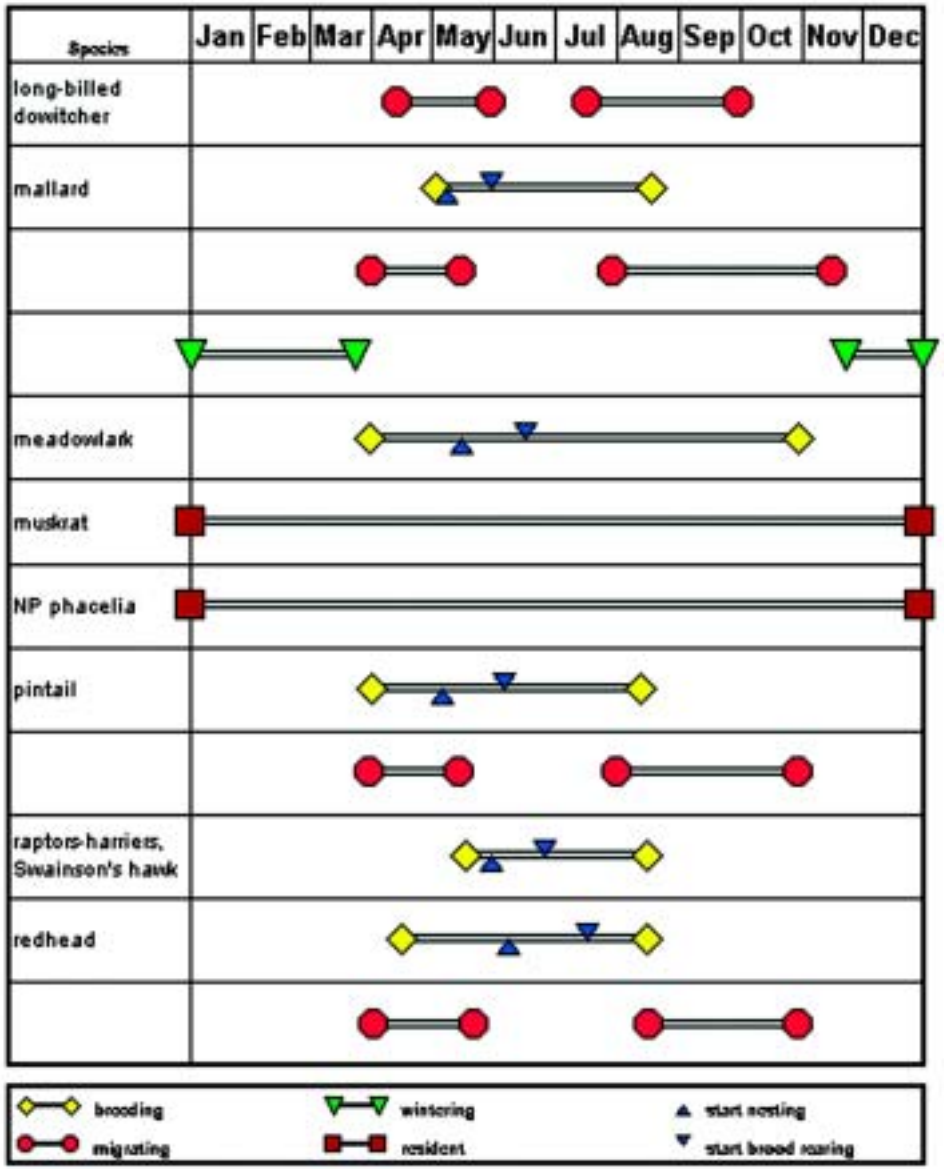
Habitat Use Chronology
Arapaho National Wildlife Refuge

Chronology Chart #3



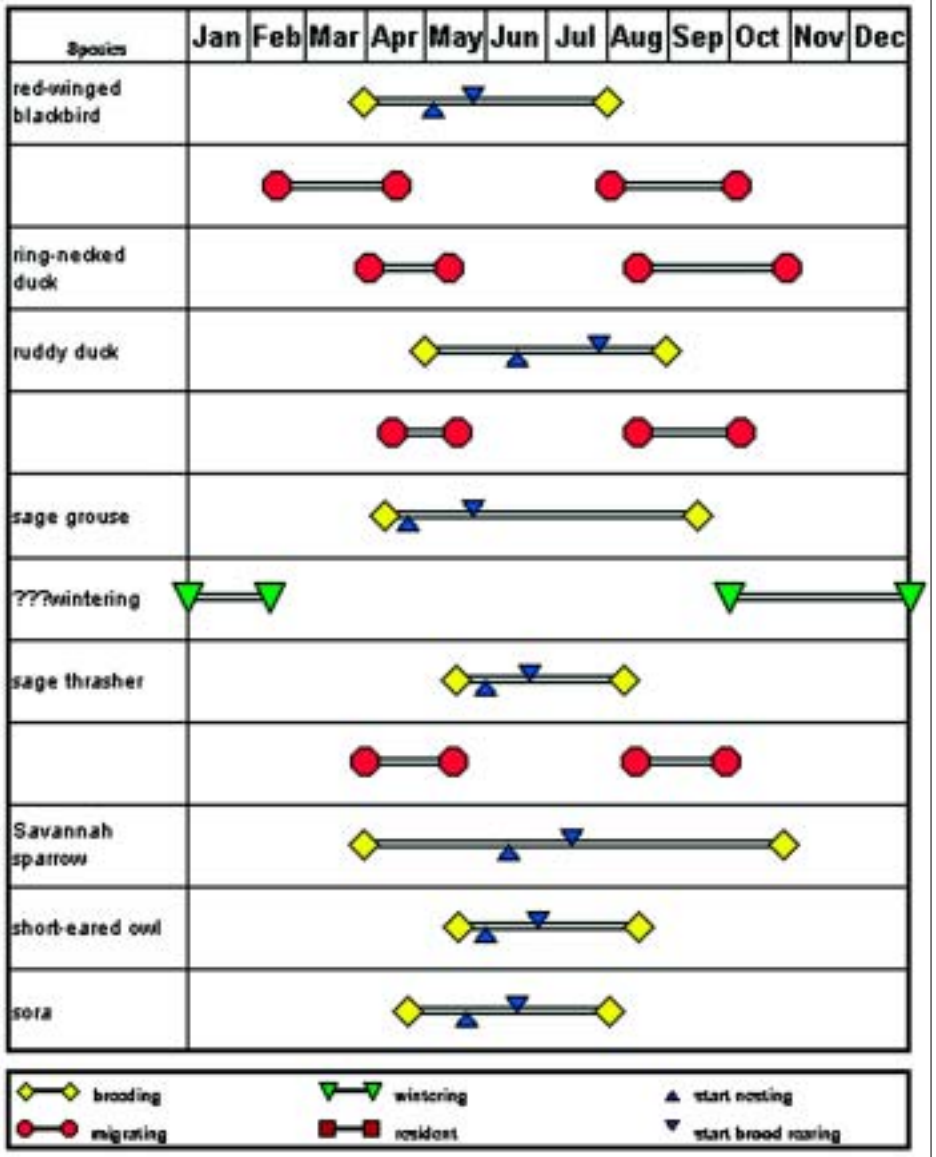
Habitat Use Chronology
Arapaho National Wildlife Refuge

Chronology Chart #4



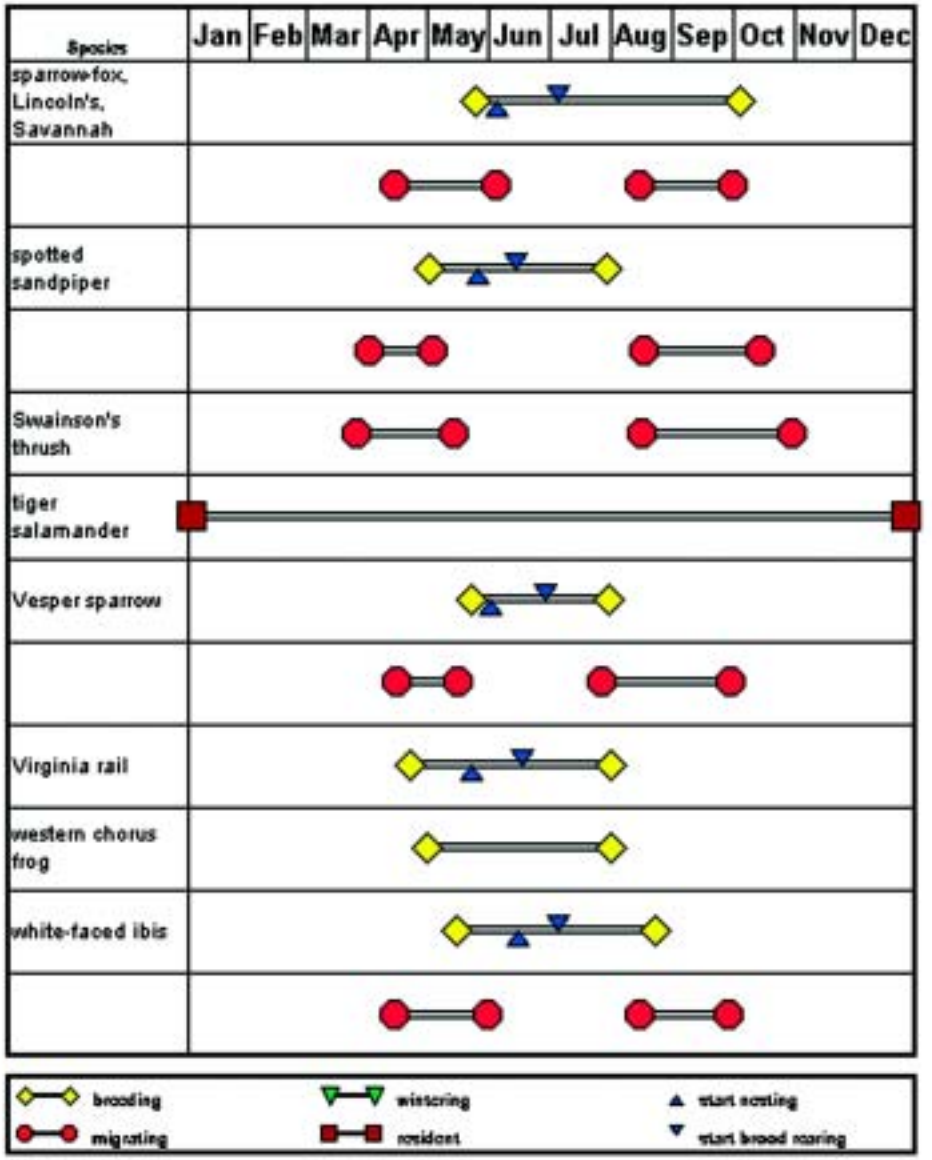
Habitat Use Chronology
Arapaho National Wildlife Refuge

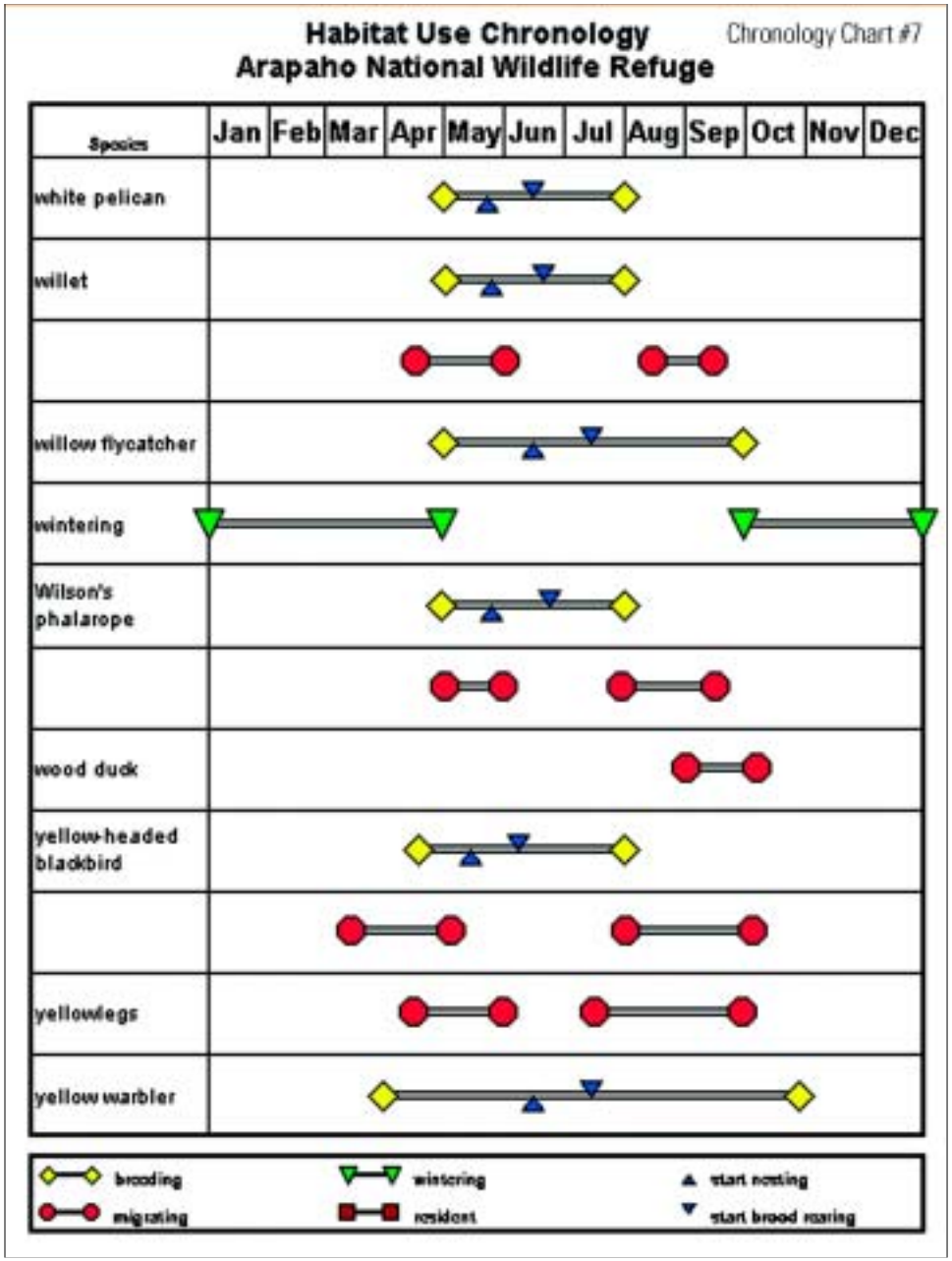
Chronology Chart #5



Habitat Use Chronology
Arapaho National Wildlife Refuge

Chronology Chart #6




Habitat Use Chronology
Arapaho National Wildlife Refuge
Chronology Chart #7
Species
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
white pelican
willet
willow flycatcher
wintering
Wilson's phalarope
wood duck
yellow-headed blackbird
yellowlegs
yellow warbler
breeding
wintering
start nesting
migrating
resident
start brood rearing

Wetlands

The Refuge will try to manipulate wetlands to fulfill the habitat needs of the diverse wetland-dependent wildlife. Much of the information on wetland species-habitat relationships results from studies conducted outside the intermountain region. While the existing information describes potentially important relationships, we must consider the source of information (e.g., what, where, when, why, and how data collected) when actual and theoretical outcomes do not coincide.

Wetland habitat selection by water birds is largely dependent on species and scale (Brown and Dinsmore 1986; Gibbs et al. 1991; Orians and Wittenberger 1991). Studies have demonstrated that wetland use by breeding birds that are wide-ranging (e.g., black tern, northern pintail) is greatly influenced by landscape level features (e.g., landscape heterogeneity, wetland isolation/density, surrounding habitat types and conditions), while use by other birds (e.g., Virginia rail, pied-billed grebe) largely is affected by habitat characteristics within the area of the nest wetland (e.g., local vegetation conditions; Brown and Dinsmore 1986; Naugle et al. 1999; Naugle et al. 2001). Farmer and Parent (1997) indicated that the foraging efficiency of migrating shorebirds increases when the distance between small wetlands decreases, forming a complex.

At the wetland scale, habitat characteristics that variably affect wetland use by water birds largely include wetland size and type, distance to shore, amount and distribution of shoreline vegetation, distance to nearest open water, distance to nearest vegetated edge, surface water area, and the interspersion of cover and open water areas. Weller and Spatcher (1965) recorded differences in the abundance and distribution of many bird species in relation to changes in habitat condition of the marsh and at nest sites. While bird species numbers and diversity were highest when the cover:water ratio reached 50:50 (hemi-marsh), the interspersion of cover and open water areas seemed even more important. For example, grebes and waterfowl preferred areas with waterways through the emergent vegetation that connected various pools. Studies also show that hemi-marsh conditions do not satisfy the requirements of all species and preferences of cover:water interspersion for a given species may vary temporally (Weller and Spatcher 1965; Murkin et al. 1997). In another study, habitat preferences of the horned, eared, and pied-billed grebes largely differed according to basin size and the amount and distribution of shoreline vegetation. Horned grebes selected smaller ponds than eared and pied-billed grebes, whereas pied-billed grebes used ponds with relatively more shoreline vegetation relative to the other grebe species. In part, these differences were attributed to behavioral characteristics. Typically, horned and pied-billed grebes nested in isolation and needed visual separation, while eared grebes nested colonially and needed more space for nesting. The importance of distance parameters in habitat selection is less clear likely due to how it differentially relates to bird behavior (e.g., solitary vs. colonial nesters, secretive vs. social species, territoriality) and other habitat variables (e.g., wetland size (Boe 1993), proximity to other habitat types).

The significance of microhabitat characteristics in determining bird use within a wetland, such as structure (plant height and density), plant composition, litter, and area, was discussed in the riparian habitat section. Those same concepts similarly apply to other habitat types, including wetland habitat. In addition, water depth at nesting and foraging sites are distinctive features of wetland habitat that greatly affect bird use. Relationships between water depth and water bird use are discussed under the objectives below.

Objective

Maintain 10 acres of, and attempt to establish in one other wetland basin, tall (>60 cm VOR) emergent vegetation in water depths >4 cm over a 5-year period to provide nesting habitat for over-water nesting birds (black-crowned night-heron, white-faced ibis, waterfowl, marsh wrens, coots, and blackbirds).

Value

The most conspicuous attribute of this habitat condition is the tall, dense vegetation that provides the necessary nesting cover for large-bodied wading birds (e.g., black-crowned night-heron, white-faced ibis) and more secretive waterbirds (e.g., rails). No other habitat objective shares this feature. The vegetation density largely is a function of the litter or duff layer (the amount of new and residual plant growth), commonly used by water birds as nesting substrate. As well, flooded emergent litter is important for macroinvertebrate production in the spring (Nelson et al. 1990), prior to the emergence of submergent vegetation (Nelson and Kadlec 1984). Invertebrate matter is a primary source of protein for many wetland and terrestrial birds (Fredrickson and Reid 1986). Waterfowl especially rely on invertebrate matter as a component of their diet during the breeding (Bartonek and Hickey 1969; Krapu and Reinecke 1992; Baldassarre and Bolen 1994) and brood-rearing seasons (Sudgen 1973; Cox et al. 1998).

Achievability

The current coverage of tall emergent vegetation (primarily cattail [*Typha spp.*]) on Arapaho NWR is extremely limited. Our attempt to maintain the estimated 10 acres that currently exists is largely experimental as we learn more about our ability to manage for the desired habitat condition described in the objective. We believe it is possible because it exists in similar high elevation parks in Colorado, specifically South Park and the San Luis Valley. Our present concern is that some of our wetland basins have margin slopes that do not favor plant germination. In addition, some of our basins possibly have enough sedimentation accumulation and turbidity to adversely effect germination of some plant species. Most of the sedimentation comes through the ditches that enter the ponds. Wang et al. (1994) found that sediment loads of 0.2-0.4 cm decreased cattail seed germination by 60-90 percent. Further, coarse-textured sediments had more adverse effects on seedling density compared to fine-textured sediments (Dittmar and Neely 1999). If sedimentation has occurred, the source (e.g., bank erosion, inflow from adjacent uplands or ditches), extent (e.g., current sediment load, seed burial, turbidity), and rate of sedimentation (e.g., retention/re-suspension of potential of bottom materials, past and current rates of inflow, wind action, shoreline slope) should be examined. This information in addition to

our ability to manage water levels may indicate which sites have the highest management potential for cattail establishment.

Strategies
To encourage germination and establishment of cattail, experimental wetland basins that show the highest potential for cattail establishment would need to be selected. Selection criteria may include water control capabilities, rates of evaporation (e.g., how fast <1 inch of water becomes a mudflat and how soon mudflat dries out completely), amount and distribution of existing cattail in each basin, and shoreline conditions (slope). Our ability to expose mudflats when temperatures are optimal for cattail germination (25-35° C) would have to be evaluated for relatively dry, average, and wet years. For established cattail stands, effective management requires periodic disturbance. Disturbance characteristics (e.g., flooding depth, frequency, duration) and timing in relation to the annual cycle of cattail growth will largely determine cattail response (Beule 1979; Apfelbaum 1985; Sojda and Solberg 1993).

An understanding of the environmental conditions that favor and discourage cattail germination and growth likely will improve our ability to manage for the desired habitat condition described in the objective. Cattail reproduces by seed and vegetatively via rhizomes. Germination of cattail occurs in shallow water depths (e.g., ≤0.5 inch of water, Sojda and Solberg 1993) and on mudflats (van der Valk and Davis 1978; Sojda and Solberg 1993) under a wide range of temperatures (Sojda and Solberg 1993). Results of greenhouse experiments indicated that cattail germination required flooding (Bedish 1967). Cattail germination seemed best in water 1 inch deep when light and temperatures were optimal (Bedish 1967; Weller 1975). Under field conditions, most studies show germination of cattail occurs after mudflats have been exposed (Beule 1979). Subsequent shallow flooding may promote seedling establishment (discussed below). Fully saturated or flooded soils produce anaerobic conditions near the soil surface (e.g., <2 cm, Mortimer 1971 in Bonnewell et al. 1983). Cattail seed germination was reported highest on the soil surface, but occurred <1 cm below the surface of sandy soil (Galinato and van der Valk 1986). Studies show reduced O_2 concentrations promote cattail germination (Hutchinson 1975 in Bonnewell et al. 1983). Bonnewell et al. (1983) found that germination of submerged cattail seeds was maximized in O_2 concentrations of 2.3-4.3 mg/L. In the same study, seeds flooded for <24 hours had higher germination then those flooded for 7 days. Seed germination of cattail was significantly reduced by 1000 mg/L of NaCl (Galinato and van der Valk 1986). A salinity of 10 ppt was responsible for the decreasing cattail cover that was flooded for most of a growing season (Sojda and Solberg 1993). Thus, especially in arid environments, it is important to pay close attention to increasing soil and/or water salinities as water levels decrease. Though results vary, optimum soil-surface temperatures for cattail germination generally range 25-35 degrees C (Bonnewell et al. 1983; Sojda and Solberg 1993). Bonnewell et al. (1983) found no germination occurred at 10 degrees C and was very low at 15 degrees C. Long light exposure is another cattail germination requirement and an environmental characteristic of open mudflats (Bonnewell et al. 1983). Following germination, cattail establishment may occur fastest in 1 inch water depth, though it is able to grow well in saturated soils and in water 6 inches deep (Bedish 1967). Once mature plants are established, cattail may tolerate a range of water depths (generally ≤20 inches). However, extended periods of deep (>26 inches) flooding have stressed cattail plants and may terminate growth (Apfelbaum 1985; Sojda and Solberg 1993). In Wisconsin, cattail endured water depths of 3 ft (91 cm) for <2 full growing seasons before a die-back was observed (Beule 1979).

In the process of managing to favor cattail germination, other benefits are gained depending on the timing of a drawdown or flooding event. For example, food resources may be made available as a result of a drawdown during spring or fall migration. A drawdown may also stimulate Submerged aquatic vegetation beds.

Objective
Provide 10 percent of the wetland acres over a 5-year average in short (<10 cm), sparse (<10 cm VOR) emergent vegetation in water depths <4 cm from April to August to provide foraging habitat for shorebirds and waterfowl, as well as nesting and brood-rearing habitat for shorebirds.

Shallowly flooded, short, sparse emergent vegetation are typical foraging sites for many waterbird species (Fredrickson and Reid 1986; Helmers 1992; Laubhan and Gammonley 2000). This habitat condition is notably important for various shorebird and waterfowl species that occur on Arapaho NWR during spring and fall migration and throughout the breeding season (April to August). Further, while similar habitat exists off-Refuge in North Park, we feel the number of sites that satisfy all the conditions (e.g., <4 cm water depth) described in this objective is limited. In part, this habitat condition may be limited because of differences in land management objectives of on- and off-Refuge sites. Relatively open stands of vegetation allow shorebirds to utilize visual and/or tactile strategies to acquire food resources that occur in sites with dry/moist ground and/or in flooded sites with water depths of <10 cm (Helmers 1992). While morphological attributes (tarsus and culmen length; Baker 1979), foraging preferences, and nesting behavior (semi-colonial, solitary) differ among shorebird guilds (Helmers 1992), habitat conditions (water depth <4 cm) described in this objective primarily allow relatively small bodied shorebirds of the Interior Region (e.g., plover, curlew, turnstone, small and medium sandpipers, yellowlegs) to exploit the necessary invertebrate resources typically found in newly flooded areas. The medium to large bodied shorebirds (godwit, avocet, stilts, phalarope) also may use these areas for foraging and nesting, but more characteristically forage for invertebrates resources in water depths >4 cm and <20 cm (Helmers 1992).

Objective
Provide 20 percent of the wetland acres over a 5-year average of emergent vegetation >25 cm tall with visual obstruction reading >80 percent of vegetation height in water depths 4-18 cm to provide escape cover and foraging habitat for dabbling duck broods and molting ducks, and foraging habitat for water birds.

Unlike the habitat conditions described in the other wetland objectives, these conditions provide both shallow water and moderately dense cover that is especially important for

water birds with relatively low mobility (e.g., molting ducks, broods). The relatively shallow water increases the availability of food resources and the moderate cover permits movement and concurrently decreases the risk of predation. Brood-rearing habitat is a limited resource in North Park in dry years partly because of the arid climate and agricultural activities that demand water resources earlier in the growing season. While agricultural activities have created reservoirs for irrigation that provide some brood habitat, they do not always satisfy all the conditions described in the objective and may differ from habitat provided on-Refuge in terms of quality.

Value
The availability of different habitat conditions may benefit a greater diversity of wildlife species and/or support species for longer periods in their annual life cycle.

Achievability
The above two habitat objectives are created when water levels in wetland basins are artificially and/or naturally drawn down (e.g., to encourage germination and growth of emergent vegetation or to stimulate submerged aquatic vegetation growth). At present the Refuge tries to provide some shoreline habitat for spring migrating shorebirds resulting from drawdowns. In fall, water levels naturally drop in many of the ponds and spring flooding also creates much shallow water. The Refuge is unique in North Park in managing for shorebirds. Slow, staged drawdowns can work well, but cannot refill basins in most years. Nevertheless, those habitat conditions likely are similar to historic dynamics of many of the natural basins. Drawdown will also help Submergent aquatic vegetation beds.

Strategies
Strategies used to achieve habitat described in Objective 2 involve both drawdowns and back flooding of different areas to create the habitat described. For Objective 3, drawdowns will provide the desired conditions in subsequent years.

Objective
Provide 10 to 20 percent of the wetland acres, within each wetland complex, over a 5-year average with 70 percent coverage of submergent species (*Potamogeton, Ruppia*) in wetlands of >18 cm water depth provide invertebrates and seed sources for foraging water birds, especially waterfowl broods, and escape cover for diving ducks.

Value
Submergent vegetation provides complex structure for macroinvertebrate production when it becomes established in early summer (Krull 1970, Voigts 1976, Nelson and Kadlec 1984). Sago pondweed and wigeongrass are two major submergent plant types that occur on Arapaho NWR. Both submergents are reputable productive waterfowl food resources (drupelets, tubers, stems/leaves, and invertebrates; Kantrud 1990, 1991). Waterfowl broods rely heavily on the availability of both invertebrate and plant foods (Sudgen 1973). In addition, these submergents are used by many wetland-associated wildlife species (Kantrud 1990, 1991) for nesting, foraging, and escape habitat.

Achievability
Some submergent vegetation already exists on the Refuge, but its occurrence has not been a result of actively managing for its production. These habitat conditions have regional importance due to the limited availability of quality open water habitat (e.g., extent of submergent vegetation with water depth >18 cm proximate to nesting habitat) in North Park during the brood-rearing season. By managing for these habitat conditions within each complex, we will maximize the availability and accessibility of resources that these habitat conditions provide.

Strategies
A monitoring plan will be developed to show when significant changes from *Potamagetons* and wigeongrass to other submergent types occur on Arapaho NWR, signifying the need for a drawdown. In order to favor wigeongrass production, Hietzman (1978 in Kantrud 1991) recommended drawdowns to consolidate and oxidize sediments when silt deposition and decomposing vegetation on the substrate was deeper than about 4 cm. Otherwise, wigeongrass might become poorly rooted and susceptible to damage by wave action. Partial early spring and fall drawdowns and complete summer drawdowns with reflooding in the fall have also been used to stimulate wigeongrass growth (Kantrud 1991). Wigeongrass shoot survival may increase if produced earlier in the growing season and if able to reproduce. Also, floating fragments may eventually grow roots, sink, and attach to the bottom substrate. Water level manipulations have also been used to encourage sago production, but success has varied. Where sediments are high in organic material, complete drawdowns may be used to release nutrients that may stimulate sago production when the wetland is reflooded. Partial drawdowns (e.g., to 0.3 m water depth by August in the aspen parkland region of Canada) have increased Sago and other pondweed production as well (Kantrud 1991).

Accomplishing this objective requires management that encourages the production of macrophytes, specifically sago pondweed (*Potamogeton pectinatus L.; sago*) and wigeongrass (*Ruppia maritima L.*). Unless otherwise cited, all information on the germination and growth requirements of sago and wigeongrass was derived from Kantrud (1990, 1991), respectively.

Sago has a circumpolar distribution and has exhibited both annual and perennial life cycles due to its ability to adapt to a wide range of environmental conditions. Sago absorbs nutrients from the water column and, therefore, may be rooted (>0.5 m in sandy soils and <0.5 m in finer textured soils) in sediments with low oxygen levels. Sago vegetative growth begins when water temperatures are 10 degrees C (late March - late June), but may not reach the water surface for weeks (May - mid-July). Low light conditions increase the rate of growth. Sago may reproduce from fruit (drupelets), but more often reproduces vegetatively via root or stem structures termed winter buds, tubers, or turions. The number of turions often far exceeds that of drupelets and some sago plants only use this form of reproduction, especially in permanently flooded wetlands. Germination and turion growth is maximized when temperatures are 15-26 degrees C. Minimum temperatures reported for turion germination in the field are 5.5 degrees C and temperatures of >30 degrees C may inhibit germination. Germination of drupelets and development of overwintering turions may occur as early as late March. New drupelets form about 3 weeks after flowering. Drupelets exposed for >1 year on dry

substrate and then moistened may germinate in >4 days. Turions develop at the tips of branches that grow from rhizomes (beneath the surface of the substrate) and at the tips of leafy shoots (above the surface of the substrate). It is unclear whether turions are produced throughout the growing season or after peak plant biomass. Peak turion development occurs in late summer or early fall. Turions may remain viable from one to several years, longer when conditions are flooded compared to exposed. It has been reported that when sediment moisture was <23 percent for 2 weeks, most overwintering turions did not germinate due to desiccation. Vegetation senecas sometime between late August - October.

Several environmental factors regulate sago growth. As with most macrophytes, production and depth distribution of sago is largely determined by water transparency or turbidity. Turbidity is an environmental condition resulting from complex interactions involving characteristics (e.g., texture, slope, aspect) of the bottom substrate, wave action (prevailing wind speed and direction in relation to basin size) or water movement (e.g., bottom-feeding fish activity), and water chemistry. A secchi transparency of >60 cm seems to favor sago growth and low production has been reported where secchi depths were <30 cm. Field studies indicate that sago growth does not occur in waters with pH<6.3 and >10.7. A study that sampled 116 sites where sago occurred in central North America found a mean pH of 8.5. Optimum biomass occurs at 2-15 g/L TDS and lower values within this range favor reproductive material (propagules). Sago often occurs in waters high in CO_3 or HCO_3 ion (>18 mg/L). Sago may be out-competed by Ruppia in SO4-dominated waters with salinities >26 g/L and by other macrophytes in HCO3-dominated waters with salinities <0.7 g/L (Stewart and Kantrud 1972 in Kantrud 1990). Relative to sago, wigeongrass is a more salt tolerant macrophyte and *Utricularia vulgaris* is less salt tolerant. As water levels fluctuate and environmental conditions (e.g., water chemistry) are modified, changes in composition of submergent plant species will occur naturally.

Like sago, wigeongrass is adapted to a wide range of environmental conditions. It also exhibits annual life cycle traits in extreme environmental conditions (e.g., drought, high salinities) and perennial traits in more stable environments where productivity usually is highest. Almost all below ground biomass is within 10 cm below the surface of the bottom substrate and close to 90 percent is within 5 cm. Rhizomes occur within a few mm and most drupelets within 5 cm of the surface of the bottom substrate. The shallow root system makes turbulent waters a limiting factor. Wigeongrass is able to grow in well-oxygenated and reduced sediments if able to obtain enough oxygen from photosynthesis. Numerous flowers are produced about 5-6 weeks after wigeongrass begins growth. Drupelets and rhizomes on overwintering plants develop about 2 weeks after the start of flowering. Annual wigeongrass requires water temperatures of 10-33° C to complete its life cycle. Temperatures for drupelet germination and seedling development occur at 10-20° C and 15-25° C, respectively. Peak growth typically occurs sometime in July or August in temperate regions. In north temperate wetlands, temperatures of >30° C may adversely affect wigeongrass growth. Measurements of water transparency have indicated the importance of light as a growth requirement of wigeongrass. In Canada, wigeongrass dominated in waters with a Secchi disk reading of 3.0 m (Gallup 1978 in Kantrud 1991) and, in another study, biomass decreased with Secchi disk reading <1 m (Bailey and Titman 1984 in Kantrud 1991). However, other environmental factors may have contributed to the reported increases and decreases in wigeongrass growth.

Below ground biomass has been reported most productive in well-oxygenated, coarse-textured sediments. Optimum growth of wigeongrass in the laboratory and the field occurred in 0.4 m and 0.6 m water depths, respectively. The most productive growth of wigeongrass in finer substrates (clay and silt) occurred in water depths of >0.61 m compared to up to 4.0 m in sandy substrates. Germination of drupelets will occur in shallow water depths (5-10 cm), but plants produced may have low drupelet production. Germination of drupelets is reduced or may not occur if buried >10 cm, exposed on moist soil, in sediments with >1-2percent soluble salts, or in waters with NaCl concentrations of 15 g/L. However, drupelets are highly drought-resistant, may recover from high salinities when inundated in freshwater for about 2 weeks, and may remain viable for <3 years. Water chemistry (e.g., salinity, alkalinity) parameters for wigeongrass occurrence seem to vary greatly among study locations (e.g., regions, lab vs. field) and among plant life stage (e.g., germination, growth, reproduction). Generally, it tolerates higher salinities than other submersed macrophytes and does not do well in fresh, soft, or acidic water. In the prairie pothole region, Stewart and Kantrud (1972 in Kantrud 1991) reported the greatest abundance of wigeongrass occurring in waters with salinities 0.35 to >100 g/L. While other studies in prairie wetlands found wigeongrass commonly occurring in waters with salinities ranging from 15 to >45 g/L (Millar 1976 in Kantrud 1991) and abundantly fruiting where salinities were 36 g/L (Metcalf 1931 in Kantrud 1991). Wigeongrass generally occurs in natural waters with alkalinities of about pH 6.0-10.0.

Other key factors to consider in macrophyte production is the amount of algae and phytoplankton growth. Extensive algae cover may limit light, temperature, and oxygen (from photosynthesis) necessary for macrophyte growth. Phytoplankton achieves high growth rates when nutrient availability is high (e.g., from water inflows) and, like epiphytic algae, may affect photosynthesis of wigeongrass.

Meadow

The Refuge will maintain and enhance existing meadow habitats to provide grass-forb communities, composed primarily of native plants, to benefit migratory birds and other wildlife species.

Rationale

The meadow objectives are written similarly to riparian objectives 2 and 3 and the rationale for those riparian objectives applies to these meadow objectives. Therefore, in this section, we will only note how the meadow and riparian habitat areas differ and how those differences may influence wildlife use. Major differences include the proximity to different habitat types (e.g., the river in the lowland), the riparian habitat is subject to flooding from the river channel, and plant composition (e.g., willow in riparian zone and not in upland irrigated meadows).

(1) Provide 20 to 50 acres over a 5-year average of grass-forb (75:25) plant community composed primarily of native plants (rushes, sedges, grasses, forbs) characterized by <20 cm height, <10 cm VOR, with dry to moist soils (no standing water), adjacent to (within 50 m) or intermingled with sagebrush (10-25 percent sage canopy cover), from early June to July, to benefit sage grouse and snipe broods.

Value
North Park has developed a Sage Grouse Working Plan for the declining sage grouse population in the Jackson County. We suspect that the current amount of interspersed grasses and forbs in the sagebrush may not support a sufficient abundance of arthropods and invertebrates for foraging sage grouse broods. Meadows have the moisture and nutrients that encourage plant growth. The decomposing plant matter promotes invertebrate production. We believe that if we provide some meadow habitat devoid of surface water during the brood-rearing season, these food resources would be accessible to sage grouse broods. Meadow areas that are proximate to the sagebrush may increase sage grouse survival because they would not have to travel as far for different resource requirements.

Achievability
Management of these habitat conditions in the meadow is somewhat experimental to see if we are able to create sage grouse brood habitat (some in riparian zone too).

Objective
Provide 630 to 790 acres, over a 5-year average, of a grass:forb (75:25) plant community composed primarily of native plants (grasses, sedges, forbs, and rushes) characterized by >30 cm VOR, 10-20 cm duff layer and minimal (<5 percent) bare ground to benefit nesting waterfowl (mallard, gadwall, pintails, scaup), songbirds (savannah sparrow, meadowlark), and foraging shorebirds if flooded (snipe, phalarope, white-faced ibis, curlew, willet, and sora).

Achievability
We currently are able to keep maybe 40 percent of the meadows flooded through end of July in most years. Only about 20-30 percent of the meadows defined as dense in the riparian objectives can be kept flooded to 2-3 inches through July most years (largely due to channel alterations). Therefore, we must try to enhance the irrigation systems to providing more of this type of habitat in upland meadow areas.

Objective
Provide 1,650 to 1,850 acres, over a 5-year average, of a grass:forb (75:25) plant community composed primarily of native species (grasses, sedges, forbs, and rushes) characterized by 10-30 cm VOR, 0-10 duff layer and minimal (<5 percent) bare ground from mid-April to the end of July to benefit nesting waterfowl (gadwall, shoveler, pintail and green-winged teal) and sage grouse broods.

No substantial differences exist in the meadow and riparian habitats in regards to this objective.

Upland Habitat

Refuge Habitat Description
The upland habitat consists of 14,285 acres of a shrub-steppe plant community dominated by sagebrush, drought tolerant perennial bunchgrasses and forbs. Uplands are the dominate Refuge habitat type and includes all lands not accounted for in the wetland, meadow and riparian descriptions. Many upland habitats exhibit a mosaic pattern around meadows sites on the Refuge. These sites are generally managed in conjunction with associated meadows, including using the same grazing regime. The focus of past Refuge management efforts have been to create quality wetland habitats, therefore general upland plant community information is limited.

History
Historically, the shrub-steppe community encompassed 9.4 million acres in the intermountain west. Early explorer accounts of sagebrush densities are varied and conflicting. Vale (1975) reviewed 29 historic explorer documents and concluded that presettlement (prior to 1843) conditions included a range type dominated by sagebrush, and that grasses became more scarce as you traveled west. Alternately, Stewart (1941) concluded that historical documents emphasized an abundance of grass under pristine conditions. Historical records are too incomplete to tell us what comprised the pristine vegetation of the Artemisia ecosystem (Young et al. 1984). Geologist F.V. Hayden entered North Park in 1868 and described the site as "an excellent grazing region" and reported seeing "myriads of antelope" that were "quietly feeding." Naturalist George Bird Grinnell entered the Park in 1879 near the Pinkham ranch and writes "the country at this point had been burned over, and was black and extremely desolate in appearance; I learned from the owner of the ranch that the burn had been made to clear off the sagebrush which takes up so much room that might be occupied by grass" (in) (Hampton 1971). The historic plant composition of the North Park basin may never be determined; however, it is likely relatively similar to today's conditions. The shrub-steppe community is dominated by sagebrush, and a small percentage of grasses and forbs. Relative abundance of the plant components has been altered by range management practices (fire, grazing, mowing, and chemicals) over the last 125 years.

Vegetation types
Dominant Sage:
The intermountain west contains 11 sagebrush species and 13 sagebrush sub-species. Big sagebrush (*Artemisia tridentata*) and its five subspecies is the most common and widely distributed (McArthur 1992). The three most common big sagebrush species are basin big sagebrush *(A. tridentata tridentata*) also potentially the largest and most floriferous; mountain big sagebrush (*A. tridentata vaseyana*); and Wyoming big sagebrush (*A. tridentata wyomingensis*) the smallest and least floriferous (McArthur and Welch 1982). Most sagebrush species distribution is controlled by moisture-elevation gradients, seasonal moisture and soil properties (McArthur 1992). Generally, *A. tridentat tridentata* occupies deep soils, with minimal profile development in low to moderate precipitation and moderate-elevations. *A. tridentata wyomingensis* prefers to occupy moderate depth, low-to-moderate precipitation and lower elevations. *A. tridentata vaseyana* dominates areas where moisture improves and high elevations. Big sagebrush traits

include good digestibility, high winter crude protein and provide high winter phosphorus and carotene (Welch 1983; Welch and McArthur 1990). Herbaceous growth in sagebrush occurs only when the appropriate warm temperatures and available soil moisture occurs in the late spring and early summer (West 1996). Summer precipitation is usually not sufficient to allow plant growth; fall moisture patterns are too sparse to allow plant regrowth. The three primary sage species located on the Refuge include basin big sagebrush, mountain big sagebrush and Wyoming big sagebrush; however, small stands of silver sagebrush (*A. cana*), alkali sagebrush (*A. longiloba*), fringed sage (*A. frigida*), black sage (*A. Nova*), and others may exist. The Refuge lacks basic plant inventory and distribution data to fully assess and manage upland habitats. Therefore, the Refuge proposes to complete an uplands plant survey prior to the year 2008 that will facilitate future management.

Young (et al. 1976) describes the introduction and concentrations of large herbivores in the late 1800s on *Artimisian* grasslands as having dramatic results. The result was that for most *Artimisian* grasslands, native perennial grasses were greatly reduced (Young 1994). In the intermountain west, the dominate understory grasses and grasslike species of the sagebrush communities is usually perennial bunchgrass. The major perennial grass and grasslike species include: Bluebunch Wheatgrass (*Agropyron spicatum*), Thurber's needlegrass (*Stipa thurberiana*), Needle-and-thread (*Stipa comata*), California brome (*Bromus carinatus*), *Elymus cinereus*, Sandberg bluegrass (*Poa secunda*), and elk sedge (*Carex geyeri*) (Young et al. 1984). Common forbs include silverleaf lupine, sulfer flower, hooded phlox and Douglas phlox.

Soils and Range Sites
Dry Mountain loam Range site: This site comprises 25.7 acres of the Refuge. The most extensive range type in North Park, it consists of moderate-deep to deep well drained soils. The potential plant community includes 15 percent stream bank wheatgrass, 10 percent sheep fescue, 10 percent muttongrass, 8 percent pine needlegrass, 5 percent Letterman needlegrass, 3 percent Sandberg bluegrass, and 5 percent junegrass, bluebunch wheatgrass. Big sagebrush makes up 15 percent of the community. The forb community consists of lupine, pussytoes, aster, fleabane, yarrow, bluebells, buckwheat, phlox, fringed sage, snakeweed and other forbs. Total annual production of all vegetation is 600 pounds per acre (USDA-NRCS). Heavy grazing by herbivores causes more undesirable grasses such as bluebunch wheatgrass, sheep fescue, pine needlegrass, and other plants such as big sagebrush and less palatable forbs to increase.

Valley Bench Site
This site comprises 3,065.9 acres of the Refuge. This site is extensive, typically found on uplands and benches, and can be deep to shallow, well drained sites. The potential plant community consists of 20 percent streambank wheatgrass, 15 percent mutton grass, 10 percent junegrass, 9 percent Indian ricegrass, 5 percent pine needlegrass, and 5 percent other grasses. Big sagebrush makes up 15 percent of this community, Douglas rabbitbrush makes up 3 percent. Forbs consist of 5 percent phlox, 3 percent pussytoes, and 5 percent lupine, gray horsebrush and other forbs. Heavy grazing by herbivores causes pine needlegrass, junegrass and muttongrass to decrease and big sagebrush, Douglas rabbitbrush and forbs to increase. Total annual production ranges from 400 to 900 pounds per acre.

Mountain Meadow Range Site
This site comprises 1,416.5 acres of the Refuge. It is a highly productive site along natural streams consisting of deep, poorly drained soils. The site is characterized by 20 percent thurber fescue, 12 percent tufted hairgrass, 10 percent slender wheatgrass and 5 percent sedges, Baltic rush may also be found. Forbs are abundant and include 3 percent iris, 3 percent herbaceous cinquefoil, 2 percent yarrow, 15 percent wild celery, cow parsnip, clovers, American bistort, aster, arnica, groundsels, waterhemlock, false-hellebore, monkshood, marsh marigold, sedum, fireweed, shooting star, primrose, green gentian, elephant-head and others. The community also contains 5 percent silver sage, 10 percent willow, and 5 percent other shrubs. This site can produce 2,000 to 4,000 pounds of forage per acre.

Salt Flats Range Site
This site comprises 3,290.7 acres of the Refuge. This site consists of deep, well drained soils that are effected by sodium salts. The potential plant community is 25 percent western wheatgrass, 20 percent saltgrass, 5 percent Indian ricegrass, 5 percent alkali bluegrass, 5 percent alkali grass, and 5 percent other grasses. Forbs are not abundant on this site and make up 10 percent of the plant composition. The site is also 10 percent greasewood, 5 percent winterfat, 5 percent mat saltbrush, and 5 percent other shrubs. Excessive grazing causes Indian rice grass, winterfat, and alkali bluegrass decrease and western wheatgrass, alkali grass, saltgrass and greasewood increase. The site produces 500 to 900 pounds per acre depending on annual precipitation.

Alkaline Slopes Range Site
This site comprises 2,078.1 acres of the Refuge. This site contains well drained soils that are 20 to 40 inches deep over shale. The potential plant community is 15 percent wheatgrass, 10 percent saltgrasss, 10 percent Indian rice grass, 10 percent squirreltail, 5 percent pine needlegrass, 5 percent bluegrasses and 10 percent other grasses. Phlox, buckwheat and other forbs makeup 5 percent of the community. The community is also 15 percent big sagebrush, 10 percent greasewood, and 5 percent winterfat, masaltbrush, fringed sage and other shrubs. Excessive grazing causes Indian rice grass, bluebunch wheatgrass and pine needlegrass to decrease, and rhizomatous wheatgrasses, Sandberg bluegrass, big sagebrush and greasewood to increase. Total annual production for these sites is 300 to 700 pounds per acre depending on moisture.

Spatial Considerations
Dominace of grasses or sagebrush in upland systems may be attributed to differences in management (Cooper 1953; Savory and Butterfield 1999). Overgrazing can cause a loss and vigor and density of native grasses which permit *Artemisia tridentata* to dominate a site (Wright and Wright 1948). Evidence is also clear that proper management of grazing can permit grasses to reduce sagebrush to a subordinate role in the community (Cooper 1953).

Big sagebrush is the most widespread and common shrub of the Western United Sates (Rice 1974). Numerous studies have presented evidence that *Artemisia Sp.* have allelopathic effects against neighboring species. The success and distribution of *A. tridentata* may partly depend on its production of allelopathic substances which inhibit the germination and growth of potential competitors (Weaver and Klarich 1977). Groves and Anderson (1980) demonstrated inhibition of crested wheatgrass and giant wildrye germination using crushed *A. tridentata* leaves.

Structural Considerations
Annual precipitation levels clearly cause changes in habitat physiognomy in sagebrush steppe plant communities. Structural changes are not just associated with changes in shrub species, but instead are strongly correlated with forb and litter coverage, coverage diversity and total vegetation cover. Bird species showed no abundance changes of either individual species or local or regional assemblages due to changes in habitat physiognomy. Perhaps local changes in sage cover are not significant enough to change avian use. (Rotenberry and Wiens 1980). Rotenberry and Wiens (1991) also conclude that bird populations in shrub steppe vary largely independent of each other. Structural components of the uplands can also be changed with treatment. Several studies have investigated how treatment of sagebrush may effect structure (Cooper 1953; Savory and Butterfield 1999). Clearly management can change plant community structure toward desired conditions.

Primary Factors Influencing Distribution and Structural Conditions
Soils
We utilized Jackson County, Colorado soil type maps as depicted by U.S. Department of Agriculture, and generated number of acres of each soil type within the Refuge. Five soils that list sagebrush being "common" included Boettcher-Bundyman association, Bosler sandy loam, Dobrow loam, Morset loam, and Spicerton sandy loam for a total of 9,877.04 Refuge acres. Generally, these soils are considered moderate to deep and typically are used for grazing or pasture. These soils are found on slopes less than 15 percent, and generally have slow to moderate permeability.

Physical Characteristics
Soil depth, soil texture, aspect, and soluable salts and slope all determine vegetation densities in the shrub-steppe. Following precipitation, water flows downslope and establishes a moisture gradient with respect to slope position. The slope crests are the most xeric and the slope base being the most mesic. Slope effects vegetation density, generally at the base of the knolls is more dense, with the midslope vegetation being moderately dense and the vegetation of the knoll crest being the least dense (Brotherson 1999). Sturges (1977) found mountain big sagebrush, for example, growing at midslope and bottom slope sites and suggested that these sites were more mesic and, therefore, were better suited for mountain big sagebrush. In general, soil depth increases downslope, as does the number of plant species. Total cover of both annuals and forbs decreased downslope, while shrubs cover was most important at the slope base (Brotherson 1999).

Salinities
Artemisia species generally will not tolerate soil salinities higher than 18 mmhos/cm^3 (Gates et al. 1956). Generally, as soil salinity increases, sagebrush becomes less dominate, and greasewood species become more abundant.

Soil Textures
Soil textures form the slope crest, show lower clay content, and higher sands and exposed rock. As water moves downslope, it takes the smaller textured particles and dissolved nutrients along with it. Soil organic matter, pH, bare ground, litter cover, total dissolved salts and concentrations of sodium and potassium all increase downslope (Brotherson 1999).

Aspect
The direction that a slope hillside faces influences soil temperature, air temperature, soil moisture, solar radiation and, therefore, plant community characteristics. Overall, south and west facing slopes are warmer than north and east facing slopes. Air temperature on south facing slopes averages 0.9 Celsius warmer than north facing slopes. The morning sun finds moist soils and plants, and a large part of the solar radiation received is lost to evaporation. However, afternoon sun shines on relatively dry soils and plants; therefore, the received energy is applied to increasing soil temperature. Soil moisture is 1.7 percent to 2.2 percent higher on north facing slopes (Ayyad and Dix 1964) than south facing. Soil temperature on the upper and middle positions of a hillside are warmer than lower sights. South facing hillsides have 5 to 6 degree difference in soil temperature between upper and lower sites.

Climate
Climate conditions of North Park are characterized by low relative humidity, abundant sunshine, large daily and seasonal temperature variations, and increasing precipitation with elevations (Fletcher 1981). North Park's remoteness from moisture sources and high elevation result in low humidity and a semi-arid climate (Kuhn et al. 1983). Mean annual precipitation ranges from about 10 to 16 inches in the basins, and up to 40 inches in the surrounding mountains. The basin receives the majority of precipitation during the summer month s (May – September). Snowfall is the most significant precipitation and accumulates in the mountains in depths of 5 – 10 feet. Melting snowpack provides 65 to 85 percent of annual stream flow. Summer precipitation is generally produced by convective thunderstorms, but because moisture is lacking, the rainfall from these storms is generally less than one inch (Kuhn et al. 1983).

Daily temperature variations at Walden (8,120 feet elevation) are reported to be 25 Fahrenheit during winter and 40 Fahrenheit during midsummer and fall. Recorded temperature extremes are 96 and minus 49 with a mean

annual temperature of 36.5. Walden averages 43 frost-free days per year due primarily to high elevation. Winter winds are frequent and typically from the west or southwest. The May – September average evaporation potential estimated for North Park is about 35 inches (McKee et al. 1981).

Disturbance: Fire / Grazing
Big sagebrush communities had fire cycles that varied between 60 and 110 years before European settlement (Whisenant 1990). Grasses and forbs have an advantage over sagebrush when sites are burned. Most *Artemisia* species do not resprout after fire, but have to reestablish from seed. The introduction of cheat grass (*bromus tectorum*) led to more frequent fires, and combined with unrestricted grazing, native vegetation becomes easily replaced with exotic annual plants (West 1996). Much of the sagebrush steppe has been burned at least once in the last three decades and is now dominated by introduced annuals like cheat grass and medusahead. This replacement is undesirable in all aspects (West 1996)

Grazing in sagebrush steppe systems tends to increase sagebrush density, decrease sagebrush cover, reduce litter accumulation, decrease soil moisture, reduce grass and forb abundance, and increase the potential for nonnative invasion. Large grazers and grasses have co-evolved. Without moderate grazing and/or fire, plant litter builds thatch that withholds nutrients and physically limits vegetative regrowth and seedling establishment (McNaughton et al. 1982). Some grazing and burning are necessary to allow optimal light penetration and nutrient cycling. Maximum grassland plant community diversity is usually attained under moderate grazing (West 1993). The dense stands of excess sagebrush prevent the herbaceous species from recovering. Such brush-choked stands are usually chosen by both livestock and wildlife managers for manipulation to diversify vegetation structure (West 1996). A reduction in sagebrush also enhances water yields (Sturges 1977).

Goodrich (et al. 1999) estimated ground cover at sagebrush steppe sites protected from livestock averaged 55 percent. Sites grazed annually in the spring averaged 30 percent ground cover. The greatest difference in ground cover was the amount of litter or plant residue deposited on the ground. Litter cover was about two times greater in areas protected from livestock grazing. High ground cover can be maintained under moderate intensity, rest or deferred rotation grazing. Holechek and others (1998) concluded: . . . various studies of gazing impacts on rangeland soils and watershed status are highly consistent in showing that vegetation residue is the primary factor determining degree of soil erosion and water infiltration into the soil. As residue is depleted by heavy grazing, soil erosion increases, water infiltration decreases and water overland flow increases . . . .

Where ground cover is less than 50 percent over more than 10 percent of a grazing unit, a need for change in management is strongly indicated. Exclusion of either or both wild ungulates and moderate intensity cattle grazing has not resulted in overall higher resource values than where both were present (Goodrich et al. 1999).

Close grazing reduces soil moisture, decreases infiltration, the energy of falling raindrops is not dispersed by vegetation, and the soil surface is compacted and sealed by raindrop splash. In Ashley National Forest, eastern Utah, a comparison of summer-long grazing and three rest-rotation systems that revealed no difference in residual cover (Johnson 1987).

Timing of grazing or fire treatments and rest significantly effects outcome. A study in Browns Park, Colorado and Daggett County, Utah found crown cover for Wyoming big sagebrush after 30 years of ungulate exclusion was 22 percent, 11 percent after 9 years of exclusion, and 17 percent after 13 years. Absence of cattle grazing, coupled with high levels of wild ungulate use reduced Wyoming big sagebrush cover to less than 5 percent (Goodrich et al. 1999). Twenty-two percent crown cover appears to be the maximum crown cover Wyoming big sagebrush will support. At this level, the frequency of needle-and-thread grass was significantly less, and production and vigor appears to be reduced.

Refuge Objectives:
Development of Refuge objectives involved selecting sage-obligate species, identifying species habitat requirements, detailing period of Refuge use, and finally developing measurable habitat based objectives that specify desirable range conditions. Unfortunately, little is known about Refuge upland habitats. The Refuge's first priority is to conduct vegetative assessments of upland habitats and incorporate the information into map databases. Past management efforts have focused on developing suitable waterfowl nesting and brood-rearing sites in meadow habitats. Much of the upland plant community information that had been acquired was lost to an office fire in April of 1997. Therefore, uplands management is conservative, identifying only 4,000 acres with specific and measurable objectives. The remaining upland acreage will be utilized for sagebrush research. Specific and measurable objectives will be determined on the remaining acreage after the vegetative assessments are completed, and research on desirable range conditions is conducted.

Species Selection:
The Intermountain West Regional Shorebird Conservation Plan recognizes that throughout the Great Basin, uplands associated with wetlands and riparian areas provide critical nesting areas for shorebirds, especially long-billed curlew (*Numenius americanus*) and willet *(Catoptrophorus semipalmatus*). The Partners in Flight (Colorado State Plan) identifies northern sage grouse (*Centrocercus urophasianus*), Brewer's sparrow (*Spizella breweri*), sage sparrow (*Amphispiza belli*), vesper sparrow (*Pooecetes gramineus*), and sage thrasher (*Oreoscoptes montanus*) as species of concern (priority >20). Arapaho NWR is uniquely situated to support several goals and objectives identified in these plans. Working with the Colorado Division of Wildlife, and with existing data on uplands use by songbirds and shorebirds, the Refuge developed the following objectives. Northern sage grouse are a species of concern for the State of Colorado. Elk and pronghorn antelope are common on upland habitats and were considered during objectives development.

Upland Objective #1:
1. Provide 2,000 acres over a 5-year average of uplands composed of shrubs (>70 percent sage) >25 cm height and 20 – 30 percent canopy cover, >20 percent grass cover, and >10

percent forbs (native species preferred) to benefit sage grouse, vesper sparrow, elk, and antelope.

Habitat requirements of species: Sage Grouse
Sage grouse are closely associated with sagebrush ecosystems of western North America. Sage grouse are well adapted to a variety of sagebrush heights including tall sage, low sagebrush, forb-rich mosaics, riparian meadows, steppes with native grasses and forbs, and scrub willow. (Schroeder et al, 1999). Nests are placed in thick cover, generally dominated by big sagebrush. Vegetative diverse habitats (horizontally and vertically) provide the best habitats. Broods are found in rich mosaics of habitat including sagebrush, riparian meadows, greasewood bottoms. The common feature of brood areas is they are rich in forbs and insects. Females with broods prefer 19-31 percent sagebrush cover with 9-19 percent cover of forbs (Drut et al 1994). Broods respond to dry conditions by concentrating in areas with succulent vegetation. Nesting predation is lowest in dense (41 percent) canopy cover with heavy grass (19 percent) canopy cover (Gregg et al. 1994) and at least 17 percent sagebrush cover. Winter range includes sagebrush with 6-43 percent canopy cover but prefer at least 15 percent canopy cover (Johnson and Braun 1999). Diet consists of leaves, buds, stems, flowers, insect and grit. Grouse tend to feed on the ground in open habitats during morning and mid-afternoon (Hupp and Braun 1989). Hupp and Braun (1989) noted that sage grouse feeding activity was influenced by snow depth and mountain big sagebrush exposure above the snow. Feeding activity of sage grouse occurred in drainages and on slopes with south or west aspects. Additionally, big sagebrush plants in drainages tend to be taller, and northeast slopes and flat sagebrush sites were shorter in height. Sagebrush is essential for sage grouse and dominates the diet during late autumn, winter and early spring (Girard 1937).

Habitat requirements of species: Vesper sparrow
Vesper sparrows are distributed from the from Northwest Territories across to Alberta south to central California, Nebraska, Illinois, Virginia and Maine (Breeding Bird Survey data). Vesper sparrows prefer dry, open areas with short, sparse and patchy vegetation including sagebrush plant communities (Roberts 1932). Vesper sparrows prefer upland habitats and are most abundant in shrub steppe environments (Kantrud 1981). In Wyoming, the availability of sagebrush for nest cover and song perches was important. Vesper sparrows occurred in areas dominated by sagebrush, and were absent from areas with only grass or cactus (Fautin 1975). Abundance of vesper sparrows is also positively correlated with forb cover. Perches may be any structure or vegetation higher than nest height, such as sagebrush (Berger 1968). Average vesper sparrow territory size in Montana was 1.65 ha (Reed 1986). Vesper sparrows are a fairly common host to brown-headed cowbird nest predation, and will frequently raise cowbird young (Friedmann 1963). Vesper sparrows arrive on the breeding grounds March to late May, and depart in mid-August to late November (Johnsgard 1980). In Wyoming, vesper sparrows were among the most common breeding species in the grass/sagebrush areas. Generally, a lack of sagebrush (perch sites) accounts for low density of vesper sparrows. Nesting occurs on the ground beneath relatively short (14 to 34.3 cm in height) big sagebrush using grass to conceal the nests. Western wheatgrass, bluebunch wheatgrass, green needlegrass, and junegrass were commonly used food items (Best 1972). Vesper sparrows are also known to occur near white-tailed prairie dog colonies (Clark et al. 1982).

Habitat Requirements of Species: Elk
Herbivory (elk, moose, cattle) impacts to riparian, upland and meadow habitats are not known. Willow regeneration along the Illinois river is slow, and small willow shoots are frequently grazed to 2-5 cm in height. Elk damage to riparian areas is well documented in the scientific literature (Zeigenfuss et al. 2002). Currently, approximately 150 elk utilize the Refuge during the spring, summer and fall. During winter months (November - March), elk numbers vary considerably but average 1,000 to 1,400. Elk distribution is varied; however, most use occurs in the willow riparian community along the Illinois River and on the Case Flats. Elk numbers and elk damage are not necessarily a linear relationship. Snow depth, temperature, duration of feeding, and a host of other factors may determine wintering elk impacts. Elk wintering on the Refuge may minimize game damage on adjacent private lands.

Wintering elk (*Cervis elaphus*) diets include approximately 63-100 percent (average is 84 percent) grasses, 9 percent shrubs, and 8 percent forbs (Kufeld 1973). Spring grass use in eight Montana elk food habitat studies averaged 87 percent grass. During summer months, forbs became more important, averaging 64 percent, 30 percent grasses, and 6 percent shrubs. Forbs can grow to 100 percent of the summer diet. Fall elk diets revert primarily back to grasses (73 percent). (Geer 1959; Geer 1960; Kirsch 1963; Mackie 1970; Morris and Schwartz 1957). Nutritionally, forbs were highly valuable for Montana elk, especially *Agoseris glauca* and *Geranium viscosimum*. *Luipinus spp.* and *Aster spp.* were also highly valuable forbs. Grasses and grass like plants included *agropyron spicatum*, *carex spp*, *carex geyeri*, *Festuca idahioenisis*, *Festuca scabrella*, *and Poa sp.* Highly valuable shrub species (based on a large number of references) were *Amelanchier alnifolia*, *Ceanothus sanguineus*, *Ceanothus velutinus*, *Populus tremuloides*, *Prunus virginiana*, *Pushia tridentata*, *Quercus gambellii and Salix spp.* (Kufeld, 1972)

Habitat Requirements of Species: Pronghorn Antelope:
Sixty-eight percent of antelope (*Antilocapra americana*) in North America occur in grassland habitats (Yoakum 1978) and 56 percent occur on wheatgrass (*agropyron*) dominated prairies (Sundstrom et al. 1973). Pronghorn antelope use is widely distributed across the Refuge. During all seasons, 25 to 250 antelope utilize the Refuge and are generally concentrated in upland habitats. Winter habitat use in south-central Wyoming indicates that high pronghorn densities occurred in habitat complexes containing an average of 0.5 big sagebrush plants/sq m that were >29 cm tall (Ryder and Irwin 1987). Use of sagebrush dominated habitats was 45 percent. Wintering antelope tended to use northwest ridges and benches and those containing black greasewood mixed with big sagebrush in stands averaging 0.4 plants/sq.m in draws and lowland flats. Antelope responded to deep snow (>25 cm) by moving to windswept terrain or draw bottoms where taller sagebrush is available. In Montana, silver sagebrush is the dominate food item in antelope diets. Presence of silver sage is a characteristic of

optimum antelope habitats. (Wood 1989). Fall and winter diets consist primarily of sagebrush. Antelope normally avoid areas with broken topography and vegetation >76 cm tall (Sundstrom et al. 1973).

Uplands Objective #2:
2. Provide 2,000 acres over a 5-year average of uplands composed of shrubs (>70 percent sage) >40 cm height and >30 percent canopy cover, <20 percent grass cover, and >5 percent forbs (native species preferred) to benefit brewer's sparrow, sage thrasher, and antelope.

Habitat Requirements of Species: Brewer's Sparrow:
Brewer's sparrow forage primarily on arthropods in sagebrush shrubs with an average canopy height <1.5 m (Rotenberry et al. 1999); little foraging occurs in nearby rabbitbush (Rotenberry and Wiens 1998) or on open ground between shrubs (Wiens et al 1987). Compared to surrounding shrubs, these sparrows forage in larger and more vigorous shrubs (Rotenberry et al. 1999) In a study across the breeding range, vigor (percent live stems) of a shrub patch was the best vegetative descriptor of Brewer's sparrow habitat (Knopf et al. 1990).

Compared to surrounding habitat, Brewer's sparrow nests tend to be located in significantly taller, denser shrubs (primarily big sagebrush) with reduced bare ground and herbaceous cover (Peterson and Best 1985). In Idaho, nest shrubs averaged 69 cm (range 42-104 cm) versus an average of 43 cm for surrounding shrubs. Brewer's sparrows prefer shrubs that are entirely or mostly alive (Rotenberry and Wiens 1989).

Habitat Requirements of Species: Sage Thrasher:
Sage thrasher are considered a sage obligate species but noted in black greasewood habitats (Braun et al. 1976). Sage thrasher numbers are positively correlated with the amount of sagebrush cover, positively correlated with sagebrush height (30-60 cm), and negatively correlated with grass cover (Rotenberry and Wiens 1980). Foraging characteristics indicated a strong preference for ground insects such as ants (*Formiciae*) and ground beetles (*Carabidae*) (Stephens 1985). Sage thrashers are opportunistic feeders and may take grasshoppers (*acridomorpha*), crickets, ants, various true bugs and may take larger seeds (Knowlton and Harmston 1943).

Individual nesting sites indicate a preference for taller shrubs with wider crowns. When adequate canopy coverage exists, sage thrasher abundance is positively correlated with a perennial grass understory. Canopy coverage in 175 nest sites in Idaho ranged from 11 to 44 percent (Rich 1980).

Uplands Objective #3:
Establish research plots to evaluate herbivory impacts to sage height and grass/forb abundance to benefit nesting and wintering sage grouse, songbirds (vesper sparrow, sage thrasher, Brewer's sparrow) and antelope.

The lack of knowledge on upland habitats (plant species, distribution, condition, height, density) prevent the development of habitats specific goals and objectives. The remaining 10,225 acres of upland habitats will be surveyed by 2008. The staff will focus on evaluating impacts of current management and herbivory on upland habitats, and will develop habitat based goals and objectives by 2017.

Strategies:
Conduct plant composition surveys of Refuge uplands by 2008. The Refuge staff will develop research plots (exclosures) to evaluate herbivory impacts to sage height and grass/forb abundance to benefit nesting and wintering sage grouse, songbirds (vesper sparrow, sage thrasher, Brewer's sparrow) and antelope. Working with partners, the Refuge will develop management strategies for all 14,000 acres of sagebrush uplands.

Investigate methods to increase sagebrush abundance or quality. Attempt to modify forb component using Dixie harrow, fire, fertilizers, seeding and/or herbicides as tools. Native grasses and forbs are preferred; however, limited nonnative species would be considered to enhance the Refuges ability to achieve objectives. The Service policy is to promote natives; additionally, natives tend to sustain ecological integrity of the system (wildlife, plants, system function). The disadvantage is higher costs, lower success rates, and viability of the stand. Nonnatives are less expensive, generally show higher success rates, are readily available, and many have high wildlife value. The downside to nonnatives include risk of spread, poor ecological integrity, compete with native species, and other unknown consequences. Revegetation and sagebrush enhancement preference will be given to soil types that typically support quality sagebrush stands.

Uplands Objective #4:
Monitor North Park *phacelia* populations currently known to exist on the Refuge. Initiate research to understand the plants life history and develop a management plan to ensure its continued existence.

North Park *phacelia* is an endangered plant that exists in at least three general areas of Jackson County. One area occurs on the Case tract of the Refuge and includes two primary plant strongholds. Since 1997, Refuge staff have monitored plant numbers on these two sites. Enumeration of rosettes have averaged 741 (range 221 to 1,692) and flowering plants average 1,783 (range 104 to 5,391). The plants inhabit wind swept, gravel dominated hillsides with little or no competing vegetation. Currently, the plant is not excluded from grazing, and no specific plant management is occurring. The plant does not appear to be increasing or decreasing in abundance on the Refuge. Therefore, the Refuge proposes to investigate the life history, life requirements and management options of North Park *phacelia*. Additionally, the ongoing monitoring of rosettes and flowering plants will continue annually. A step-down management plan will be created by 2010 that details future management actions. Strategies will include a research component that emphasizes full recovery of the plant species.

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Appendix J. Mailing List

Federal Officials

- U.S. Senator Ben Nighthorse Campbell, Washington, D.C.
  Keith Johnson, Fort Collins, CO
- U.S. Senator Wayne Allard, Washington, D.C.
  Kristine A. Pollard, Englewood, CO
- U.S. Representative Scott McInnis, Washington, D.C.
  William Endriss, Glenwood Springs, CO

Federal Agencies

- US BLM, Chuck Cesar, Linda Gross, Kremmling, CO
- NRCS - Jackson County, Walden, CO
- US EPA, Denver, CO
- US Forest Service, Chuck Oliver, Walden, CO
- US FWS, Albuquerque, NM; Alamosa/Monte Vista NWR, CO; Anchorage, AK; Arlington, VA; Arrowwood NWR, ND; Atlanta, GA; Denver, CO; Browns Park NWR, CO; Fort Snelling, MN; Hadley, MA; Juneau, AK; Air Quality Branch, CO; Ecological Services Field Office, CO; Fish Springs NWR, UT; Lost Trail NWR, MT; Medicine Lake NWR, MT; Portland, OR; Sacramento, CA; Sand Lake NWR, SD; Sherwood, OR; Seedskadee NWR, WY; Shepherdstown, WV
- USGS, Biological Resources Division, Fort Collins (David Hamilton, Murray Lauhban, Rick Schroeder)

State Officials/Tribes

- Governor Bill Owens
- Representative Al White
- Senator Jack Taylor
- Southern Ute Indian Tribe
- Arapaho Business Committee
- Pawnee Tribe

State Agencies

- Colorado Division of Natural Resources
- Colorado Division of Wildlife
  Brad Petch, Meeker, CO; Josh Dilley, Walden, CO; Jim Gammonley, Fort Collins, CO; Liza Graham, Steamboat Springs, CO; Jim Hicks, Steamboat Springs, CO; Rick Kahn, Fort Collins, CO; Steve Porter, Fort Collins, CO; J. Wenum, Walden, CO; Kirk Snyder, Walden, CO; Sue Werner, Steamboat Springs, CO
- Colorado Natural Heritage Program, Fort Collins, CO
- Colorado State Forest, Jackson County, Walden, CO
- Colorado State Historic Preservation Office, Denver, CO
- Colorado State Parks and Recreation, Walden, CO
- Colorado Water Commissioner, Walden, CO
- IL Department of Natural Resources, Springfield, IL

City/County/Local Governments

- Jackson County Administrator; Commissioners; Extension Office; Sheriff's Office; Weed Coordinator; Soil Conservation District
- Mayor Kyle Fliniau

Organizations

- Colorado Cooperative Fish & Wildlife, Fort Collins, CO
- Colorado Ducks Unlimited
- North Park Cattlewomen's Association
- North Park Chamber of Commerce, Walden, CO
- North Park Fair Board Association
- North Park Stockgrowers Association, Cowdrey, CO
- North Park Water Conservancy District, Walden, CO
- North Park Habitat Partnership Program, Walden, CO
- National Audubon Society, Washington, D.C.
- Natl. Wildlife Ref. Assoc., Brent Giezentanner, CO Springs, CO
- Owl Mountain Partnership, Walden, CO
- Sage Grouse Working Group, Walden, CO
- TWS, Central Mountain & Plains Section, Fort Collins, CO
- Wildlife Management Institute, Washington, D.C.
- KRA Corp., F&W Reference Section, Bethesda, MD
- Defenders of Wildlife, Washington, D.C.
- The Wilderness Society, Washington, D.C.
- Animal Protection Institute, Sacramento, CA
- The Nature Conservancy, Boulder, CO
- National Trappers Association, New Martinsville, WV
- Fund for Animals, Silver Spring, MD

Newspapers, Radio, TV

- Jackson County Star, Walden, CO
- Steamboat Pilot, Steamboat Springs, CO
- The Coloradoan, Fort Collins, CO

Schools/Universities and Libraries

- Colorado State University, Fort Collins & Walden, CO
- Jackson County Library, Walden, CO
- Mesa State College
- Northwestern Univ., Prof. Friesema, Evanston, IL
- North Park School District
- University of Wyoming

Individuals

Heman Adams
Dale Agger
Mike Allnutt
Philip Anderson
Jackie Boss
Bill Broderick
Les Burde
Tom and Anne Butler
Phil and Kris Cafaro
Louie and Barb Czencz
John Decker
Brian DeVries
Blaine Evans
Sarah Flick
Iveta Glover
Deb Hankins
David Hanni
Rick Harness
James Hines
Marcus Honnecke
Garrety Hudkins
Dale Hudspeth
Jerry Kaltenhanuer
J-B Ranch
John and Kay Kemp
Norbert & Elizabeth Ketola
Nick Komar
Carey Lewis
Dick Martley
Dave McClone
Cynthia Melcher/Ken Geisen
Bill Miller
Michele Miller
Eugene Patten
Jeff Phillips
Jeune Reinhold
Kate Rite
Bob Sinclair
Jeff Stark
Carl Trick II
Mike and Barb Turnbull
Geo Uyeno
Wilford Ranch
Laurie Zuckerman/Tom Mathies