White pelican
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Appendix E

Biological Integrity, Diversity, and Environmental Health

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The Refuge System Administration Act directs managers to maintain the biological integrity, diversity, and environmental health (BIDEH) on refuges for the benefit of present and future Americans. Accordingly, the following assessment of BIDEH has been prepared for each of the major habitats at Malheur National Wildlife Refuge.

Table E-1. Biological Integrity, Diversity, and Environmental Health for Malheur National Wildlife Refuge

Characteristics of the Community (Structure, Seral Stage, Species Composition, Age Class)	Natural Processes Responsible for these Conditions	Limiting Factors
Lacustrine (Lakes)		
Malheur Lake fluctuates greatly in size, from a typical minimum pool of 500 acres to approximately 90,000 acres in the mid-1980s. It has also been completely dry (1934) and has extended up to 170,000 acres (mid-1980s). Historically, a chemical and physical gradient could be observed from west (Mud Lake and directly east of Hwy 205) to east. The far west side consisted of a complex network of ponds, islands, and peninsulas. The center of the lake was dominated by emergent (e.g., hardstem bulrush) marshes and interspersed open water areas. The eastern side has been highly alkaline and contains large areas of open water. Common emergent species included hardstem bulrush, cattail, bur-reed, Baltic rush, and various sedges. Open water areas included submergent plants such as watermilfoil, sago pondweed, horned pondweed, coontail, small and leafy pondweed, white water buttercup, bladderwort, and widgeongrass. Soil surveys indicate that emergent vegetation responded to existing water levels and did not persist in specific areas with the exception of river inlets and significant spring sources.	Inflow sources include the Blitzen and Silvies rivers and Sodhouse Spring. River flows are predominantly influenced by snowpacks on Steens Mountain and Malheur Forest. Shallow water levels, annual and seasonal fluctuations in water depth, and a mosaic of permanent and cyclical water levels. The prevailing chemical gradient and variable water depths determined the composition of plant communities throughout the lake. Ice movement/scouring following flood events impact topography and reduce the presence and cover of emergent vegetation.	Common carp (introduced to the system in the early 1900s) has decimated the productivity of this marsh/lake system. They root up submergent vegetation and dramatically increase turbidity. Hydrological inputs to the lake, particularly from the Silvies River, have been altered.

Characteristics of the Community (Structure, Seral Stage, Species Composition, Age Class)	Natural Processes Responsible for these Conditions	Limiting Factors
Riverine		
Waterways support riparian communities that are appropriate to stream channel type. The hydrologic floodplains are intact with balanced pool/riffle/glide ratios depending on slope and substrate. Water turbidity is typically low with an appropriate level of sediment storage, which buffers against the sediment loading of critical rearing pools and spawning gravels for native fish. Boulders, undercut banks, logs, and vegetation provide ample hiding cover for native fish and other aquatic species. Eddies and other slow current areas contain abundant populations of various aquatic invertebrates. Low turbidity also allows a variety of native aquatic vegetation to establish and propagate in suitable micro niches.	Streams such as Bridge and Mud had 1%-4% gradients and were dominated by boulders, cobbles, and gravel. The Blitzen River had a low gradient (<1%) and was dominated by gravel and silt substrates. Sediment discharge and particle size as well as streamflow and slope were in balance. Balance between sinuosity and percent slope maintained the physiological integrity of the channel by reducing velocity while intact floodplains disperse energy.	Common carp There has been a loss of riparian plant diversity due to past management and competition with invasive plant species. Channelization of the Blitzen River has compromised in-stream habitat and the system's ability to disperse energy during high flow events. Incised channel. Most floodplains are no longer functionally active as a result of altered hydrology from ditching, diversions, and dams along the river.
Woody Riparian		
The Refuge hosts a variety of riparian/riverine systems, ranging from the Blitzen River itself to various tributaries that flow into it from neighboring valleys and canyons on the northern side of Steens Mountain. Although many plant associations are found within this broader community, the principal woody species include various species of willow, redosier dogwood, Woods' rose, golden currant, common snowberry, Lewis' mock orange, water birch, and alder. Herbaceous groundcover characterized by Nebraska sedge, yellow monkey-flower, Northwest cinquefoil, American speedwell, woolly sedge, slenderbeak sedge, meadow barley,	Stream bank soils consist of gravel and cobble due to common flooding disturbance, alluvial bars, and very little soil development. Within the active floodplain, the soils are deep and consist of pluvial deposits on alluvium.	Reed canarygrass, hemlock, perennial pepperweed, and other invasives are able to out-compete native vegetation following most disturbances. River channelization Historical livestock grazing Lowered groundwater table Infrastructure (ditches, dams, roads) Water quality impairments

Characteristics of the Community (Structure, Seral Stage, Species Composition, Age Class)	Natural Processes Responsible for these Conditions	Limiting Factors
tufted hairgrass, western yarrow, and Baltic rush.		Altered hydrology and minimum flows Broad-scale loss of functional connectivity between rivers and streams, and their floodplains
Palustrine Emergent (Temporarily Flooded Wet Meadows)		
Wet meadows typically occupy the transition zone between marsh and moist meadow plant communities. Native vegetation includes Baltic rush, woolly sedge, Nebraska sedge, slenderbeak sedge, arrowgrass, meadow barley, tufted hairgrass, Nevada bluegrass, western yarrow, slender cinquefoil, largeleaf avens, Oregon checker mallow, and fringed willowherb.	Surface water is generally present during the growing season (at least 2 months). Only isolated depressions or sloughs hold water into the early fall. Soils are derived from alluvium and are very deep and poorly drained (pH of 6.6-7.0).	Introduced species such as Kentucky bluegrass and common timothy have become “naturalized” within these communities, but offer habitat structure similar to that of many native species. Invasive species such as reed canarygrass (an introduced cultivar), phragmites, and perennial pepperweed displaced native species. Cattails appear to encroach on areas that are inundated for longer than two months. Altered hydrology through river channelization and ditching as well as agricultural practices including livestock grazing.
Palustrine Emergent (Seasonally Flooded Marsh associated with Wet Meadows)		
This habitat type commonly exists within mosaics of wet meadow and open water. Stand density varies greatly and has a maximum height of approximately 3 meters (9.8 feet). Common emergent plant species include bur-reeds, bulrushes, cattails, sedges, rushes, and spikerushes.	Emergent vegetation can typically tolerate fluctuations in water availability, ranging from approximately 1 meter above to 10-12 cm (4-5 inches) below the soil surface. Extended periods of standing water aid in preventing the transition to mesophytic plant	The maintenance of existing emergent communities is artificial, requiring extensive infrastructure and active water diversion from the Blitzen River, its tributaries, and springs. All water delivery in the Double-O Unit, including Silver Creek

Characteristics of the Community (Structure, Seral Stage, Species Composition, Age Class)	Natural Processes Responsible for these Conditions	Limiting Factors
Submergent plants such as pondweeds, bladderworts, waterweeds, and duckweeds occur in nearby open water. Willow species can occur along elevated ecotones along marsh perimeters.	communities. Emergent marshes existed throughout the lower Blitzen Valley and became less extensive north of Buena Vista. Associated with very deep, very poorly drained soils that formed in alluvium, alluvium over lacustrine deposits derived from igneous rock, or organic matter. These soils are located on low stream terraces and their depressions as well as lake basins. The natural hydroperiod for most marsh communities likely existed from spring through mid-summer.	flows, is highly manipulated. Increased densities of emergent vegetation reduce boundary habitat for wildlife and decrease the diversity of this community type. Historical livestock grazing and haying practices favored the establishment of meadows. Altered hydrology via river channelization and the creation of irrigation ditches.
Palustrine Emergent (Semipermanent Flooded Wetland Impoundments)		
These open water habitats are semipermanently flooded at depths that preclude the development of extensive stands of emergent vegetation. Submerged and floating plants such as common and greater duckweed; Canadian waterweed; coontail; watermilfoil; common bladderwort; white water crowfoot; and sago, longleaf, and small pondweed regularly occur in open water. Emergent plants (e.g., bulrushes, cattails, sedges, rushes, spikerushes) occupy shallow areas within and alongside open water communities.	With the exception of small natural depressions next to springs (i.e., Double-O Spring), this community type has been maintained through active and intensive management. Occasional drawdowns (drought) oxidize and consolidate substrates to facilitate the germination of submergent vegetation such as sago pondweed. When pond and lake bottoms are exposed, production of smartweed and other desirable native colonizers also is often quite high, especially on mudflats in shallow benches.	Aging infrastructure and management of vegetation within water delivery systems pose challenges in ensuring ready and consistent water availability. Invasive species such as carp and reed canarygrass. Historical ditches and canals and the removal of beaver have altered hydrology.

Characteristics of the Community (Structure, Seral Stage, Species Composition, Age Class)	Natural Processes Responsible for these Conditions	Limiting Factors
Dry Meadow		
Moist meadows typically occupy the transition zone between wet meadow and upland plant communities. Dominant native grass species include creeping wildrye, bluejoint, and Nevada bluegrass. Native forbs include slender cinquefoil, western yarrow, and lanceleaf goldenweed.	Soils are similar to those of wet meadow communities, but are generally located in slightly elevated areas with increased aerobic conditions during the growing season. Depth to water table typically ranges from 0 to -12 inches during the growing season.	Native forb understory has been greatly decreased through competition with invasive species and noxious weed treatment. These communities are highly susceptible to invasion by perennial pepperweed. Due to the introduction of irrigation infrastructure and the leveling of some meadows in the early twentieth century, the extent of this community has likely been reduced.
Salt Desert Scrub		
This plant community resides in barren alkali flats or alkaline valley bottomlands. It consists of widely spaced shrubs with dense patches of rhizomatous grasses with low densities of other annual and perennial grasses and succulent forbs. Plant species include black greasewood, inland saltgrass, alkali sacaton, alkali cordgrass, and alkali bluegrass. Mat muhly and Sandberg bluegrass may be present in mosaics, which exhibit more moderate conditions (lower pH).	Infrequent inundation of outer playa areas or wind erosion from these playas distributes salts to nearby low-lying areas, causing elevations in alkalinity and pH, which favor this community association.	Heavy livestock grazing may compromise plant species diversity in more moderate areas within this plant community type.
Sagebrush Lowland		
Commonly found in swales, toeslopes, the base of alluvial fans, and adjacent to moist meadow communities within the Blitzen Valley. Native plant species include native	Sites are moist or wet in the spring and dry by mid-summer. Associated species are fairly tolerant of high soil sodium	Susceptible to invasive plants such as cheatgrass and perennial pepperweed invasion. Historical livestock grazing

Characteristics of the Community (Structure, Seral Stage, Species Composition, Age Class)	Natural Processes Responsible for these Conditions	Limiting Factors
shrubs (e.g., Wyoming big sagebrush, basin big sagebrush, rabbitbrush, bitterbrush, and horsebrush) interspersed with bunchgrasses such as basin wildrye, Sandberg bluegrass, crested wheatgrass, needle and thread, and Indian ricegrass. These sites are typically forb-poor.	content and alkalinity. Soils are generally deep and have moderate water-holding capacity (sandy loams).	decreased plant species diversity in many of these areas.
Sagebrush Steppe		
This community is dominated by shrubs with an understory of various bunchgrass and forb species found within interspaces. It can be found above greasewood/basin big sagebrush communities on various aspects, slopes, and soil types. Plant species include Wyoming big sagebrush, low sagebrush, bluebunch wheatgrass, Sandberg bluegrass, bottlebrush squirreltail, Idaho fescue, needle and thread, Thurber's needlegrass, western yarrow, arrowleaf balsamroot, and various locoweed and phlox species.	A gradient in soil depth determines whether Wyoming big sagebrush or low sagebrush dominates a site. Low sagebrush sites typically host higher densities of forbs due to higher concentrations of available soil moisture due to shallow, rocky conditions. These communities depend on natural fire cycles or equivalent disturbances to maintain a balance between shrub, grass, and forb components. A lack of disturbance lends itself to high shrub densities with sparse vegetation in the interspaces.	Invasive plants (especially cheatgrass) have compromised many sites from recovering naturally from wildfire. Livestock grazing Juniper encroachment from historical fire suppression greatly reduced native shrub densities and increased soil erosion. Medusahead infests clay sites and is capable of out-competing native grasses and forbs in the understory. Much of this habitat has been replaced on the Refuge with crested wheatgrass monocultures after wildfires.
Dune		
Open sand dunes hosting with widely spaced shrubs, grasses, and forbs located adjacent to playa basins. Shrubs include shortspine horsebrush, fourwing saltbush, bud sagebrush, green and gray rabbitbrush, and basin big sagebrush. Grasses include Indian	These plant communities are created by wind erosion off nearby dry playa bottoms (i.e., Stinking Lake and Harney Lake). As sites deteriorate (loss of vegetative cover and increased	Susceptible to invasion by halogeton, povertyweed, and Russian thistle Agricultural practices have altered plant community composition and succession in many dune areas.

Characteristics of the Community (Structure, Seral Stage, Species Composition, Age Class)	Natural Processes Responsible for these Conditions	Limiting Factors
ricegrass, needle and thread, bottlebrush squirreltail, and alkali sacaton. Forbs include tufted evening primrose, Paiute suncup, Geyer's milkvetch, sharpleaf penstemon, and various lupines.	wind erosion), a shift toward black greasewood and inland saltgrass is possible. Soils are formed by lacustrine sands and are neutral to moderately alkaline (pH 8.2). They are moist in the winter and spring and are usually dry June through October. Low available water capacity on or near the soil surface limits the survival of seedlings. Drought-prone	
Playa		
Virtually no vascular plants reside within Harney and Stinking lakes, with the exception of spring areas where steady freshwater inflows modify water chemistry. High water events provide temporary opportunities for aquatic plants and animals (i.e., sago pondweed and tui chub) to increase. These systems are rich in invertebrates such as brine flies and brine shrimp.	Evaporation of closed basin water results in high levels of alkalinity and associated pH. Dilution during high water events stimulates temporary production of aquatic species. Soils are typically very deep and poorly drained and were formed in volcanic lacustrine deposits. Texture commonly consists of silty clay loam and is strongly alkaline (10.5), with pH dropping to 8.0 at approximately 50 inches depth.	Altered irrigation/water movement patterns may have disrupted natural water level cycles (particularly in Stinking Lake).