VEGETATION INVENTORY, MAPPING, AND FUNCTIONAL HEALTH ASSESSMENT OF WETLANDS ON THE BENTON LAKE NATIONAL WILDLIFE REFUGE IN MONTANA

Prepared for USDI Fish and Wildlife Service

June 2002

by

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INTRODUCTION

Benton Lake National Wildlife Refuge (BLNWR), operated by the USDI Fish and Wildlife Service (FWS), occupies over 8,000 acres (3,000 hectares) about 15 miles north of Great Falls, Montana. The refuge is within a closed basin that held a large lake of postglacial melt water during the Pleistocene era. The central expanse of flat, low-lying area has been re-wetted to create wildlife habitat (primarily waterfowl) by bringing water in through Lake Creek on the northwest end of the refuge. This inflow of irrigation water is dispersed over the refuge through a controlled system of gated canals to partitioned units of land (Figure 1) that can be flooded or dried according to management plan.

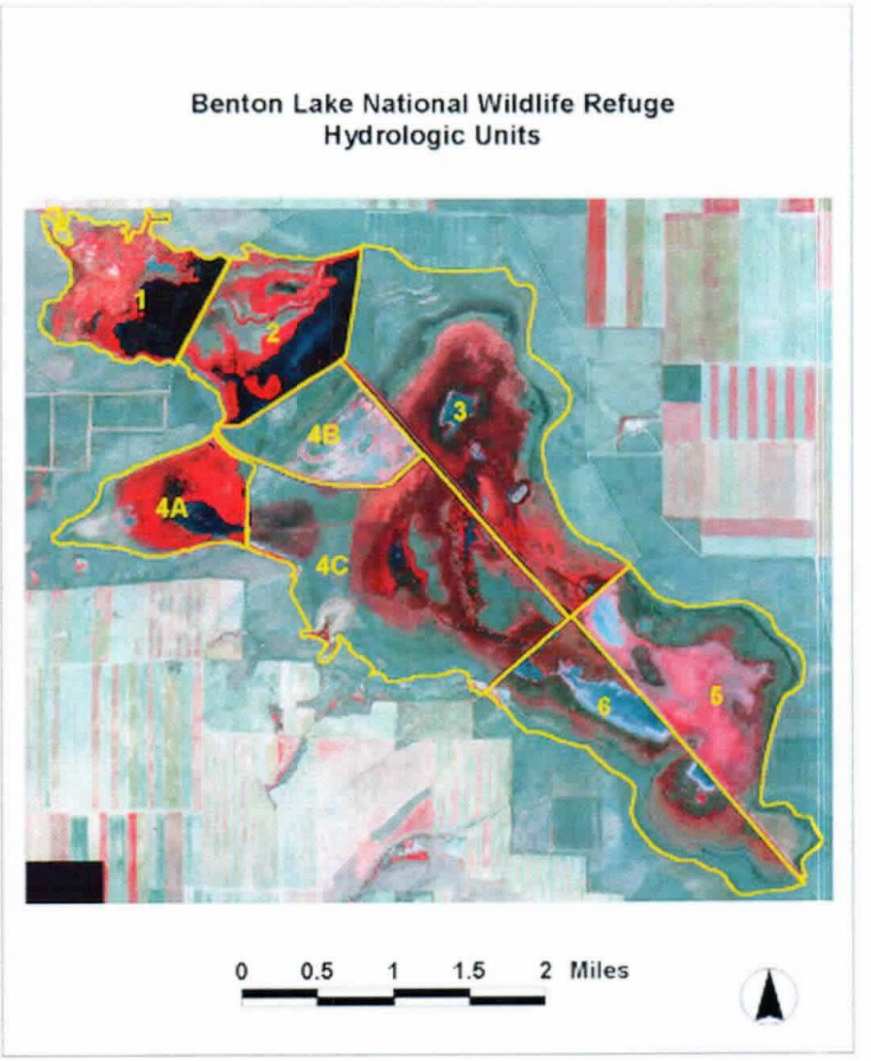

Figure 1. Management (Hydrologic) units of the Benton Lake National Wildlife Refuge

The BLNWR is managed primarily for waterfowl production and habitat. This function requires that large areas of land be inundated by shallow water, through which emergent herbaceous vegetation may grow as feeding, hiding, and nesting habitat for migratory birds. Due to the great degree of evapotranspiration water loss in conjunction with the inherent loading of alkaline elements in the native soils of the region, salts accumulate in the Benton Lake basin. The entire system may be considered a saline/alkaline system. The incoming irrigation water through Lake Creek may be relatively fresh, but the system also receives saline inputs on all sides from seepage off neighboring small grain farming operations.

For several reasons, including the buildup of selenium and occasional outbreaks of avian botulism, the areas flooded must be alternated on a systematic basis. This means that the vegetation of a given land unit in a given year may be dry-site pioneer species colonizing an exposed, freshly drained field, or it may be emergent obligate wetland species growing through shallow standing water.

Bitterroot Restoration, Inc. (BRI) contracted with the FWS at BLNWR to conduct an inventory of existing wetland vegetation and habitat, and to create a map of vegetation types on the refuge. The field data collection was completed during the period from August 14 to October 1, 2001.

Study Objective

The objective of this study is to characterize and quantify the wetland vegetation present on the BLNWR in terms of individual species, as well as vegetation types (habitat types and community types). This will be related spatially on a map created to present the vegetation data at a scale to show individual landform and vegetational features, such as small nesting islands and patches of bulrush. The project was designed for quantifying vegetative habitat values and liabilities, as well as for analyzing potential responses to various water management alternatives,

ASSESSMENT METHOD

We conducted lentic and lotic wetland inventory and functional health assessments (Hansen and others 2001a,b, c, d) on polygons of all wetland area across the BLNWR. Polygons for inventory were delineated based on vegetation differences shown on satellite imagery (scale 1:7,500) taken in July 2001 supplied by IKONOS Space Imaging. A lotic wetland inventory was conducted on each of six linear polygons along the channel of Lake Creek, three in the upper end of Unit I at the northwest corner of the

refuge, and three along the channel of Lake Creek in Unit II. A lentic wetland inventory was conducted on each of 300 polygons not on the channel of Lake Creek.

This method utilizes an extensive set of site data on wetland vegetation and physical parameters to compile a comprehensive set of plant species and vegetation structural data, site character and condition data, and to derive a functional health index for comparing the ecological status at different locations.

The vegetation data collected on the Lentic Wetland Inventory used on the bulk of the area in this study (Hansen and others 2001a) includes a comprehensive listing of species with canopy cover (abundance) estimations, as well as age class breakdowns for any tree and shrub species, and a systematic description of vegetation structure on the site. Physical site data includes shore and bank morphology and condition, substrate composition, disturbance degree and kind, amount and cause of bare ground, and commentary. Photographs were taken at each polygon to provide a visual context for the data.

The Lentic Wetland Health Assessment (derived from the Lentic Wetland Inventory) is an evaluation of wetland functional health derived from the data collected in the Lotic Wetland Inventory form. An array of vegetation (biotic) and physical site (abiotic) items is weighted and rated in calculating a health evaluation index score.

Polygons along Lake Creek were inventoried using the Lotic Wetland Inventory Form (Hansen, and others 2001c). Completion of this form is a comprehensive inventory of a stream or river segment and its associated riparian area, including detailed vegetation data, physical site data, some wildlife data, trend commentary, and photographs. The vegetation data is collected in a method identical to that used on lentic polygons. Physical site data includes channel morphology and condition, substrate composition, disturbance degree and kind, amount and cause of bare ground, and commentary.

Using a manner similar to the lentic, a Lotic Wetland Health Assessment (derived from the Lotic Wetland Inventory) is derived from the data collected in the Lotic Wetland Inventory form. An array of vegetation (biotic) and physical site (abiotic) items is weighted and rated for calculation of a health evaluation index score.

Using the IKONOS satellite imagery as a base layer, a GIS map was created showing the inventory polygons and having link to individual polygon data. Using the GIS computing capabilities, vegetation species abundance and other parameters were quantified in terms of area represented.

RESULTS AND DISCUSSION

Results will be presented in two ways: 1) in a general sense over the entire complex of BLNWR wetlands, and 2) in a more detailed way on each management unit. A total listing of plant species on the refuge at the time of inventory is presented, with acres of canopy cover represented by each species.

Due to repeated cycles of inundation and drying, much of the refuge on any given year is in an early seral stage of vegetation, (i.e., dominated by pioneering species that opportunistically establish on the newly exposed areas). At the time of this study, approximately one third (about 2000 acres) (820 hectares) of the refuge was covered by early seral species (e.g., *Hordeum jubatum* [foxtail barley] and *Chenopodium* spp. [goosefoot] species). However, some of the major wetland late seral species on the refuge have extensive rhizomatous root systems that are adapted to cyclic periods of drought. Species in this category are *Scirpus maritimus* (alkali bulrush) and *Typha* spp. (cattail) that can suffer mortality of above ground material during extended drying, but reemerge from rhizome reserves below ground when conditions become wet again. Related to this also is the incidence of large amounts of bare ground on some areas where soil conditions are especially harsh, or recent flooding and drying have left sites temporarily unvegetated.

Total Number of Species (Species Richness)

Species richness is often used as a measure of ecologic health, although a greater total number of species present does not indicate better health on all sites. For example, a healthy marsh site might have present only a mono-specific stand of cattails or bulrushes. Often, because of disturbance, a greater number of "weedy" and/or "pioneer" species is present on a site than would be there under undisturbed conditions.

Table 1. Total species richness and species richness by lifeform on areas studied

	NUMBER OF SPECIES RECORDED				
AREA NAME	**All Plants**	**Trees**	**Shrubs**	**Graminoids**	**Forbs**
Entire Refuge	91	2	3	36	50
6 Lake Ck. Lotic	45	0	0	23	22
Unit I	32	0	0	17	15
Unit II	45	1	1	23	20
Unit III	43	0	1	17	25
Unit IV-A	32	0	0	13	19
Unit IV-B	30	0	0	8	22
Unit IV-C	52	0	1	23	28
Unit V	38	0	0	15	23
Unit VI	37	1	0	14	22

Species Origin (Native or Introduced)

Often of ecologic interest is whether a community is composed of native or introduced species. Native fauna have evolved adaptations to native vegetation for feed, cover, and nesting habitat. In most cases introduced, or non-native plants, are unpalatable to native wildlife, if only because of unfamiliarity. Although the taxonomic literature is not definitive on this issue for all species, we have assigned a category of origin (native, introduced, or undetermined) to all species recorded in the study. This is presented in Table 2 for comparison of the community composition.

Table 2. Distribution of native and introduced (exotic) plant species

	UNIT		Trees	Shrubs	Graminoids	Forbs	All Plants
Number and percent of species per category in each area	All	All Species	2	3	35	45	85
		Species Native	1	3	19	26	49
		Percent Native	50	100	54	58	58
	I	All Species	—	—	17	15	32
		Species Native	—	—	10	6	16
		Percent Native	—	—	59	40	50
	II	All Species	1	1	22	20	44
		Species Native	1	1	13	7	22
		Percent Native	100	100	59	35	50
	III	All Species	—	1	17	25	43
		Species Native	—	1	9	13	23
		Percent Native	—	100	53	52	53
	IV-A	All Species	—	—	13	19	32
		Species Native	—	—	8	8	16
		Percent Native	—	—	62	42	50
	IV-B	All Species	—	—	8	21	29
		Species Native	—	—	4	10	14
		Percent Native	—	—	50	48	48
	IV-C	All Species	—	1	23	27	51
		Species Native	—	1	12	11	24
		Percent Native	—	100	52	41	47
	V	All Species	—	—	15	22	37
		Species Native	—	—	7	9	16
		Percent Native	—	—	47	41	43
	VI	All Species	1	—	14	22	37
		Species Native	0	—	8	11	19
		Percent Native	0	—	57	50	51

Species Prominence

It can be useful to know which species predominate on the different units, since this relates to the recent history of water management. In Table 3, we list the five most prominent species on each unit. Lower overall prominence values indicate either greater plant diversity or unvegetated area (i.e., open water) within a unit. For example, *Scirpus maritimus* (alkali bulrush) is the most prominent species on the entire wetland area of the Refuge, but due to both unvegetated area and great diversity, its prominence is only 17.40; whereas on Unit VI, at 41.92, it is by far the most prominent (all the more remarkable, given that over 15 percent of Unit VI was open water at the time of this inventory).

Table 3. The relative prominence[1] of the five most prevalent plant species[2] recorded on each unit and on the entire refuge

		Species Rank				
		1	2	3	4	5
Entire Refuge	**Species:**	SCIMAR	HORJUB	AGRSMI	CHEALB	TYPHAX
	Prominence:	17.40	12.26	7.53	6.70	5.36
6 Lake Ck. Lotic	**Species:**	PHAARU	TYPHAX	ALOARU	POLAMP	AGRSMI
	Prominence:	41.62	26.39	7.41	6.14	5.10
Unit I	**Species:**	TYPHAX	AGRSMI	ALOARU	POAPRA	SCIMAR
	Prominence:	31.08	15.29	9.05	8.70	7.47
Unit II	**Species:**	ALOARU	TYPHAX	AGRSMI	POAPRA	CIRARV
	Prominence:	18.83	14.22	12.25	5.54	2.61
Unit III	**Species:**	SCIMAR	HORJUB	CIRARV	TYPHAX	LACSER
	Prominence:	31.04	18.08	11.13	9.23	4.59
Unit IV-A	**Species:**	SCIMAR	AGRSMI	POAPRA	HORJUB	CHEALB
	Prominence:	21.70	15.63	9.38	5.92	3.78
Unit IV-B	**Species:**	HORJUB	AGRSMI	CHEALB	ATRPAT	AGRCRI
	Prominence:	12.78	8.59	5.75	4.31	3.81
Unit IV-C	**Species:**	HORJUB	SCIMAR	AGRSMI	TYPHAX	SONARV
	Prominence:	19.21	15.55	14.15	3.22	1.87
Unit V	**Species:**	CHEALB	SCIMAR	HORJUB	CHECAP	DESSOP
	Prominence:	25.86	13.56	6.01	5.79	5.34
Unit VI	**Species:**	SCIMAR	HORJUB	CHEALB	AGRSMI	SONARV
	Prominence:	41.92	9.61	8.49	5.98	4.47

[1] Prominence is the product of Average Percent Canopy Cover (on polygons where the species was recorded) and Constancy of Occurrence (the fraction of polygons having the species out of those inventoried)

[2] Species names are listed alphabetically in six-letter code:
AGRSMI = *Agropyron smithii* (western wheatgrass)
AGRSTO = *Agrostis stolonifera* (redtop)
ALOARU = *Alopecurus arundinaceus* (creeping foxtail)
CHEALB = *Chenopodium album* (lambsquarter)
CIRARV = *Cirsium arvense* (Canada thistle)
DESCES = *Deschampsia cespitosa* (tufted hairgrass)
MEDSAT = *Medicago satvia* (alfalfa)
POAPRA = *Poa pratensis* (Kentucky bluegrass)
PUCNUT = *Puccinellia nuttalliana* (Nuttall's alkaligrass)
SCIMAR = *Scirpus maritimus* (alkali bulrush)
TYPHAX = *Typha* spp. (cattail)
HORJUB = *Hordeum jubatum* (foxtail barley)
LACSER = *Lactuca serriola* (prickly lettuce)
PHAARU = *Phalaris arundinacea* (reed canarygrass)

Prominence, as used here, is the product of constancy (of occurrence on polygons in the study area) and species average canopy cover (on those polygons where it occurred). Prominence is equivalent to average canopy cover taken across the entire unit in question, including polygons not having the species.

The total of prominence values on a unit, when summed for all species recorded, would approximate the total area covered by vegetation in the unit; however, few polygons were fully vegetated. Significant area was occupied by bare ground and open water. For this reason, units with large areas of open water show lower prominence values. Furthermore, on units having a more balanced distribution of canopy cover among a larger list of species, the top five account for less of the total. For example, in Unit IV-B the top five prominent species (Table 3) account for about 36 percent of the area, whereas in Unit III the top five account for about 74 percent.

The entire refuge is predominantly covered by herbaceous vegetation. Woody species are found on only isolated spots in special circumstances. For example, *Salix exigua* (sandbar willow) was recorded on only a single polygon near the north end of the levee between Units I and II. A small patch of *Rosa woodsii* (woods rose) was recorded on the large constructed island in Unit III.

Seral Status of Plant Species on the Refuge

Plant species fulfill ecological niches based in part on their particular propagation strategy and habitat requirements. Considering the continual hydrologic manipulation, we thought it might be informative to quantify the relative coverages of early seral (pioneer) species, late seral (climax) species, and also the opportunistic group of perennial species (including the exotics and invaders) that can come in on a recently exposed site and capture it for indefinite term (disclimax). Table 4 lists the major species in each of these categories and summarizes the relative amounts of area occupied by each group.

Plant species seral status tables (Appendix D) list all vascular plant species that account for at least 0.1 percent of the wetland area within each unit. Wetland area total within a unit may differ from the unit area derived from the GIS because of inclusions (i.e., open deep water, uplands, roads, etc.). In some cases the sum of plant species coverages may exceed the total acreage reported by the GIS for a unit. The main cause of this difference is plant species foliar overlap, where multiple layers of plant canopy may cover the same point on the ground. Therefore, to normalize the data for use in comparative analysis across units on the Refuge, we have calculated the percentage covered by each species in a unit as being the fraction of the total area covered by all species in that unit (ignoring overlapping canopy, open water area, roads, etc.), i.e., we simply summed all species cover values to arrive at a base value of vegetated wetland area in the unit to use as the denominator to calculate percentage.

Table 4. Refuge wetland area covered by early seral, late seral, and perennial-generalist plant species

		SERAL CATEGORY					
		Early Seral (Pioneer) Species		Late Seral (Climax) Species		Perennial Generalists (Including Exotics and Invaders)	
Area/Unit Name	Unit Wetland Total Acres	Acres	Percent Of Total	Acres	Percent Of Total	Acres	Percent Of Total
Entire Refuge	5,454	1,940	35.6	2,644	48.5	870	16.0
Lake Ck. Floodplain	29.7	2.9	9.8	21.3	71.7	5.5	18.5
Unit I	323.2	34.0	10.5	193.8	60.0	95.4	29.5
Unit II	361.0	37.0	10.2	144.8	40.1	179.2	49.6
Unit III	1,206.7	440.6	36.5	539.9	44.7	226.2	18.7
Unit IV-A	386.3	56.9	14.7	284.4	73.6	45.0	11.6
Unit IV-B	264.3	157.9	59.7	53.5	20.2	52.9	20.0
Unit IV-C	1,182.8	380.2	32.1	634.4	53.6	168.2	14.2
Unit V	997.2	640.5	64.2	307.5	30.8	49.2	4.9
Unit VI	695.0	187.1	26.9	469.6	67.6	38.3	5.5

Community Successional Stage (Habitat Type or Community Type)

Successional stage was determined using the document *Classification and Management of Montana's Riparian and Wetland Sites* (Hansen and others 1995). The seral stage of a plant community can indicate relative age of, or degree of disturbance to, that community. Many polygons are dominated by pioneer, weedy, or introduced species. Using the key to wetland habitat type or community type (Hansen and others 1995), these do not key out to a type name. Some areas are dominated by weedy pioneer forbs (i.e., *Chenopodium album* (lambsquarter) or *Cirsium arvense* (Canada thistle) that may occupy sites with potential for any one of several late seral species, depending on the amount and duration of water supplied to the site over the long term. Five to 10 years might be needed for a wetland graminoid community to reach its late seral community composition. Few wetland areas on the refuge are allowed this term of hydrologic continuity for plant community development.

Other wetland areas on the refuge are dominated by introduced, or exotic, vegetation that is not limited to early seral or pioneer status. One such type is the *Alopecurus arundinaceus* (creeping foxtail), that covers extensive wet areas in a zone generally just above the *Scirpus acutus* (hardstem bulrush) and the *Typha* spp. (cattail) that stand in (more or less) permanent water. Less extensive, but distinct areas that

do not key out are saline sites dominated by *Puccinellia nuttalliana* (Nuttall's alkaligrass) and seeded areas of *Agropyron cristatum* (crested wheatgrass).

Table 5. Site types (habitat types [HT] or community types [CT]) recorded on BLNWR wetlands, ranked by percent of area represented

	Percent of Area Per Type in Each Unit								
Habitat or Community Type Name	**I**	**II**	**III**	**IV-A**	**IV-B**	**IV-C**	**V**	**VI**	**ALL**
Agropyron smithii (Western Wheatgrass) HT	23.26	23.76	14.51	20.56	18.49	26.40	2.73	18.52	***18.05***
Agrostis stolonifera (Redtop) CT	0	0	0	0	0	0.10	0	0	***0.02***
Bromus inermis (Smooth Brome) CT	0	0.41	0	0	0		0	0	***0.04***
GRAVEL ROADWAY: Land occupied by loose gravel-surfaced public roadways, not including vegetated rights-of-way	0.58	1.01	1.08	0.68	1.70	0.83	0.94	0.40	***0.88***
Hordeum jubatum (Foxtail Barley) CT	7.19	0.21	31.03	2.10	24.46	28.61	9.73	8.61	***17.36***
OPEN WATER: Area covered by unvegetated open water	33.48	33.15	2.33	11.52	0	1.72	1.21	15.70	***9.65***
Poa pratensis (Kentucky Bluegrass)	4.35	2.38	0	0	0	0.94	0	0	***0.78***
Salicornia rubra (Red Glasswort) CT	0	0.16	0	0.02	0	0.11	0	0.20	***0.07***
Salix exigua (Sandbar Willow) CT	0	0.04	0	0	0	0	0	0	***<0.01***
Scirpus acutus (Hardstem Bulrush) HT	0.06	0.32	0.39	0	0	0.05	<0.01	0.54	***0.20***
Scirpus maritimus (Alkali Bulrush) HT	1.79		29.29	57.41	8.48	28.75	54.56	53.84	***31.20***
Scirpus pungens (Sharp Bulrush) HT	0	0	0	0.06	0	0.78	0	0.10	***0.18***
Spartina pectinata (Prairie Cordgrass) HT	0	0.02	0	0	0	0	0	0	***<0.01***
Typha latifolia (Common Cattail) HT	18.73	15.42	10.24	0	0.75	5.59	0	0.07	***6.57***
UNCLASSIFIED WETLAND TYPE Dominated by *Alopecurus arundinaceus* (creeping foxtail)	8.19	19.83	0	0.41	0	0.88	0	0	***2.85***
UNCLASSIFIED WETLAND TYPE Dominated by Annual Species	0.68	0.20	8.58	4.63	39.70	0.12	29.06	0	***8.84***
UNCLASSIFIED WETLAND TYPE: Dominated by Saline Tolerant and Other Species	0	0.49	0.73	0.42	1.40	2.85	0	0	***0.91***
UPLAND TYPE: Vegetated land showing no wetland indicators and that can not be keyed to a riparian/wetland habitat type or community type	0	0.28	0.26	0.03	4.67	0.56	0.41	0.09	***0.57***

Prediction of Successional Progression

***Scirpus maritimus* (alkali bulrush)**—Areas dominated by this late seral graminoid species comprise the largest fraction of the Refuge wetland; however, much of this area is in a disturbed state (not supporting a late seral community composition) due to fluctuating water level. Alkali bulrush is a rhizomatous species that can store significant energy reserves below ground in tuberous structures. This advantage helps it to persist through fairly long periods of drought.

Large stands of alkali bulrush were recorded in Unit V with mostly dead above-ground material that had not been flooded for more than two years, but that still had sufficient live plant cover to key to the alkali bulrush habitat type (at least 15 percent canopy cover). This unit had been drained for (two years??), and was being re-flooded at the time of this inventory. Most of the alkali bulrush aboveground material was stunted and brown, and the annual *Chenopodium album* (lambsquarter) currently dominated the stands. With continued flooding, the annual forbs will be drowned, and the alkali bulrush will re-establish dominance in the next growing season.

The bulk of the wetland area on the Refuge can be considered to have the potential for alkali bulrush, given the necessary hydrologic regime, which means shallow flooding during much of the growing season most years. Deeper flooding for extended periods would shift potential to either *Typha* (cattail) species or to *Scirpus acutus* (hardstem bulrush) According to Kantrud (1996), maximum water depth that alkali bulrush will not tolerate is about 39 in (1 m), and that the maximum optimum growing conditions are at a depth of about 7 in (18 cm). Drier conditions (shallower, shorter duration, or less frequent flooding will shift the potential to one of the drier types with tolerance for salty soils, such as the *Agropyron smithii* (western wheatgrass) habitat type.

***Typha* (cattail) species and *Scirpus acutus* (hardstem bulrush)**—These species require deeper water that persists over most of every growing season. Topography on the Refuge limits the extent on which these conditions may be maintained. There are areas with sufficiently deep topographic relief where water depth could be maintained to support these communities within Units I, II, III, IV-A, IV-C, and VI in addition to the major canals that supply water to the different management units. Presently there are stands of cattail and/or hardstem bulrush totaling more than 4 ac [1.6 ha] within Units I, II, III, IV-C, and VI.

Some stands in Unit III, which have been drained for one or two years, have small amounts of *Typha* (cattail) as a codominant component with *Scirpus maritimus* (alkali bulrush) and *Alopecurus arundinaceus* (creeping foxtail). These cattail plants show the severe stress of the drying and also of the increased salt level that results from the drying.

***Agropyron smithii* (western wheatgrass)** — Western wheatgrass stands occur on the higher elevation peripheries near the toeslopes of the surrounding uplands. The *Agropyron smithii* (western wheatgrass) habitat type is one of the driest of functional wetland site types described for Montana. Although the species occurs commonly in uplands and wetlands, the western wheatgrass habitat type is located on fine textured soils of swales and alluvial fans where topographic features collect additional water on poorly drained surfaces. Under the prevailing hydrologic management of the Refuge, flooding sufficient to significantly alter the extent of the present coverage by this site type is unlikely. Presently this type represents about 1,100 ac (445 ha) of the Refuge wetland. It almost entirely occurs around the outside edges of the basin, and is neither flooded, nor appreciably dried, by water level manipulation in the management units.

***Hordeum jubatum* (foxtail barley) and Annual Forbs** — Approximately on fourth the Refuge wetland area was dominated by these pioneering (early seral) species at the time of inventory. These species result form the continual hydrologic disturbance of repeated cyclic flooding and re-drainage of management units. This practice is necessary and not undesirable. While many of the pioneering species that invade the newly exposed (drained) areas are exotic (introduced) annuals, few of them seem to present a serious problem.

***Alopecurus arundinaceus* (creeping foxtail)** — Creeping foxtail is an introduced rhizomatous perennial species that has regenerative advantage on sites with conditions transitional between those required by *Typha* (cattail) and by *Scirpus maritimus* (alkali bulrush). Creeping foxtail now occupies significant areas on the Refuge (about 213 ac [86 ha]) generally in a band surrounding the major bodies of deeper water, and lying immediately above the zone occupied by the cattail. While this exotic species is aggressive in invading suitable new sites, it may be limited by soil chemistry and hydrologic regime on the Refuge to those areas where it is already established. Further study and observation of this species is advised.

Invasive Species (Weeds)

Cirsium arvense (Canada thistle) is the only weed species present in wetlands on the BLNWR. This species is widespread and common throughout the refuge on sites that are neither too saline nor too wet. It is most abundant around the small nesting mounds. See Table 6 for a breakdown of Canada thistle cover among the management units.

Table 6. Acres and percent of area covered by *Cirsium arvense* (Canada thistle)

Refuge Unit	All	Lotic 6	I	II	III	IV-A	IV-B	IV-C	V	VI
Acres of Canopy Cover	187.64	1.21	4.52	12.54	109.90	1.87	12.11	23.07	20.19	2.21
Percent of Area	3.1	4.4	0.9	2.2	8.4	0.5	3.1	1.8	2.4	0.3

Functional Health Assessment

Another way of comparing ecological status among different riparian areas is by using an index of riparian functional health. (Riparian functional health is the ability of a riparian site to perform its potential ecological functions, such as to recharge its aquifer, produce primary biotic mass, build and retain soil, provide wildlife habitat, etc.) We use such an index composed of several factors, vegetational and physical, derived from the riparian inventory data collected on each transect (Table 7).

Table 7. Average functional health assessment rating scores (weighted by area)

	Functional Health Rating Average Scores by Refuge Unit									
Refuge Unit	All Refuge	Lotic Six	I	II	III	IV-A	IV-B	IV-C	V	VI
Average Score		87	68	65	62	81	47	70	70	80
Size (Acres)	***6105.37***	27.71	501.25	576.93	1,306.85	408.83	389.89	1,272.46	852.57	768.88

Management Considerations for *Scirpus maritimus* (alkali bulrush) (from Kantrud 1996)

Alkali bulrush readily pioneers on saline bottoms of managed wetlands if water is applied and depths do not exceed 7 in (18 cm). Established stands withstand occasional exposure of bottom substrates. Invasion of glycophytes (plants intolerant of alkaline conditions), such as *Typha* spp. (cattails), is probable where conductivities of bottom substrates fall below about 6 mS/cm. Drainage of water impoundments for at least 2 years increases salinities and allows *S. maritimus* achenes to germinate and

replace the *Typha*. More *S. maritimus* achenes germinate under about 2 in (4-5 cm) of water than on moist soil. Flooding of established stands during fall and winter, followed by gradual drainage before midsummer, produces good yields of achenes on sites where competition by other halophytes is not a problem. In these areas, prolonged flooding in summer results in poor achene production and stands are usually rapidly invaded by *Typha* and other undesirable freshwater plants.

Burning in spring of stands of *S. maritimus* after removal of surface water seems to have little influence on achene production and on the number of viable achenes in the seed bank. Nevertheless, such fires probably are beneficial because the frequency of plants increases while vegetative reproduction continues. Mowing with removal of plants (haying) reduces productivity significantly more than burning, probably because of the lack of a nutrient pulse from the ash. Nevertheless, stands may benefit from occasional haying to remove excess vegetation.

GLOSSARY

Community type—An aggregation of all plant communities distinguished by floristic and structural similarities in both overstory and undergrowth layers. A unit of vegetation within a classification. As used here, a community type represents seral vegetation, and is never considered to be climax.

Decadence—A way of relating how much dead wood is present within a stand of woody plants (trees or shrubs). A decadent tree or shrub is defined here as one having at least 30 percent of its above ground material dead.

Functional health—The ability of a site to perform its potential ecological functions, such as a riparian site to recharge its aquifer, produce primary biotic mass, build and retain soil, provide wildlife habitat, etc.

Habitat type—The land area that supports, or has the potential of supporting, the same primary climax vegetation. A habitat type classification is a vegetation-based ecological site classification. It is based on the potential of the site to produce a specific plant community (plant association). It has been used to classify grasslands, shrublands, woodlands, and forests throughout western United States.

Lotic wetland—A wetland that is associated with a stream, or body of flowing water that has an identifiable channel, as opposed to a "Lentic Wetland," which is associated with a still (non flowing) body of water, such as a lake, marsh, or pond.

Pioneer species—any plant species that has the ability to colonize new sites, or sites of recently bared soil. These tend to be species that produce many light weight seeds that are easily transported by wind or water.

Polygon—an area of land for which a data record is recorded, In the sense the term is used in riparian inventory and assessment work, the polygon area is usually irregular in shape, normally bounded by discrete upstream and downstream delineations and on the sides by the outer edges of the riparian zone or floodplain.

Species prominence—a value for indexing how important a species is within a set of polygons where it was recorded on at least one polygon in the set. Prominence is defined here as the numerical value of the product resulting from multiplying the average canopy cover percent (recorded on polygons having the species present) times constancy of the species (the percent of polygons in the set having the species present).

Successional stage—An identifiable point along the path of seral progression, or relative age/development, of a plant community. As a stand of vegetation matures, it passes through stages of dominance by a generally predictable progression of different species until reaching a climax point of stability.

Weedy species—any plant species that exhibits such attributes as an aggressive nature, an ability to readily pioneer disturbed sites, and a pronounced tendency to increase its presence under pressure of disturbance such as heavy grazing.

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