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Wetlands of Crater Lake National Park: An Assessment of Their Ecological Condition

Natural Resource Technical Report NPS/KLMN/NRTR—2008/115

ON THE COVER
A wetland in Crater Lake National Park.
Photograph by: Cheryl Bartlett

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Summary

This study sought to assess the health of wetlands in Crater Lake National Park (CRLA). To address this objective, during 2006 we visited and assessed the health of 76 wetlands throughout the park, covering an area equal to about 38% of the park's known wetland area. Of the wetlands visited, 61 were selected using a statistical procedure that drew a spatially-balanced randomized sample from an existing map of CRLA wetlands and 15 were selected to represent coarse-scale attributes apparently absent from the 61 statistically-selected sites. Among the visited wetlands, we surveyed a total of 101 vegetation plots. We also characterized soil profiles and observed surface hydrologic conditions. Before beginning the field work, we used GIS and a variety of existing spatial data layers to quantitatively characterize all mapped CRLA wetlands.

Wetlands in CRLA occur in a variety of settings, including stream riparian areas, pond margins, alder-covered slopes, springs, montane meadows, and snowmelt depressions. Although occupying less than 1% of the park's area, these wetlands provide a variety of ecological services such as water storage, water purification, slope stabilization, carbon sequestration, thermoregulation, and support of plant and animal habitat and biodiversity.

Many factors define wetland health (or integrity), including contaminants that could not be measured by this study. Only a few indicators of wetland health can be estimated rapidly and at reasonable cost across a large number of wetlands. One is the prevalence of native plant species, and from these data alone our data show most CRLA wetlands being relatively healthy. We found six non-native plant species (<1% of all species we encountered) among 14 (18%) of the 76 wetlands we visited. From zero to four such species were found per wetland, but they never dominated the vegetation cover.

Our assessment of just 76 wetlands detected two-thirds of CRLA's known wetland flora. Among the 354 plant taxa (both wetland and upland) that we found in the visited wetlands were 10 that are listed by the Oregon Natural Heritage Program as rare or having limited distribution. We also found 20 species and subspecies that had not previously been reported from the park. In most wetlands, more than 45 plant species and 21 families were found, and most of the 100 m^2 plots we surveyed had more than 24 species and 15 families, with a maximum of 51 species.

All but six of the selected sites were confirmed to be wetlands. Although the primary objective of this project did not include wetland boundaries or comprehensively identifying previously unmapped wetlands, we did incidentally discover at least 16 wetlands outside the Crater Lake caldera and 28 within it that had not been previously mapped by the National Wetlands Inventory. Our on-site GPS measurements also indicated that the NWI had underestimated the spatial extent of many wetlands. We recommend further attempts be made to identify and assess wetlands in the northeastern portion of the park, and to survey more wetlands in parts of the Bybee Creek area that we could not reach during 2006 due to a forest fire at that time.

Acknowledgments

The need for this project was identified by Dr. Daniel Sarr, I & M Coordinator, Klamath Network, National Park Service. His support and feedback throughout the project was absolutely crucial to its success. Dr. Jim Good at Oregon State University administered the agreement (Cooperative Agreement #CA9088A0008). At Crater Lake National Park, Michael Murray provided helpful advice before and during our field work. Field assessments were done by Cheryl Bartlett (crew chief) with major assistance from Joshua Barazza (wetland soils) and Keir Morse (plants). Early in the project, Andrew Duff (then at Southern Oregon University) used GIS to identify and compile the most important spatial data layers for CRLA. Expert assistance with identification of sedges was provided by Joy Mastrogiuseppe at Washington State University. Jennifer Larsen and Jonathan Ellinger, graduate students at Oregon State University, assisted with the GIS tasks and data entry tasks, respectively.

1.0 Introduction

1.1 Study Background and Objectives

Wetlands include portions of features as varied as springs, seeps, alder swales, montane meadows, cottonwood stands, ponds, beaver impoundments, snowmelt pools, marshes, bogs, and fens. As water-gathering foci in watersheds, wetlands are especially vulnerable to impacts at landscape and local scales. They also are an excellent indicator of the overall ecological health of the watersheds within which they occur. Wetlands in Crater Lake National Park (CRLA) are potentially vulnerable to a range of cumulative impacts, including non-native species invasions, air-borne or water-borne pollutants, hydrologic alterations, and excessive traffic. Some of them may be experiencing lingering effects of logging that occurred historically.

This project sought to address three main questions:

- What is the general accuracy of the existing National Wetlands Inventory (NWI) maps of CRLA wetlands?
- What is the ecological health of CRLA wetlands?
- What is the most consistent and logical scheme for defining the plant species assemblages (vegetation communities) of CRLA wetlands?

These objectives are consistent with the park enabling legislation, the national goals of the Inventory and Monitoring Program (including Vital Signs Monitoring), and future park management. This project was not intended to be either a research study (in the sense of testing specific hypotheses) or a comprehensive resource *inventory* of wetlands or plant species. Rather, it is a resource *assessment*, characterizing the overall distribution, health, ecological services, and types of wetlands within the park. Such an assessment is necessary to profile the resource as it exists now and to provide a baseline against which future changes may be monitored – and their causes sought and where necessary, remedied (Bedford 1996). Data compiled and analyzed by this assessment also support quantitative reference standards for ongoing wetland management and restoration activities. Currently, managers are hindered in assessing the severity of possible impacts to wetlands because there are no systematic data that quantify what unaltered wetlands of each major type "should" look like, in terms of the range of plant diversity, species composition, and ecological services.

1.2 Wetland Health and Its Indicators

Whether discussing wetlands, forests, or rangelands, the terms "ecological condition," "health," "integrity," and "quality" are often used interchangeably. As noted above, a major objective of this project was to estimate the proportion of CRLA wetlands that are "healthy." However, although scientists and policy makers have long struggled with the question of how to define wetland health or ecological condition, *no consensus on a definition of wetland health – let alone an accepted procedure for measuring it comprehensively – currently exists* (Young and Sanzone 2002). To some, health is synonymous with the "naturalness" of a wetland's biological communities and hydrologic regime. For example, by such criteria, wetlands that support only native species, and especially native species that are intolerant of pollution and other human disturbance, are considered to be the healthiest. To other scientists and policy makers, wetland health means the degree to which a wetland performs various ecological services – such as storing water, retaining sediments, and providing habitat. Still other professionals believe that wetland health should reflect not only the performance of these ecological services (sometimes called "functions"), but also the *value* of the services that are provided to society in specific local settings. These three perspectives are not synonymous, interchangeable, or inevitably correlated, at least not when using only data that can be assessed rapidly (Hruby 1997, 1999, 2001). Alternatively, some have suggested use of the phrase, "proper functioning condition" to describe ecosystem health and have suggested qualitative indicators and a "condition checklist" for its assessment in fen wetlands (see below) and freshwater wetlands of the arid West (Pritchard 1994, Rocchio 2005). However, such checklists or scorecards require considerable judgment on the part of the user, tend not to generate consistent results among users and across a variety of wetland types in different regions, and are often not sensitive to important differences between wetlands. The visually-based estimates they provide have seldom been tested for correlation with meaningful measured data. Finally, the term "desired future condition" has been suggested. Although this term makes explicit the value judgments involved, the term can be defined by managers in almost any manner, which confounds the interpretation of results from broadscale comparative assessments.

Attempts to define wetland health become further confused when the simple presence of activities or features that have the *potential* to disturb wetland biological communities, ecological services, and values are *assumed* without site-specific evidence to have had that effect, and the alteration is assumed to inevitably be "negative" from a human perspective. For example, a trail adjoining a small, sensitive wetland has the potential to introduce sediment into the wetland during periods of high runoff. But without further evidence this cannot be assumed to occur, because many trails are on soils highly resistant to erosion. Even if sediment enters the wetland, the effect on wetland services, values, and health cannot be assumed to necessarily be negative.

A major challenge has always been to find *indicators* of the key ecological attributes and processes – as well as for wetland health, ecological condition, naturalness, ecological services, and value – that are both highly repeatable (among different users) and practical to apply. Many features that could yield the most information for judging ecological services and health cannot be measured without a considerable monitoring investment in each wetland over long periods of time, and comparing the data to data collected from a series of reference wetlands. Examples of such features include the duration and frequency of flooding, proportionate contributions of various sources of water to a wetland's water budget, soil organic content and buildup rates, functional diversity of microbes and invertebrates, contamination of sediments, seed germination rates, and wildlife productivity and consistency of use. Often the most rapid and objective (but not comprehensive) approach for estimating the health of wetlands is to identify their plants. Many plant species can serve as excellent indicators of wetland health (Adamus and Brandt 1990, Adamus et al. 2001); see also: http://www.epa.gov/waterscience/criteria/wetlands/. In some regions, a "floristic quality index" has been developed and applied to assess wetland health, but such a metric has not been developed for this region. It requires a considerable amount of basic information on tolerances of wetland species to various types of disturbances.

1.3 General Description of CRLA

Information in this section (1.3) is paraphrased from various existing CRLA reports.

Due to relatively high elevation, the growing season at CRLA is mostly less than 50 days in length. Summer weather is generally mild with clear skies except for occasional afternoon thunderstorms. Precipitation in CRLA averages 70 inches per year at park headquarters, with the majority falling as snow. The park records some of the heaviest snow in the U.S. each winter, with annual totals averaging over 520 inches, making it the largest source of water for the park's wetlands. Snow typically begins to accumulate in October and does not melt in most places until early summer. Despite the large amount of precipitation, only a fraction of this water becomes available to wetlands due to the porous soils and pumice that charcterize the surrounding uplands. The park's soils have recently been mapped and described in detail (NRCS 2002). The park's vegetation is typical of that found throughout the Southern Cascades, reflecting a mosaic of mixed conifer forested areas and open non-forested areas. Climate, topography, soil development, and fire history all affect the composition and distribution of existing plant communities. Conifer forests that evolved under the influence of fire dominate the park. Varying fire regimes over the landscape, over time, have resulted in plant communities in various stages of ecological succession, thus providing a diversity of habitats for wildlife. Approximately 27% of the park is comprised of late seral forest. Habitats are distributed from lower to higher elevations in about this order: ponderosa pine forests, lodgepole pine forest, hemlock and whitebark pine forest.

1.4 Previous and Ongoing Studies Related to the Park's Wetlands

Wetlands of CRLA have not previously been studied in a holistic and statistically-rigorous manner. Existing published data are of limited use in assessing health of specific wetlands within the park because few such data were referenced to precise geographic locations. Prior to this study, botanists had previously visited many of the park's wetlands (as well as all other habitat types) non-systematically, as reflected in publications on the park's flora (e.g., Applegate 1939, Zika 2003). Two wetland complexes, Sphagnum Bog and Whitehorse Ponds, had been the focus of limited studies (Seyer 1979, Salinas et al. 1994, Murray et al. 2006). Records have been published of amphibians (e.g., Bury and Wegner 2005) and other wetland wildlife observed at various locations in the park over the years, and the Whitehorse Ponds complex has been a particular focus of amphibian surveys. Nonetheless, a comprehensive wildlife survey specifically in wetlands has not yet been completed. The following summary of aquatic studies in CRLA is excerpted from Hoffman et al, (2005):

The first survey of park streams was completed in 1947 (Wallis 1948). This survey focused primarily on trout distribution, included 41 stations on 19 streams where water temperature, average station width and depth, and velocity were measured and stream habitat was described. A more extensive survey of part streams and springs was conducted in 1967-1968 (Frank and Harris 1969). These surveys recorded 106 flow measurements for 46 streams and 21 springs, and collected 45 water samples from a subsample of 17 streams and 21 springs. Eight samples were analyzed for a complete suite of water quality variables, and 37 samples were analyzed for a subset of variables. In 1981-1985, approximately 10 springs were sampled for water chemistry analysis (Thompson et al. 1987).

In addition, as described by Hoffman and Sarr (2007), plans are currently underway to begin monitoring, about once every three years, of water chemistry and aquatic invertebrates in park streams (beginning this year) and ponds outside the caldera (tentatively beginning in 2010). However, except for Sphagnum Bog, wetlands will not be sampled. The quality of water in wetlands can be influenced not only by proximity to pollutant-generating human activities, but also by water source (groundwater vs. surface water runoff), residence time (flow rate), geologic and soil types, precipitation pattern, and location (high or low in watershed, east or west side of park). Outside the park, several publications discuss the ecological condition and threats to wetlands and other aquatic habitats in the northern Sierra – southern Cascade region (e.g., Moyle and Randall 1998, Noss et al. 1999, Hayslip et al. 2004, Landers et al. 2008). A qualitative method for assessing the ecological condition of fen wetlands of the Sierras and southern Cascades was proposed by Weixelman et al. (2007), following generally the "Proper Functioning Condition" (PFC) approach used widely by some federal agencies (Pritchard 1994).

2.0 Methods

We used three complementary strategies for characterizing the wetlands of CRLA:
1. GIS Strategy. This involves summarizing available information on every known wetland within the park. By measuring the entire wetland population using digital spatial data and GIS, it avoids having to extrapolate data collected from a limited number of sites whose representativeness and scope can be challenged. However, the merits of this comprehensive strategy can be offset if spatial data are unavailable for themes relevant to wetlands, or if spatial data are inaccurate or spatially imprecise.
2. On-site Sampling, Randomized. This involves measuring a limited subset of wetlands, and has the advantage of allowing collection of more detailed and accurate information during actual site visits. Selecting sites in a statistically random manner for those on-site visits allows inference to the entire population. However, in some parks it is not feasible to sample enough wetlands during a single field season to allow reliable extrapolation of all the measured wetland features.
3. On-site Sampling, Selective. This involves augmenting (not replacing) the randomly-selected wetlands with ones that have complementary features not included in the random sample, such as greater levels of environmental threat, rare soil types, and extreme elevations.

These strategies are now described in more detail.

2.1 Initial Site Characterization

We began this project by obtaining wetland maps for CRLA from the National Wetlands Inventory (NWI). Those digital maps had been based solely on recent aerial imagery and had not been checked in the field for accuracy. The maps show gross cover types (emergent, shrub, forested, etc.) as distinct polygons (shapes). Where these are contiguous, they had not been digitally joined to create a hydrologically "whole" wetland, so this was done by graduate student at Oregon State University (Jennifer Larsen) supervised by the project scientist (Dr. Paul Adamus). Ms. Larsen overlaid the resulting wetland polygons with digital maps of various other natural resource themes that had been prepared for CRLA over previous years, as identified and compiled in an inventory by Andrew Duff, formerly on the faculty of Southern Oregon University.

2.2 Wetland Inventory

This project was not intended to provide a complete inventory of wetlands in all or any part of CRLA, nor to delineate with high precision the boundaries of any of the park's wetlands. Rather, a primary objective was to determine what proportion of areas mapped by the National Wetlands Inventory (NWI) as wetlands are actually not wetlands (i.e., "commission errors"). This was accomplished by our field inspections, as described in Section 2.4.

2.3 Field Site Selection

We estimated that we would be able to assess an average of about one wetland per day, allowing for variations in wetland accessibility, size, and other contingencies. Given a single field season of about 60 days (late June through September), we estimated that at least 60 wetlands could be visited once, using one crew of two persons, and occasionally splitting into two crews of two persons each when additional persons were available. Wetlands to be assessed in the field (Table 1, Figure 1) were chosen using two strategies, one random and the other non-random (selective). The random strategy featured the use of GRTS (Stevens 1997, Stevens and Olsen 1999, 2003, 2004, Stevens and Jensen 2007), a state-of-the-art statistical algorithm being used by several state and federal resource agencies, and applied to our data by its developer, Dr. Donald Stevens at Oregon State University. GRTS selected a statistically-random sample of spatially-distributed points. That is, wetland sample points were selected randomly in a manner that gave equal weight to all previously-mapped wetland polygons in the park. Use of GRTS minimizes problems associated with spatial autocorrelation, which otherwise limits making valid statistical inferences from site-level data to an entire park. The GRTS application resulted in a list of 254 points, one for each NWI wetland polygon. Of course, not all wetlands (points) could be visited during the single season available for field work, so initial plans were to visit only the first 61 specified by the GRTS application. Selecting wetlands in the sequence specified by GRTS was necessary to achieve geographic spread and maintain statistical integrity of the sample.

An additional 15 wetlands not prioritized as highly by the GRTS application were also selected and visited. They were selected to cover major features not present among the 61 randomly-selected GRTS wetlands. To select those wetlands, we first used GIS to extract and compare attributes of the 61 GRTS-selected wetlands with attributes of the remaining 198 wetlands that GRTS had assigned lower priority for a site visit. For example, a few geologic types were found to be lacking among the GRTS-selected wetlands we had planned to visit, so the first one of the non-GRTS wetlands that had the missing type was added to the list of wetlands to be visited. We then ran a cluster analysis on the complete GRTS wetland dataset to determine if wetlands having unusual *combinations* of attributes were lacking among the 61 wetlands we planned to visit. Attributes used in the cluster analysis were geologic type, elevation, annual precipitation, and stream presence/absence – all of which could be determined from existing spatial data. Thus, the cluster analysis, together with the queries of single attributes, was used to identify the 15 additional wetlands to be assessed and these “non-random” (NR) wetlands were added to the agenda for the field season.

Once field work began, it became apparent that three sites (K23, K69, NR92) could not be safely accessed due to extreme surrounding terrain. As a result of the ongoing Bybee fire, we could not access nine wetlands selected by GRTS (K5, K8, K12, K16, K24, K32, K36, K40, and K47) or eight nearby wetlands initially chosen using the GRTS process to replace them (K56, K63, K66, K67, K70, K74, K78, and K82). We ultimately were able to substitute in five wetlands that had the next-highest GRTS rankings: NR54, NR62, NR65, NR73, and NR79. Also, eight sites in other parts of the park were determined, upon visitation, to not contain wetlands although they had been mapped as such by the NWI. They are: K14, K27, K59, K72, NR152, NR216, NR245, and NR248. In our sample, we replaced them with other wetlands prioritized by the GRTS rankings.

In all, we fully assessed a total of 76 wetlands comprising about 38% of the park’s 532 acres of mapped wetlands and 30% of the 254 mapped wetland polygons. In these wetlands, plant species composition was quantified in 101 plots, one or two per wetland, each plot covering 100 m^2. In all, 68 of the plots were dominated by herbaceous plants, one by non-vascular herbaceous plants, eight by dwarf shrubs, 18 by larger shrubs, and six by trees. Except where noted otherwise, data summaries presented in this report are for all 76 visited wetlands, rather than for just the 61 selected by GRTS. When statistically-defensible projections of wetland conditions in CRLA are needed, the accompanying data should be compiled just for those 61 wetlands.

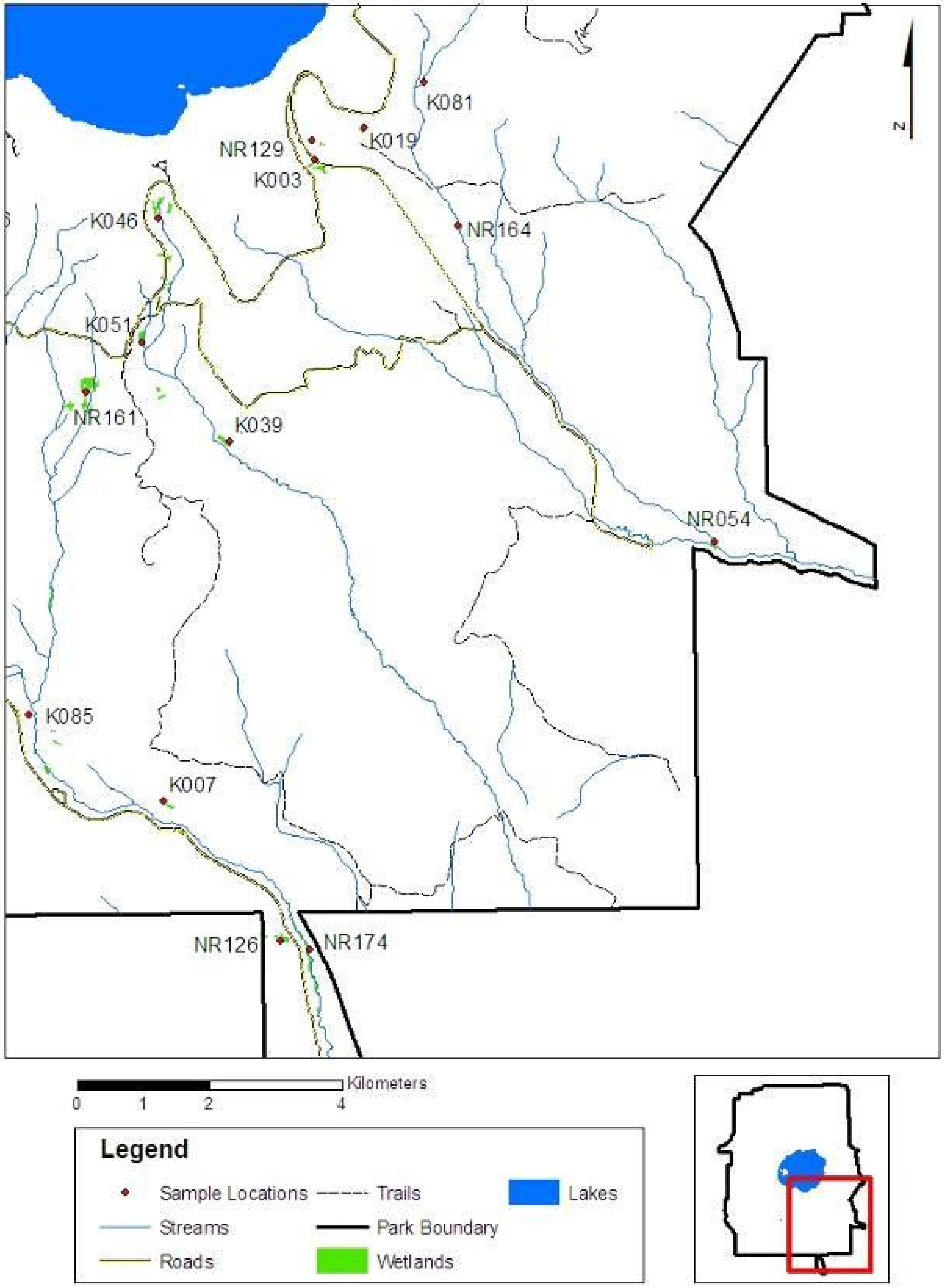

Figure 1. Wetlands visited and assessed in the southeastern portion of CRLA during 2006.

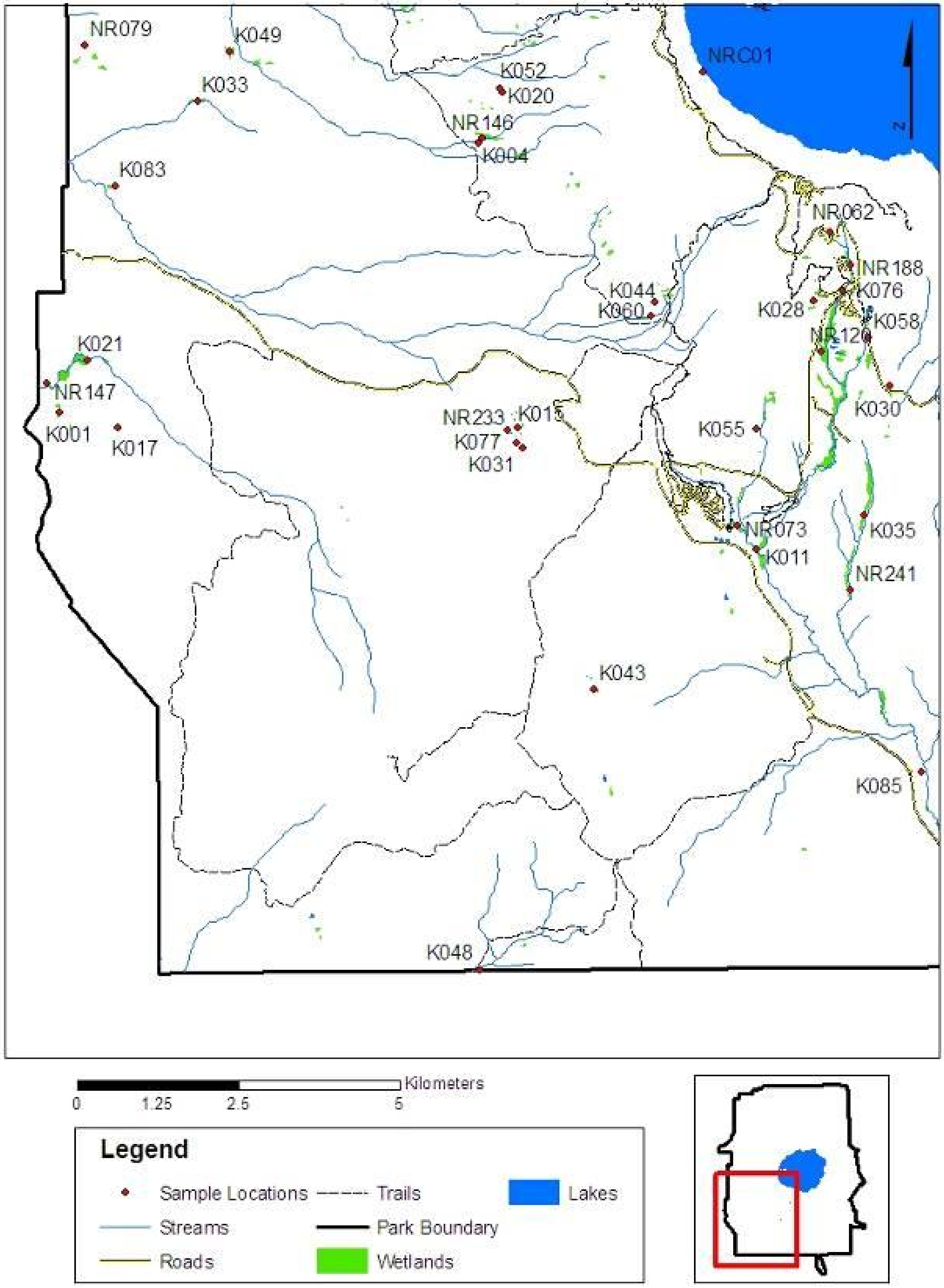

Figure 2. Wetlands visited and assessed in the southwestern portion of CRLA during 2006.

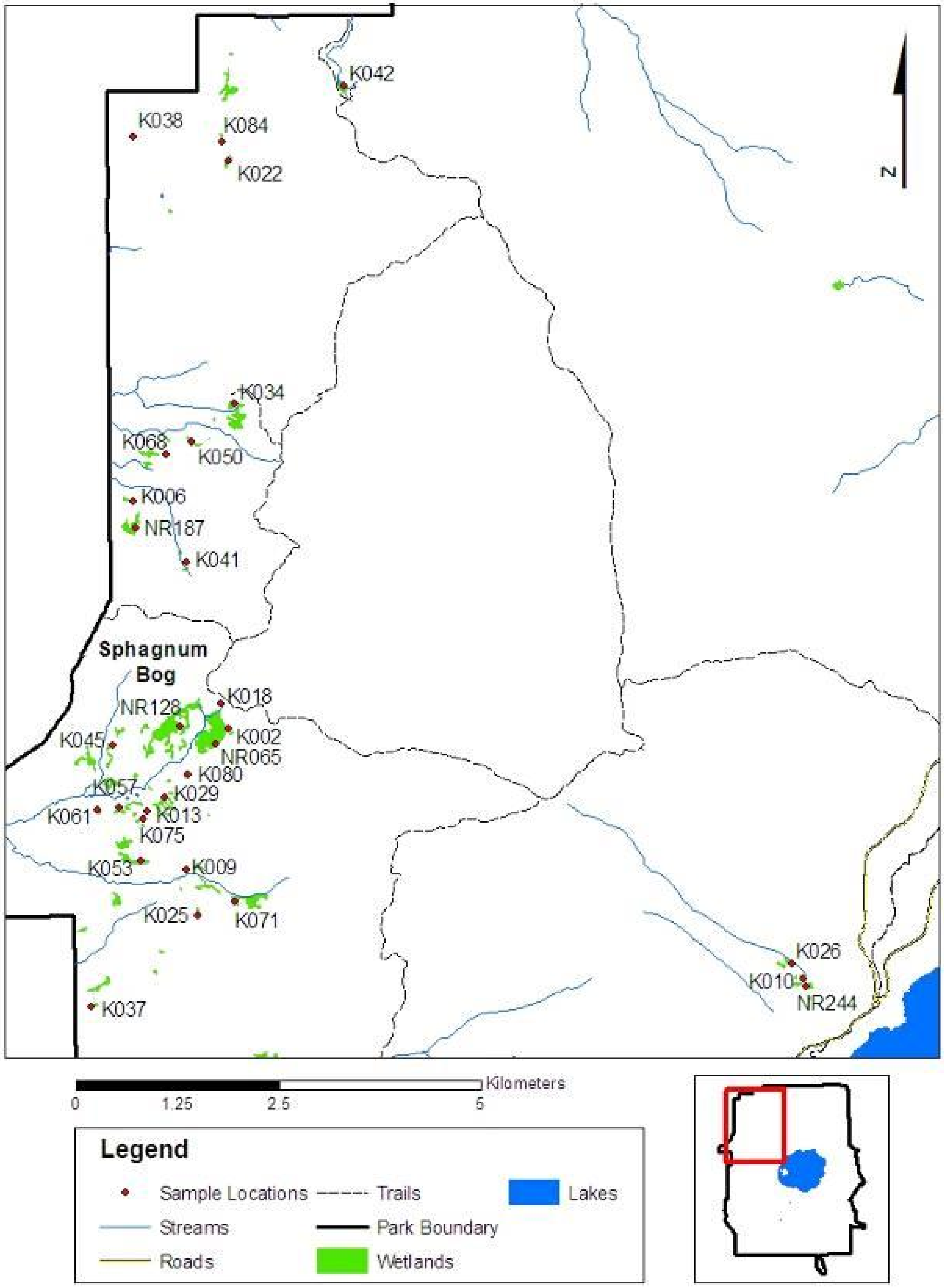

Figure 3. Wetlands visited and assessed in the northwestern portion of CRLA during 2006.

Table 1. GPS coordinates and general descriptive information on the assessed wetlands.

Stratum: 1= part of statistical sample; 0= hand-picked (judgmental) site
HGM Class: S= slope, D= depressional, R= riverine
Acres Covered: Bold font indicates wetland is larger than mapped by NWI; non-bolded font indicates either that less than the entire mapped polygon was covered by our field effort, or (less often) that the NWI polygon boundaries overestimate the extent of wetland.

Stratum	Site ID	UTMn	UTMe	Site Name	Date Visited	HGM Class	Acres Covered	Acres Mapped by NWI	Elevation (m)
1	K1	558411	4747671	Thousand Springs Slope	7/1/2006	S	**9.26**	0.37	1499
1	K2	561208	4760729	Paul's Paradise	7/13/2006	S	**0.46**	0.24	1631
1	K3	576040	4750455	Talus Spring	8/8/2006	S	**3.93**	1.04	1976
1	K4	564904	4751830	Fireman	8/11/2006	S	0.17	0.38	1806
1	K6	560029	4763538	South Fork National Ck.	7/12/2006	S	0.05	1.24	1534
1	K7	573766	4740814	Annie Falls	7/24/2006	D	**2.51**	1.73	1644
1	K9	560681	4758983	Crater Creek South	7/24/2006	R	0.17	1.22	1606
1	K10	568317	4757633	Llao Rock South	8/21/2006	D	0.21	0.50	2115
1	K11	569194	4745554	Annie Junction	7/25/2006	S	4.55	4.71	1752
1	K13	560196	4759710	Lily Pond	8/1/2006	D	**0.37**	0.34	1561
1	K15	565514	4747432	Whitehorse Pond	8/23/2006	D	**0.22**	0.19	1940
1	K17	559318	4747431	Avocado Springs	7/5/2006	S	0.42	0.86	1618
1	K18	561108	4761039	Sphagnum Meadow	7/13/2006	S	0.69	0.76	1652
1	K19	576780	4750917	Gooseberry	8/14/2006	S	0.05	1.20	2120
1	K20	565259	4752625	Mud Pot	8/15/2006	S	0.30	0.38	1885
1	K21	558844	4748474	County Line	6/30/2006	S	0.59	29.75	1519
1	K22	561212	4767744	Bald Crater	7/7/2006	S	**1.83**	1.44	1693
1	K25	560833	4758423	Skink	7/24/2006	S	0.04	1.12	1611
1	K26	568177	4757831	Llao Rock North	8/21/2006	D	1.03	3.73	2101
1	K28	570082	4749399	Sleep Hollow	8/9/2006	S	0.69	1.64	2021
1	K29	560422	4759882	Corn Lily	8/1/2006	S	1.61	6.13	1575
1	K30	571254	4748096		8/8/2006	S	**2.30**	1.31	2020
1	K31	565578	4747134	Woodpecker	8/23/2006	D	0.14	0.23	1942
1	K33	560549	4752485	Aspen	8/23/2006	S	0.64	3.06	1670
1	K34	561286	4764742	Oasis Springs	7/31/2006	S	**6.85**	6.29	1615
1	K35	570867	4746090	Midcanyon	8/31/2006	R	1.34	30.71	1846
1	K37	559509	4757291	Copeland Creek	7/10/2006	R	0.45	1.16	1539
1	K38	560025	4768043	Hamacker Butte	7/7/2006	R	**1.74**	0.83	1640
1	K39	574766	4746202	Frosty	8/31/2006	S	**4.14**	3.57	1818
1	K41	560681	4762793	Blueberry	8/9/2006	S	**1.85**	1.37	1627
1	K42	562629	4768676	Boundary Springs	7/6/2006	S	2.04	3.00	1589
1	K43	566686	4743403	Wasps	9/7/2006	D	0.34	0.16	1986
1	K44	567627	4749393	Castle Creek	7/26/2006	S	0.17	0.46	1889
1	K45	559783	4760526	Mossy Seep	8/2/2006	S	**4.05**	1.26	1596
1	K46	573699	4749572	Sun Creek	8/10/2006	S	4.64	5.25	2104
1	K48	564907	4739044	Bald Top	9/7/2006	R	0.58	1.22	1726
1	K49	561048	4753247	Alder Alley	7/11/2006	S	**4.32**	3.12	1622
1	K50	560758	4764278	National Ck. MidFork	7/12/2006	R	0.86	1.41	1575
1	K51	573453	4747707	Vidae Creek	8/17/2006	S	2.33	6.91	1972
1	K52	565221	4752683	Frank	8/15/2006	S	**1.09**	0.51	1882
1	K53	560129	4759092	Leg Sucker	8/1/2006	R	1.84	16.34	1564
1	K55	569200	4747427	Elksland	8/22/2006	R	**0.63**	0.56	1917

Table 1. GPS coordinates and general descriptive information on the assessed wetlands (continued).

Stratum	Site ID	UTMn	UTMe	Site Name	Date Visited	HGM Class	Acres Covered	Acres Mapped by NWI	Elevation (m)
1	K57	559862	4759759	Gley	8/29/2006	D	1.05	1.79	1541
1	K58	570931	4748824	Roadside	8/21/2006	S	0.22	0.45	1946
1	K60	567575	4749175	PCT	8/22/2006	R	1.46	1.95	1859
1	K61	559594	4759724	Dragonfly	8/28/2006	D	0.15	0.53	1529
1	K68	560448	4764126	Paulygon	9/5/2006	S	**4.98**	0.15	1557
1	K71	561285	4758598	Grouse	8/28/2006	D	1.08	18.94	1656
1	K75	560150	4759617	Bare Bark	8/29/2006	D	0.34	0.86	1562
1	K76	570534	4749567	Maintenance	8/24/2006	R	0.54	0.76	1975
1	K77	565479	4747200	Shag	8/30/2006	D	0.10	0.17	1943
1	K80	560703	4760167	Snag	8/29/2006	D	**0.79**	0.58	1588
1	K81	577680	4751621	Anderson Spring	8/30/2006	S	**0.42**	0.09	2147
1	K83	559269	4751166	Castle Creek	8/24/2006	R	**3.80**	1.40	1536
1	K84	561132	4767986	Deeper	9/5/2006	D	**1.33**	0.70	1682
1	K85	571756	4742107	Triple Fat Annie	9/6/2006	S	**2.68**	0.41	1598
1	NR54	582048	4744702	Floating Pumice	8/14/2006	D	0.00	2.58	1638
1	NR62	570341	4750463	Hairpin Turn	8/8/2006	S	1.68	2.49	2111
1	NR65	561050	4760539	Sphagnum bog east	8/1/2006	S	17.37	140.18	1619
1	NR73	568909	4745935	Annie Creek Trail	7/25/2006	D	1.22	2.68	1752
1	NR79	558801	4753354	Froggie	8/17/2006	D	**1.07**	0.22	1598
0	NR120	570201	4748615	Munson Meadow	7/27/2006	S	4.56	615.89	1913
0	NR126	575523	4738699	Panhandle	7/17/2006	S	8.38	10.12	1450
0	NR128	560608	4760766	Sphagnum bog west	8/1/2006	S	39.54	125.96	1621
0	NR129	576012	4750730	3rd place	9/11/2006	D	**2.85**	0.31	1973
0	NR146	564960	4751927	Beaver	8/11/2006	R	1.80	7.92	1809
0	NR147	558227	4748118	Thousand Springs	6/29/2006	S	0.63	0.85	1509
0	NR161	572613	4746949	Tututni Pass	8/16/2006	S	16.20	47.80	1960
0	NR164	578202	4749464	Lost Creek north	9/11/2006	R	**1.19**	1.03	1873
0	NR174	575972	4738583	Annie Alcove	7/26/2006	D	0.23	20.66	1411
0	NR187	560053	4763209	Humongo Tree	7/25/2006	S	6.17	6.88	1552
0	NR188	570655	4749955	Willow Patch	9/14/2006	R	6.07	9.56	1996
0	NR233	565355	4747404	Blue Fairy Shrimp	7/20/2006	D	**1.54**	0.43	1936
0	NR241	570641	4744929	Nogylop	9/6/2006	R	0.28	5.13	1776
0	NR244	568345	4757572	Two Day Old	8/30/2006	D	0.04	1.35	2128
0	NRC	568378	4752930	Crater Lake caldera	9/13/2006	S	**0.80**	0	1889
					TOTAL		202.05	1178.45	

2.4 Field Data Collection

Over 700 variables were assessed in each of the 76 wetlands visited. This included variables measured from existing data layers using GIS, variables pertaining to wetland plant community composition and richness, and other variables potentially important to wetland health and ecological services. The number of variables was undoubtedly more than some minimum necessary to estimate wetland health and ecological services. The additional variables were assessed because knowledge of indicators of wetland ecological services and health is rapidly evolving; what seems superfluous to measure today may very well be recognized as a critical indicator at a future time. Therefore, decisions about whether to include a variable were based largely on how rapidly it could be assessed, taking into consideration also its repeatability and anticipated relevance, and the time needed to assess higher-priority variables. The main consideration was to ensure that all variables together could be assessed in less than six hours per wetland. All variables included in the database files resulting from this project are listed in the Data Dictionary (an Excel file that accompanies this report) which explains and is cross-referenced to specific items in the field forms (Appendix F) and their supporting protocols (Appendix G).

The field crew was trained in protocols specific to this project by the protocol author, Dr. Adamus. The crew consisted of two experienced botanists (Cheryl Bartlett and Keir Morse) and a college senior accomplished in soils classification (Joshua Barraza). Dr. Adamus helped the crew collect data during 2 of the 14 weeks of the field season.

As noted in Section 2.2, two types of areas were visited: areas identified as wetlands (from existing NWI maps) and areas identified as "possible wetlands" by our statistical models. Depending on the indicator being assessed, field estimates of indicators were made at the scale of centerpoint, plot, polygon (site), and/or polygon buffer:

A ***polygon*** is the entire contiguous wetland, usually separated from similar polygons by upland or deepwater (>6 ft deep) or by major constrictions in sheet flow patterns. Recognizable wetland vegetation forms or communities were not used to delineate separate polygons.

A ***centerpoint*** is the point that represented the polygon during the site selection process and has specific coordinates which have a precision of within 40 ft. It was not necessarily located in the center of a wetland polygon. This point is the target location for the first plot completed at each wetland.

A ***plot*** is a plot of variable dimensions but standard area in which detailed vegetation data were collected.

A ***buffer*** is the upland zone extending upslope a specified distance from the polygon's outer edge.

Basic tasks that were accomplished during each site assessment were:

- Navigated to and from the centerpoint of a wetland that was targeted for assessment (those with a "K" prefix in the parkwide map of sample points).
- Determined if the site is a wetland.
- If the site was found to be a wetland, one marker (***benchmark***) was placed at a measured distance and direction from the centerpoint. The marker was a round, numbered metal tag nailed into a live tree at eye level, with at least 0.5 inch protruding. Locations of most data collected in the wetland were referenced to this benchmark. It could serve as a basis for linking our data to future "vital signs" and trends monitoring data.

Recorded data from the following tasks:

- Dug at least three 12-inch deep pits, determined their coordinates using a GPS, evaluated soil indicators and vegetation, and then replaced soil.
- Identified plants and estimated their cover classes in a standard-sized plot, as well as while walking as much of the wetland as time and physical access allowed.
- Observed and assessed vegetation structure, distribution of water, signs of human presence, and other indicators of wetland ecological service and health as shown in the data forms (Appendix F)[1].

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[1] These were initially derived partly from data forms used previously by the author (WET, HGM), in other NPS projects (Pt. Reyes, CRAM), and officially by the California Native Plant Society (releve procedure). However, this form is intended to describe wetlands with much greater detail than existing methods, with regard to structural components important to wetland ecological service and ecological integrity. This greater level of detail is needed to provide the

- Took one series of panoramic shots from a fixed point with a digital camera (documented the location and direction by including a labeled whiteboard in the picture).
- Delineated the approximate wetland boundary (polygon perimeter) using a hand-held GPS unit. At times the boundaries between the assessment wetland and nearby wetlands were indistinct and erratically contiguous (e.g., connected by a channel containing a very narrow band of wetland vegetation). In those situations, judgment was exercised in deciding where to draw the boundary. Constrictions in surface runoff patterns were used predominantly, while in larger wetlands an additional consideration in limiting the boundary was the extent of wetland that was feasible to walk in about an hour while actively identifying plants.

To maintain consistency, all plants except some difficult sedges (*Carex* spp.) were identified by Cheryl Bartlett. Those sedge species were referred to an expert, Joy Mastrogiuseppe, who kindly identified them. We preserved voucher specimens of most of the plant species we identified and also photographed many species. With NPS permission, our pressed specimens have been placed in permanent repository at the herbarium of either Oregon State University or CRLA.

This study was not intended to comprehensively survey the flora of any wetland visited, nor estimate precisely the overall percent cover (throughout a wetland, not just in plots) of any plant species. It also is important to understand that the detectability and identifiability of plants was greatest in mid-season, and consequently there probably was a tendency to discover more species per plot and per wetland among sites visited at that time. Early and late in the season, some plant species were not evident or, because they were not flowering and/or were senescing, were not reliably identified[2].

2.5 Data Analysis

Wetland ecologists have proposed a variety of indices, variables, or metrics for representing wetland health (Cronk and Fennessey 2001). Few have been validated experimentally by correlation with various types of wetland disturbances. Because they have been used in similar surveys in other regions, we employed the metrics shown in Table 2 to summarize our data at both plot scale and the wetland (= plot + polygon) scale. All focus on vegetation, especially at a community level, because vegetation is relatively easy to monitor, does not move around rapidly on the landscape, and is sensitive to many environmental changes. We computed a variety of summary statistics (e.g., means) for these metrics and all other major variables. All original data files, shape files, and imagery have been provided to the NPS Klamath Network Office, along with a data dictionary and metadata.

The extent of vegetation (especially trees) with damaged, decayed, or missing foliage has been considered by some citizens to be synonymous with unhealthy conditions, and thus was considered for potential use as an indicator. However, wetland science has shown that such conditions, in moderation, are quite normal even in wetlands that have been subjected to little or no human disturbance. Dead trees commonly are the result of either short- or long-term changes in wetland water levels that occur routinely as the result of beaver activities, seismic events, or increased annual precipitation, and are essential to maintaining the diversity of all species that use wetlands.

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sensitivity necessary to distinguish ecological serviceally significant differences among wetlands of which most are expected to be in nearly-pristine condition.

[2] By intent, higher-elevation sites were surveyed later in the season. Their plots tended to contain fewer species.

Table 2. Vegetation community metrics used by this assessment to represent wetland health.

Note: These have not been validated by statistical comparison with measured levels of environmental disturbance, due to the narrowness of the measurable gradient of human disturbance within CRLA. Because of the lack of such validation, no attempt was made to scale or combine them into an overall index of wetland health. They are drawn mainly from the off-site experience of the principal investigator and other wetland scientists.

Metric	Definition	Expected Response
Native Species Richness	Number of native plant species. To reduce bias, species should be counted in equal-sized plots.	Other factors being equal, wetlands with more species (native ones especially) tend to be healthier. The relationship to disturbance is less definitive if most of the species are ones that are common and widespread in the region, or which also respond readily to natural (vs. human) disturbance. Also, both human-related and natural disturbances can temporarily increase species richness in wetlands.
Non-native Proportional Cover and Richness	The proportion of total vegetation cover that is comprised of cover of non-native species. Also, the number of non-native species.	Other factors being equal, wetlands with greater proportional cover and/or number of non-native species are assumed to be more disturbed.
Native Perennial Graminoids	The number of native perennial grass-like plant species (graminoids).	Other factors being equal, wetlands with more (in the southern Cascades at least) might be considered to be healthier.
Frequency Index	An index wherein each species found in a wetland is assigned a coefficient, that being the number of wetlands in which it was found among all visited wetlands. These coefficients are averaged among all species found in a wetland. Higher values indicate the wetland's species list is dominated numerically by species that are more ubiquitous among the visited wetlands. When frequency is expressed as a percent, the index is termed "Constancy."	Other factors being equal, lower values suggest a wetland is healthier. This assumes that a wetland containing a high proportion of uncommon species is one whose species, overall, have limited occurrence due to narrow environmental tolerances and greater sensitivity to disturbance.
Dominance	The cover of a particular species relative to the total vegetated area.	Other factors being equal, in degraded wetlands a very few species often comprise nearly all the vegetative cover, whereas healthy wetlands are often characterized by many species, none of which cover a significant proportion of the vegetated part of the wetland. Thus, the number and proportion of the species that cover the most space can be used as one indicator of possible disturbance, with fewer dominants sometimes indicating less disturbed conditions.
Prevalence Index	The average cover of hydrophytic species, weighted by a coefficient reflecting the relative tolerance of each species to prolonged saturation.	Other factors being equal, wetlands whose species cover is dominated by "true" wetland species (those least tolerant of drier upland conditions) might be considered healthier, because upland species tend to invade wetlands that have been partially drained, filled (intentionally or from incidental sedimantation), or whose water table has been dropped for long periods. Such wetlands have smaller values for their Prevalence Index (PI).
Moss Cover	The proportion of a wetland's vegetated area that is covered by mosses	Most mosses grow slowly and are major contributors to accumulation of peat, thus sequestering carbon for long periods, and many are very sensitive to environmental change.

Although not used to characterize wetland health, statistical classification of vegetation from the wetland plots is being conducted by co-author Cheryl Bartlett as part of her graduate research at Oregon State University. Although a preliminary version is presented in this report, the complete details and final results, including statistical association of the defined classes with various environmental variables, will be presented in her thesis. An agglomerative cluster analysis was used to determine groups (classes or “communities”), and then an indicator species analysis procedure was employed to determine the optimal number of groups and indicator species for each group. The computer program PC-ORD was used for these analyses, after first transforming the cover data in the species x plot matrix using an arcsine squareroot function.

3.0 Results

3.1 Wetland Inventory

3.1.1 Rates for Errors of Commission

Wetlands are defined partly by having a prevalence of plant species that characteristically are hydrophytic (i.e., grow in water or in soils that are periodically saturated). "Prevalence" is commonly quantified with a "Prevalence Index." In its simplest form, the predetermined, published "indicator status" scores of all species present in an area are averaged. If the average is less than three, the area is considered a wetland, contingent as well on soil and water conditions[3]. All but 10 of the visited wetlands had Prevalence Index values indicating they are, indeed, wetlands. The ones that did not qualify as wetlands, based only on their vegetation, are: K2, K3, K7, K15, K26, K28, K77, NR126, NR187, and NRC. However, many species we found had not been assigned wetland indicator ratings by federal agencies (i.e., were "NOL"). On the average, 10% of each site's species fit that description. When those species were excluded from the calculation, all sites qualified as wetlands based on their vegetation. Thus, the lack of information on the hydrophytic tendencies of many species limited broad conclusions about the accuracy of the NWI maps, but in general our field inspections suggested the areas shown to be wetlands are, indeed, wetlands.

3.1.2 Rates for Errors of Omission

To what extent do the existing NWI maps for CRLA fail to show wetlands? Given the fact that (a) development of those maps relied entirely on NWI's interpretation of aerial imagery (not field inspections), and (b) many small wetlands are partially concealed by a forest canopy, it can be expected that some wetlands are not shown on NWI maps. We noted the locations of unmapped wetlands that we discovered incidental to our other field activities (i.e., walking to and from wetlands we had targeted as part of our statistical sample). We recorded their coordinates, dominant vegetation species, and geomorphic setting. We also spent one day on Crater Lake itself, identifying possible wetlands on the surrounding inside western, southern, and southeastern caldera slopes. Most of these were shrublands dominated by *Alnus viridis* ssp. *sinuata*; occasionally this species was mixed with willows or mountain ash. Another vegetation type we saw on the inside caldera slopes was an herbaceous wetland type dominated by *Arnica longifolia*. This was most often an extension of the larger alder-dominated wetlands. In most cases, we could see a seep or spring upslope, or small but definite channels within the wetland. Because we did not examine their soils, make a formal wetland determination, or delineate boundaries, it is possible that some of the sites we discovered on the caldera slopes or elsewhere are technically not wetlands. And because they were not searched for randomly or systematically (e.g., along transects), we cannot infer omission rates for CRLA generally from this information. Nonetheless, we did incidentally discover at least 16 wetlands outside the Crater Lake caldera and 28 within it that had not been previously mapped by the National Wetlands Inventory, and locational information for those is being provided to the NPS.

[3] When calculating the Prevalence Index, obligate (OBL) species are scored 0, upland species are scored 5, facultative (FAC) species are scored 3, etc. Species not on the official indicator list (NOL) are considered to be non-wetland species and are scored 5. The preferred form of the Prevalence Index multiplies the indicator score for each species by the percent cover of the species, and then the products are summed among all species and divided by the sum of the percent covers.

Although not a significant focus of this project, another question concerns the precision of boundaries of wetlands that NWI did map. Our field inspections found many instances where wetlands were actually much larger than shown on maps. In fact, the actual acreage of the wetlands we surveyed, as measured in the field, was in a few cases many times larger than what is shown on NWI maps.

3.2 Wetlands Profile

Under the national hydrogeomorphic (HGM) classification for wetlands (Brinson 1993) and its regionalization (Adamus 2001), CRLA's wetlands might be categorized as shown in Table 3. These results are based on topographic conditions assumed to be associated with these HGM classes (see footnotes to the table), as interpreted from the digital topographic data. Considerable subjectivity is involved in identifying the HGM class of some wetlands using only visual evidence of hydrologic conditions during a single visit, and many wetlands contain more than one HGM class.

Table 3. Number and area of CRLA wetlands by hydrogeomorphic (HGM) class, as estimated using two methods.

Tentatively Assigned Class	From GIS Analysis of All 254 NWI-mapped wetlands				All Field-checked Sites (n= 76)			
	# of Wetlands	% of Wetlands	Acres	% of Total Wetland Area in CRLA	# of Wetlands	% of Wetlands	Acres	% of Total Wetland Area in CRLA
Riverine	72	28%	17.5	36%	15	20%	22.75	11%
Slope	52	20%	9.88	20%	40	53%	162.69	81%
Depression or Flat	130	51%	21.74	44%	21	27%	16.61	8%
Lacustrine Fringe	0	0%	0	0%	0	%	0	0%

Notes:
a) The "Riverine" class as defined by HGM is not the same as the Cowardin "Riverine" class.
b) The HGM classifications based on the comprehensive GIS analysis of NWI maps are much less accurate than those based on the field-checked sites.

Under the contrasting Cowardin classification used on NWI maps (Cowardin et al. 1979), CRLA's wetlands have been categorized on NWI maps as shown in Table 4. CRLA wetlands also were characterized using GIS and available geospatial data. The 254 mostly-discrete polygons that have been mapped as wetlands in CRLA total 1483 acres, or only about 0.8% of the park's area. They range in size from a few square feet to 616 acres, with a median size of only 0.97 acres. Their median elevation is 5758 ft (range= 4387 to 7146 ft), most are in areas receiving more than 58 inches of precipitation annually (range= 29 to 65 inches), and they occur mainly on slopes of less than 6%. Geologically, the park's wetlands occur mostly on felsic-pyroclastic substrates. The soil map unit intersected most often by CRLA wetlands is the Mariel-Stirfry complex, 0 to 3 percent slopes (Table 5).

Table 4. Number and area of CRLA wetlands summarized by Cowardin classification shown on NWI maps.

Cowardin Classification Level	Classifier	Number (%) of wetlands containing any	Acreage (%) of wetlands containing any	Number (%) of **visited**** wetlands containing any	Acreage (%) of **visited**** wetlands containing any
Class	Open Water*	21 (7%)	12 (2%)	4 (4%)	1 (1%)
	Aquatic Bed	2 (1%)	1 (<1%)	2 (2%)	1 (<1%)
	Emergent	135 (44%)	209 (39%)	38 (35%)	108 (37%)
	Scrub-shrub	118 (38%)	242 (45%)	47 (43%)	142 (48%)
	Forested	33 (11%)	68 (13%)	18 (17%)	41 (14%)
Hydroperiod	Saturated	141 (46%)	268 (50%)	47 (43%)	153 (52%)
	Temporarily Flooded	7 (2%)	10 (2%)	2 (2%)	3 (1%)
	Seasonally Flooded	135 (44%)	239 (45%)	53 (49%)	135 (46%)
	Semipermanently Flooded	7 (1%)	4 (1%)	3 (3%)	1 (<1%)
	Permanently Flooded	18 (2%)	10 (2%)	4 (4%)	1 (<1%)

* mapped as Unconsolidated Bottom or Unconsolidated Shore
** conservative estimates because based on NWI maps, not on field data

Table 5. Soil types intersected by CRLA wetlands, based on existing spatial data from NRCS.

Soil Map Unit	**Acres**
Mariel-Stirfry complex, 0 to 3 percent slopes	6.95
Castlecrest gravelly ashy sandy loam, 2 to 10 percent slopes	5.36
Castlecrest-Llaorock complex, 2 to 25 percent slopes	4.86
Umak paragravelly ashy fine sandy loam, 0 to 7 percent slopes	4.76
Stirfry mucky peat, 0 to 7 percent slopes	4.23
Unionpeak-Castlecrest-sunnotch complex, 0 to 15 percent slopes	4.05
Llaorock-Castlecrest complex, 15 to 30 percent slopes	2.34
Stirfry-Grousehill complex, 0 to 10 percent slopes	1.97
Anniecreek-Stirfry-riverwash complex, 0 to 2 percent slopes	1.40
Unionpeak-Castlecrest-Llaorock complex, 15 to 30 percent slopes	1.33
Grousehill-Llaorock complex, 5 to 35 percent slopes	0.99
Badland-Stirfry complex, 0 to 70 percent slopes	0.73
Cleetwood-Castlecrest-Llaorock complex, 5 to 30 percent slopes	0.53
Maklak paragravelly ashy loamy sand, high precipitation, 0 to 10 percent slopes	0.40
Castlecrest ashy loamy sand, low, 0 to 7 percent slopes	0.36
Grousehill-Racing complex, 0 to 5 percent slopes	0.34
Rock outcrop-rubble land complex, 60 to 90 percent slopes	0.34
Sunnotch-Unionpeak complex, 15 to 35 percent slopes	0.33
Cleetwood, thin surface-Cleetwood-Dyarock complex, 2 to 20 percent slopes	0.29
Castlecrest-Sunnotch complex, 5 to 45 percent slopes	0.27
Cleetwood very gravelly ashy loamy coarse sand, depressional, 0 to 7 percent slopes	0.26
Umak paragravelly ashy fine sandy loam, dry, 0 to 10 percent slopes	0.16

Table 5. Soil types intersected by CRLA wetlands, based on existing spatial data from NRCS (continued).

Soil Map Unit	Acres
Llaorock-Castlecrest complex, 0 to 15 percent slopes	0.15
Water	0.15
Grousehill gravelly medial loam, 0 to 25 percent slopes	0.12

Vegetation cover in wetlands is commonly characterized as emergent (mainly herbaceous), shrub, tree, or underwater (aquatic bed). Among the visited wetlands, emergent vegetation comprised more than half the cover in 67% of the wetlands, shrubs in 16%, trees in 5%, and underwater vegetation in none. The median cover percentage among the 76 wetlands was 70% emergent, 8% shrub, 5% tree, and <1% underwater. Prevalent species within each of these cover types are listed in Appendix C. The species most prevalent in the emergent layer were *Calamagrostis canadensis* and *Senecio triangularis*. In seven (8%) of the emergent wetlands, one species dominated strongly (>60%). That most often was *Carex aquatilis* (three sites), followed by *Arnica longifolia* (two), and *Carex subfusca*, *Carex scopulorum*, and *Polytrichum commune* (one site each). The species prevailing in the shrub layer were most often *Alnus incana* and *Vaccinium uliginosum*, with wetland-upland edges often being characterized by *Vaccinium scoparium*. Species prevailing in the tree layer were *Abies lasiocarpa*, *Tsuga mertensiana*, and *Pinus contorta*. Data on the cover of all species is contained in the project databases, and were used to develop a formal classification of wetland plant communities in CRLA (see Table 15).

Figure 4. Wetland K42, where *Vaccinium uliginosum* is the dominant species.

The wetland hydroperiod (seasonal duration of surface water) is an extremely important indicator of wetland functions, yet is difficult to estimate during just a single visit. Table 6 shows our estimates of the numbers of wetlands having each of four hydroperiod categories.

Table 6. Number of wetlands having each hydroperiod.

Hydroperiod:	# (%) of visited wetlands having >1% of their area with this hydroperiod	# (%) of visited wetlands having ≥30% of their area with this hydroperiod
Permanently flooded	21 (28%)	3 (11%)
Seasonally or semipermanently flooded	63 (83%)	30 (39%)
Temporarily (short) flooded	64 (84%)	10 (13%)
Saturated	72 (95%)	60 (79%)

Considering just the plots where vegetation was assessed within the visited wetlands, the percent cover of vegetation forms is shown in Table 7 and Table 8.

Table 7. Cover of vegetation forms in 100 m^2 sample plots in CRLA wetlands.

Percent Cover, When Present, of:	# of plots where occurred (of 101)	30th Percentile	Median	70th Percentile
Tall (>5m) vegetation	23	3	6	12
Medium (0.5 - 5 m)	44	5	10	59
Low (<0.5 m)	96	79	94	98
Mosses and other Non-vascular	44	5	10	59
Floating Aquatics	3	17	56	62
Submerged Aquatics	3	1	7	16

Table 8. Cover of vegetation forms and height classes in 100 m^2 sample plots in CRLA wetlands.

Percent Cover by Form & Height Class, When Present*	# of plots where occurred (of 101)	30th Percentile	Median	70th Percentile
Mosses and other Non-vascular	44	5	10	59
Fern 1	32	0	1	4
Graminoid 1	73	20	41	70
Graminoid 2	22	44	75	90
Forb 1	77	19	32	50
Forb 2	11	42	60	85
Shrub-short 2	13	5	7	15
Shrub-short 3	23	12	16	43
Shrub-tall 4	24	5	25	79
Canopy 5	9	3	3	6
Canopy 6	8	4	11	35
Canopy 7	4	18	36	37

* Form-height class combinations found in only a single plot are not shown. Height classes are: 1= <0.5m, 2= 0.5-1.0m, 3= 1-2m, 4= 2 - 5m, 5= 5 - 10m, 6= 10-20m, 7= 20 - 30m

Over 100 other attributes of wetlands were measured or estimated during the site visits. They are listed and described in Appendix A, Appendix F, and accompanying files. Example tabulations of these data are shown below for just two of the attributes, downed wood (Table 9) and snags (Table 10).

Table 9. Percent of visited wetlands with various sizes and decay classes of downed wood.

	Decay Class		
Diameter	Barked	Hard	Soft
4 - 8"	66%	95%	32%
9 - 14"	46%	76%	20%
15 - 30"	5%	24%	5%
>30"	5%	1%	1%

Table 10. Percent of visited wetlands with various abundances of snag sizes and decay classes.

Snag Diameter	Decay Class	Rare	Common	Abundant
4 - 12"	Barked	11%	61%	0%
4 - 12"	Hard	67%	18%	5%
4 - 12"	Soft	13%	0%	0%
9 - 14"	Barked	0%	0%	0%
9 - 14"	Hard	1%	0%	0%
9 - 14"	Soft	0%	0%	0%
12 - 18"	Barked	41%	0%	0%
12 - 18"	Hard	53%	5%	1%
12 - 18"	Soft	4%	0%	0%
18 - 24"	Barked	1%	0%	0%
18 - 24"	Hard	7%	0%	0%
18 - 24"	Soft	0%	0%	0%

3.3 Wetland Health

3.3.1 Risks to Wetland Health as Implied by Exposure to Human-related Factors

Within CRLA, human-associated surface disturbances that have occurred and that have the potential to impair wetland health include roads, small dams, channel modifications, and trails. As a prelude to assessing the health of each visited wetland, we inventoried these and other human-related features in the wetlands we visited. We also assessed features (e.g., fire rings) which although not usually capable of harming wetlands directly, imply the possible occurrence of unmeasured accompanying factors or uses that could harm a wetland.

Overall, 63% of CRLA's wetlands show signs of human visitation, with the most frequent alteration being man-made trails (20% of wetlands) (Table 11). Severely disturbing factors such as fill, ditching, or excavation were not documented in any of the visited wetlands.

Before CRLA was created in 1902 and subsequently expanded, parts of the park were extensively logged, with accompanying fires and sedimentation of surface waters. These activities undoubtedly had a significant local impact on the water quality, vegetation, and wildlife of wetlands. The permanency of those impacts is uncertain, and extensive recovery of vegetation is evident. Until at least 1940, some of the park's streams were stocked with non-native fish, with probable negative effects on some amphibians (Bury and Wegner 2005). Campgrounds and heavily-used trails located near some of the park's waters have the potential to affect streams and wetlands. For example, a study of ponds in Kings Canyon National Park, California, found greater aquatic plant cover (mainly *Nitella* and *Isoetes*) when campgrounds and trails were present near lakes, even in cases where those features had been abandoned for several years (Taylor and Erman 1979).

Table 11. Artificial features noted in or near CRLA wetlands.

Visited wetlands not shown on this list appeared to lack any artificial features. None of the identified artificial features were of severe ecological concern. Many potential risk factors (e.g., contaminant exposure) could not be assessed during these site visits. “On-site” location means within the wetland.

Wetland	Type of Feature	Location of Feature	Distance (ft) to Benchmark	Direction to Benchmark
K30	Bridge/culvert	On-site, recent	150	S
K76	Bridge/culvert	On-site, recent	50	N, S
NR062	Bridge/culvert	On-site, recent	5	N
NR188	Bridge/culvert	On-site, recent		
K28	Waste lumber, pulleys	On-site, old	30	W
K76	Building	On-site, recent	20	W
K51	Flagging, other markers	Off-site, recent		
NR079	Flagging, other markers	Off-site, recent		
K07	Flagging, other markers	On-site, old	5	N
K46	Flagging, other markers	On-site, old	50	N
K76	Flagging, other markers	On-site, old	20	N
K39	Flagging, other markers	On-site, recent		
K51	Flagging, other markers	On-site, recent		
NR079	Flagging, other markers	On-site, recent		
NR079	Footprints/trail	Off-site, old		
K04	Footprints/trail	Off-site, recent	50	W
K18	Footprints/trail	Off-site, recent	200	
K20	Footprints/trail	Off-site, recent	500	W
K44	Footprints/trail	Off-site, recent	300	SE
K51	Footprints/trail	Off-site, recent		
K52	Footprints/trail	Off-site, recent	500	N
K60	Footprints/trail	Off-site, recent	70	S
NR065	Footprints/trail	Off-site, recent	200	W
NR146	Footprints/trail	Off-site, recent	200	SW
NR188	Footprints/trail	Off-site, recent		
NR233	Footprints/trail	On-site, old	50	
K39	Footprints/trail	On-site, recent		
K51	Footprints/trail	On-site, recent		
K76	Footprints/trail	On-site, recent	30	E
K42	Grazing: browsed veg	Off-site, recent	200	
K19	Road	Off-site, old	200	S
NR120	Road	Off-site, recent	200	SW
NR126	Road	Off-site, recent	300	
NR129	Road	Off-site, recent	100	
K30	Road	On-site, old	150	S
K03	Road	On-site, recent	30	NE
K30	Road	On-site, recent	150	S
K46	Road	On-site, recent	200	N, W, E
K58	Road	On-site, recent	10	W
K76	Road	On-site, recent	50	N, S
NR062	Road	On-site, recent	5	N
K37	Saw/axe marks	Off-site, old		
NR079	Saw/axe marks	Off-site, old		
K01	Saw/axe marks	On-site, old		

Table 11. Artificial features noted in or near CRLA wetlands (continued).

Wetland	Type of Feature	Location of Feature	Distance (ft) to Benchmark	Direction to Benchmark
K37	Saw/axe marks	On-site, old		
NR079	Saw/axe marks	On-site, old		
K58	Saw/axe marks	On-site, recent	10	W
K11	Trash			
K19	Trash	Off-site, old	100	SE
K28	Trash	On-site, old	40	E
NR062	Trash	On-site, old	40	SE
NR129	Trash	On-site, old	7	
K76	Trash	On-site, recent		
K28	Utility Area	Off-site, recent	60	SE

Figure 5. Wetland bisected by a road in CRLA.

Decades of fire suppression also have affected CRLA vegetation because some types of fires are important in shaping vegetation communities. However, intense fires can harm wetlands, as can the use of heavy equipment that disturbs soils and flame retardants that contain polluting compounds. Recognizing the importance of fire as a natural shaper of ecological communities, current policies allow fires that start naturally in many parts of CRLA to burn with only limited control efforts, as was the case with the Bybee Creek fire during the summer of our field work. NPS staff also conduct controlled burns in selected areas of the park.

Although relatively few pollution sources remain within the park, long-distance airborne transport of contaminants poses a potential threat. The Western Airborne Contaminants Assessment Project (Landers et al. 2008) determined that lichens and conifers sampled at five sites in CRLA were contaminated with several pesticides currently used outside the park, especially endosulfans and dacthal, but also chropyrifos and g-HCH (lindane). These contaminants were also present in air samples, and were mostly at or slightly above the levels found in other western parks. Concentrations increased with elevation within the park. Semi-volatile organic compounds of human origin were also present, especially PAHs (a combustion by-product) and the historically-used pesticides chlordane, DDT, HCB (hexachlorobenzene), and a-HCH (alpha hexachlorocyclohexane). Although at very low levels, PCBs also were detected. Nitrogen deposition was not elevated compared with other western parks. One of the sampling points was in the Whitehorse Ponds wetland complex.

3.3.2 Natural Disturbances and CRLA Wetlands

During mid-summer 2006, a fire spread throughout much of the area surrounding Bybee Creek in the western part of the park. Before it reached them, we had completed assessments of four wetlands in the area that later burned. Those wetlands are K20, K52, K4, and NR146. Although not a funded part of this study, in 2007 we revisited the first two of these. At K20 and K52, the post-fire plots were found to have almost exactly the same species composition and cover as before the fire in the previous year. One of the plots in this wetland had a few overstory trees, and it lost most of them from the burn, so the wetland deserves future monitoring. At K20, the forest surrounding this wetland burned in patches of varying severity, but the wetland itself was not burned. The other two wetlands that apparently burned (NR146, K4) were not revisited in 2007, and should be.

Figure 6. Bybee Creek fire, summer 2006.

Besides fire, natural factors that are likely to have influenced the occurrence and characteristics of the park's wetlands and their vegetation include landslides, seismic and volcanic activity, springs, beaver, insect and plant disease outbreaks, wind storms, and annual changes in temperature and precipitation (snow amount, date of complete meltdown in each wetland, occurrence of summer rains, timing and duration of freezing). Global climate change can alter the frequency and intensity of these natural disturbances, threatening the park's wetlands and their biological communities. Major natural disturbances noted in or near CRLA wetlands during our field work are shown in Table 12.

Table 12. Major natural disturbances noted in or near CRLA wetlands as of early summer 2006.

Disturbance Type	Wetland	Disturbance Location
Fire	K01	On-site, old
	K43	On-site, old
	K84	On-site, old
	K85	On-site, old
	NR073	On-site, old
	NR174	Off-site, old
	NR241	On-site, old
Grazing by wild ungulates	K30	On-site, recent
Severe insect/disease damage to vegetation	K17	On-site, recent
	K28	On-site, recent
Landslide/sedimentation	K11	On-site, old
	K11	Off-site, old
Rockfall	K03	On-site, recent

3.3.3 Assessing Wetland Health with Botanical Indicators

The following are results for individual variables used to represent health, as defined earlier in Table 2.

Number of Species or Families: Richness always increases with increasing wetland area (Figure 7), so it must be standardized by area. In the 100 m^2 vegetation plots, the median number of species was 27 (range = 2-51) and the median number of families was 13 (1-26). For entire wetlands, the median number of species was 44 (range = 3-83) and the median number of families was 22 (2-32).

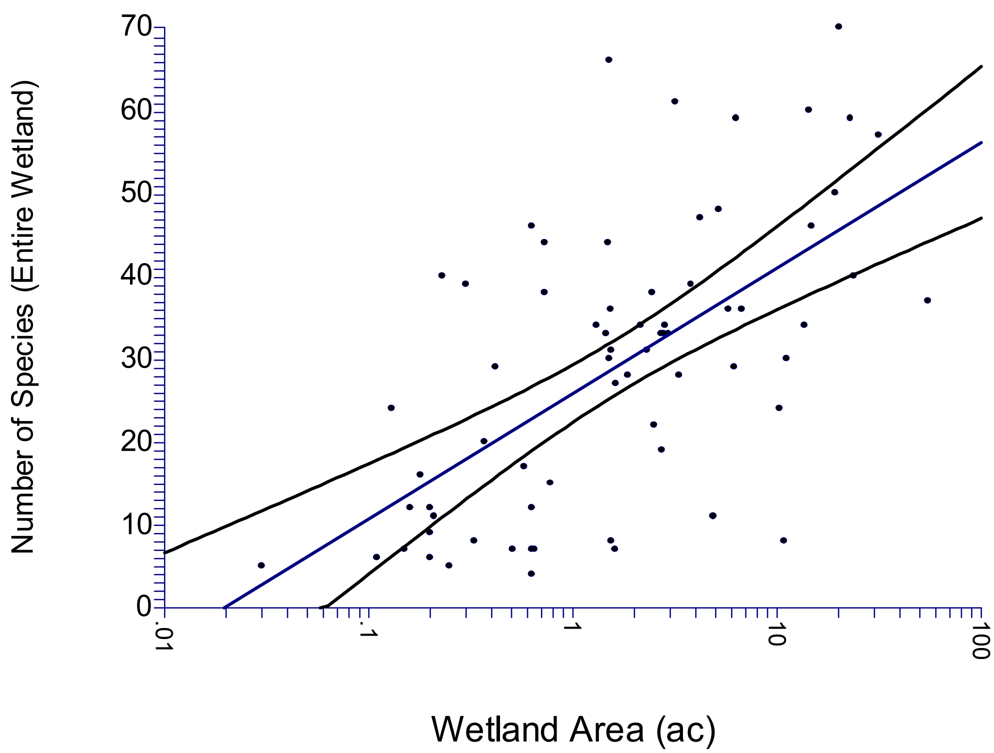

Figure 7. Plant species-area relationship among all wetlands surveyed in CRLA.

Number and Proportional Cover of Non-native Species: Non-native plant species were found in 14 (18%) of the 76 visited wetlands. The total number of non-native plant species found among all visited wetlands was seven, and were: *Taraxacum officinale* (11 wetlands), *Cirsium vulgare* (4), *Cerastium fontanum* (3), *Cirsium arvense* (2), *Hypericum perforatum* (1), *Sonchus asper* (1), and *Phalaris arundinacea* (1). All comprised less than 1% of the cover in the wetlands where they were found. Wetlands with the most non-natives were K83 (four species) and NR187 (three species).

Perennial Graminoid Species: As a percentage of all species found per wetland, perennial graminoids ranged from 0 to 62% (median = 22%). In wetlands K15 and K43, these species comprised the greatest proportion of the species list.

Frequency Index: This index is based on species distributional data from only CRLA. It was used as a surrogate for the "coefficient of conservatism" that is a component of floristic quality indices that are used widely in other states, but which were unavailable for this region. In the vegetation plots, the median Frequency Index value was about 23 (range = 3 to 33) when based on frequency of occurrence among plots or about 27 (range = 2 to 35) when based on frequency among wetlands. In the first case, this means that a species in a CRLA wetland plot had been found, on the average, in 23 other plots among all 101 plots we sampled (i.e., 23% of the plots). The second case means that a species found in a plot had been found, on the average, in a total of 27 of the 76 sampled wetlands (i.e., 36%). At a wetland scale, the median Frequency Index value was about 21 (range = 9 to 28) when based on frequency of occurrence among plots (meaning that a species found anywhere in a CRLA wetland had been found, on the average, in 21 of the 101 plots). Also at the wetland scale, the median Frequency Index was about 25 (range = 10 to 35) when based on frequency among the 76 wetlands (meaning that a species found anywhere in a CRLA wetland had been found, on the average, in 25 of the 76 wetlands).

Dominance: Species dominance was assessed at both a wetland scale *within* its vegetation form (within emergent, shrub, tree, etc.) and at a plot scale. Dominance was more difficult to quantify visually at the wetland scale because of the large and diverse area involved. At the wetland scale, one plant species showed strong dominance (comprised more than 60% cover *within its form*) in 71% of the wetlands. The dominants were varied (Appendix C). Such dominance by one species was less common at the plot scale. Of the 101 plots, 31% had no single species comprising more than 25% of the cover. The species most frequently prevailing in the plots were (in order of frequency): *Carex aquatilis, Alnus incana, Calamagrostis canadensis, Senecio triangularis, Vaccinium uliginosum, Alnus viridis, Carex lenticularis, Philonotis fontana, Scirpus microcarpus,* and *Salix commutata*.

Prevalence Index: In the vegetation plots, the median PI value was 2.07 (range = 0.14 to 5.00), or when not weighted by cover class, was 2.39 (range = 1.00 to 4.33). Among the 101 plots, and based only on the PI, only four plots (NR120-2, K46-2, K15-1, and K77-1) would not qualify as wetlands, assuming that PI values of less than 3.00 indicate wetlands. However, all were biased by having a high proportion of their cover in species whose wetland status is unknown. At a wetland scale, the median PI value (unweighted by percent cover) among all visited wetlands was 2.58 (range = 1.50 to 4.33). Among the 76 wetland polygons, and based only on the unweighted PI (an imperfect and incomplete measure of wetland status), 10 sites might not qualify as wetlands. They are: K2, K3, K7, K15, K26, K28, K77, NR126, NR187, and NRC.

Moss Cover: Of the visited wetlands, 10 had more than 10% cover of moss, and of these, seven contained more than 1% cover of *Sphagnum*. They are K20, K22, NR65, K37, K48, K71, and K84.

3.4 Wetland Plant Biodiversity

Through our survey efforts, 20 species or subspecies that previously were unreported from CRLA have been added to the park's flora by our study (Table 13).

Table 13. Plant species or subspecies not previously reported from CRLA and found by this study.

Species	Location	Indicator Status
Amelanchier utahensis	NR147	NI
Athyrium americanum	not in wetland	NOL
Botrychium simplex	K51	NOL
Calamagrostis stricta ssp. *inexpansa*	K39	NOL
Calamagrostis stricta ssp. *stricta*	K29	NOL
Callitriche verna	NR79	OBL
Carex diandra	NR65	OBL
Carex integra	K28, K58	NOL
Carex nervina	NR54	FACW-
Cerastium fontanum ssp. *vulgare* – **non-native**	K80, K83, NR187	FACU
Eleocharis bella	NR79	OBL
Lewisia pygmaea	K22	FACU
Lycopodium annotinum	NR65	FAC
Lycopodium sitchense	NR244	NOL
Perideridia gardneri ssp. *borealis*	K33, K75	FAC
Phalaris arundinacea – **non-native**	K39	FACW
Ranunculus flammula	K61, K80	OBL
Rumex paucifolius	not in wetland	FAC-
Saxifraga odontoloma	K38	FACW+
Sonchus asper ssp. *asper* – **non-native**	K83	FAC-

Figure 8. *Lycopodium sitchense* in wetland NR244, a new species for the park.

Our surveys of 76 wetlands (30% of the total number of mapped CRLA wetlands, or about 38% by acreage) detected 354 species, representing about 51% of the 688 vascular plant species known to occur in the park. Considering just the 384 plant species that are known to occur characteristically in wetlands and have been reported previously in CRLA, we detected 264, or more than two-thirds of the park's wetland flora (Appendix B). Plant species reported previously from CRLA, and which typically occur in wetlands but which our wetland surveys did not find, were inferred from Appendix B. The potential reasons for not finding any particular wetland species that had previously been reported from the park are numerous, and include (a) the fact that we did not survey all of the park's wetlands, and those we did survey were visited during only one time of the season, (b) difficulty in noting diagnostic features of some species during a single wetland visit, thus prohibiting definitive identification, (c) temporary dormancy during 2006 of some species which might still be represented in the wetland seed bank, (d) potential misidentifications in the historical reports, and (e) long-term disappearance of the species from park wetlands as a result of natural succession, other natural phenomena, or human influences.

Among the 354 plant taxa (both wetland and upland) we found in the visited wetlands, at least nine are of note for their conservation status (Oregon Natural Heritage Program 2007). Of greatest importance is *Collomia mazama*, considered to be threatened with extinction throughout its entire range. It was found in wetlands K9 and K49. Four sedges are of particular note. *Carex diandra* (found in NR65), *Carex nervina* (found in NR54), and *Carex abrupta* (found in K49, K76, and NR187) are all considered "critically imperiled" in this region, and *Carex integra* (in K28, K58) is considered "vulnerable to extirpation." *Torreyochloa erecta* also is officially considered vulnerable to extirpation, but was found in 16 wetlands. Three species have been labeled "may be threatened but information is insufficient." They are *Poa bolanderi* (found in K30), *Epilobium palustre* (NR128), and *Sorbus californica* (K17, K38). Also, Zika (2003) had categorized as "rare" (in CRLA) a few additional species that we found. They are: *Silene menziesii* (found in K7), *Stellaria borealis* (K68, NR126), *S. obtusa* (K7, K28), *S. umbellata* (K4, K49, K81), *Vaccinium ovalifolium* (K17, K21), *Hydrophyllum fendleri* (K83, NR187), *Orthocarpus imbricatus* (NR79), *Carex leporinella* (K30, K31, K75, NR79, NR233), *Eleocharis palustris* (K13, K61), *Calochortus elegans* (K2), *Bromus ciliatus* (K7, NR174), *Trisetum wolfii* (K4, K46, K75, NR129, NR146), *Lysichiton americanus* (K6, K9, K37, K71, NR187), *Delphinium glaucum* (K33, NR79), *Lonicera caerulea* var. *cauriana* (K42, K34), *Sparganium natans* (K13, K61), *Urtica dioca* ssp. *holosericea* (NRC), and *Potamogeton gramineus* (K61). Several of these hadn't been found in CRLA in over 70 years.

Figure 9. *Collomia mazama* near wetland NR147 (left) and *Lonicera caerulea* var. *cauriana* in wetland K42 (right).

Table 14. Survey effectiveness for detecting wetland indicator plant species known to occur in CRLA.

See Appendix B for list of plants used to compile this table. OBL (Obligate wetland species): occur almost always under natural conditions in wetlands (more than 99 percent of the time). FACW (Facultative wetland species): occur in wetlands 67-99 percent of the time but are occasionally found in nonwetlands. FAC (Facultative species): are equally likely to occur in wetlands (34-66 percent of the time) or nonwetlands. (+) tending to the wetter end; (-) tending to the drier end.

Wetland Indicator Status	# of Wetland Species Reported Previously from CRLA	# of Wetland Species Found During 2006 (% of total in that status category)
OBL	66	49 (74%)
FACW+	25	20 (80%)
FACW	66	46 (70%)
FACW-	22	17 (77%)
FAC+	22	10 (45%)
FAC	63	41 (65%)
total	264	183 (69%)

Note: Wetland species together comprise 38% of the CRLA flora, a relatively high percentage for a park in which known wetlands occupy less than 1% of the park's area. For comparison, 38% of Yellowstone National Park's plant species also are associated with wetlands (Elliott and Hektner 2000), and coincidentally the same is true of Lassen Volcanic National Park (Adamus and Bartlett 2008).

3.4.1 Botanical Uniqueness of Individual Wetlands

Of the 254 wetland plant species we encountered in the 76 wetlands, we found 22% of those in only a single visited wetland. These species are listed in Appendix B and their location can be determined from the accompanying database files. Figure 10 shows the overall frequency distribution of wetland plant species among the sites we visited. The large percentage of species occurring in only one or a few wetlands suggests (a) relatively low rates of population dispersal and mixing, as is often the case in undisturbed landscapes, and/or (b) short seasonal detection periods for some species, and/or (c) high spatial variation among the visited wetlands with regard to their natural physical conditions (hydrology, soils, microclimate). A statistical analysis of the environmental correlates of each of the plant communities will be presented in a separate document (Cheryl Bartlett, thesis in progress, Oregon State University).

Among the visited wetlands, those with most unusual floras overall were (from most to least unique) K61, K3, K7, NR126, and K83. However, because larger wetlands contained a larger search area, there was a bias towards encountering a larger proportion of unusual species in larger wetlands. To compensate for this, we compared wetlands using the frequency index just from the standard-sized vegetation plot (one per wetland). The results suggest that, among the visited wetlands, the ones with most unusual floras at a plot scale were (from most to least unique) K61, K43, K7, NR126, K10, and K3.

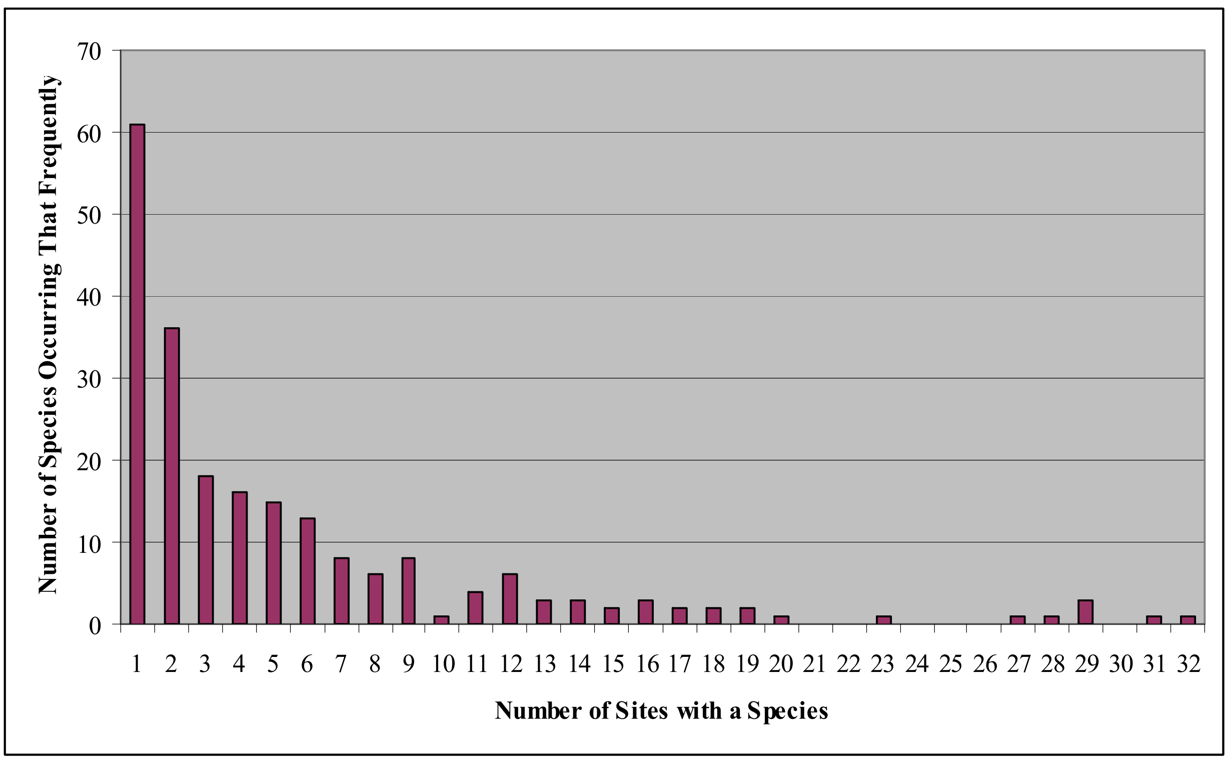

Figure 10. Site frequency distribution for wetland-associated plant species of CRLA.

3.4.2 Floristic Surveys of "Sphagnum Bog"

A large wetland complex in the western part of the park is labeled on maps as Sphagnum Bog, although technically it more resembles a fen than a bog. This area was the subject of a thesis by Seyer (1979), and portions have been surveyed botanically as well by our study and recent "bioblitz" floristic surveys coordinated by Dr. Lawrence Powers of Oregon Institute of Technology, who kindly shared those unpublished data. Data from these three surveys cannot be compared in a meaningful way because none of the investigators covered every part of the Bog complex, methods varied somewhat, and the exact boundaries of the areas that were covered by each are not known in every case. They also varied greatly in terms of level of effort and seasonal timing.

Figure 11. Wetland NR65, part of the Sphagnum Bog complex.

As shown inAppendix E, Seyer's survey reported 101 species and was the only one of the three surveys to record the following:

Abies X *shastensis*
Bidens cernua
Cardamine pensylvanica
Carex lenticularis
Gentianopsis simplex
Glyceria borealis
Hippuris vulgaris
Lonicera involucrata
Nuphar lutea
Potamogeton gramineus
Potamogeton pusillus
Pyrola minor
Sorbus sitchensis
Sparganium natans
Sphenosciadium capitellatum
Stellaria calycantha
Utricularia minor
Vahlodea atropurpurea

Our visits to four wetlands in the Sphagnum Bog complex in 2006 resulted in a cumulative list of 109 species, including the following that were not found by the other two surveys:

Achillea millefolium
Calochortus elegans
Carex diandra (new to CRLA, rare in Oregon)
Carex straminiformis
Carex subfusca
Cinna latifolia
Danthonia intermedia
Epilobium minutum
Festuca subulata
Juncus effusus
Penstemon rydbergii

Phleum alpinum
Phlox diffusa
Phlox gracilis
Prunella vulgaris
Ranunculus occidentalis
Salix sitchensis
Scirpus microcarpus
Taraxacum officinale (non-native)
Torreyochloa erecta

Mainly for the reasons given above, it cannot be determined with certainty that any of the species reported only by Seyer have disappeared entirely from this wetland complex during the intervening 28 years, or that species found only by our survey or the bioblitz surveys first became established during that time.

3.4.3 Classification of Vegetation Communities in CRLA

We noted several repeating assemblages of plant species during our field work (Table 15). Statistical analysis procedures were used to objectively and systematically organize the species cover data into 23 such assemblages ("groups" or "communities"). Defining such assemblages is an important step towards setting goals for wetland performance, e.g., in the context of wetland restoration programs.

Table 15. Vegetation-based wetland communities of CRLA derived by statistical processing of data from 100 wetland plots.

More detailed and final results will be presented in the thesis of report co-author and Oregon State University graduate student Cheryl Bartlett. For group numbers that are bolded, see following pages for comparison with the classification of Murray (2000). Indicator values are in parentheses and can range from 0 to 100, with 100 signifying a perfect indicator for the group. Indicator values do not necessarily indicate dominance of a particular species within a group; rather they are a measure of a species faithfulness to a particular group (consistency) and relative abundance when compared to other groups. Only statistically significant indicators ($p<0.05$) are included. In this table, dominant species are those that have 100% consistency values (found in every plot for that group, except where noted) and have the highest average cover values within that group. All dominants have an average cover of ≥15% within their group. Subordinate species are those that have lower average cover and consistency values ≥80% (except where noted).

Group #	Plots included in group	Dominant species	Subordinate species
1	K1-1, K17-1, N147-1	*Scirpus microcarpus* (52.7), *Equisetum arvense* (35.5)	*Saxifraga oregana* (100), *Platanthera leucostachys* (27.4), *Mitella pentandra, Hypericum anagalloides, Glyceria elata, Polygonum bistortoides, Oxypolis occidentalis, Senecio triangularis*
3	K3-1, NRC1-2	*Arnica longifolia* (100)	*Dicentra formosa* (56.2)
4	K3-2, K19-1, K28-2, NRC1-1	*Alnus viridis* ssp. *sinuata* – medium (95.6)	*Dicentra formosa*
5	K4-1, K48-1, N129-1, K84-1, K13-1, K68-1	*Calamagrostis canadensis* (31.9)	*Viola macloskeyi* (30.7), *Polygonum bistortoides, Ranunculus gormanii, Senecio triangularis*
6	K6-1, K30-1, K46-3, K28-1, N187-1, K58-1	*Senecio triangularis* (24.7)	*Aconitum columbianum* var. *viviparum* (22.1), *Viola glabella, Ligusticum grayi, Mimulus moschatus, Veratrum viride*
7	K7-1, N187-2, K41-2, K83-1, N174-1, K49-1, K71-2, N128-1	*Alnus incana* ssp. *tenuifolia* – medium (83), *Glyceria elata* (29.2)	*Alnus incana* ssp. *tenuifolia* – low (67.2), *Senecio triangularis, Viola glabella*
8	K9-1, K75-1, K80-1, N126-1, K39-1, K85-1, N241-1, K33-1, K35-1, N164-1	*Glyceria elata, Senecio triangularis, Calamagrostis canadensis+*	*Mimulus moschatus, Aconitum columbianum* var. *viviparum*
9	K10-1, N244-1, K26-1	*Potentilla flabellifolia* (95.7), *Carex nigricans* (90.6)	*Phyllodoce empetriformis* (100), *Vahlodea atropurpurea* (80.7), *Juncus drummondii* (43.9), *Erigeron peregrinus* ssp. *callianthemus, Veronica wormskjoldii, Ligusticum grayi*
10	K11-1, N65-1, K11-2, K18-1, K57-1, N73-1, K34-1, N65-3, N79-1	*Carex aquatilis* var. *dives* (45.8)	
13	K13-2, K61-1	*Nuphar lutea* ssp. *polysepala* (100)	*Sparganium natans* (100), *Glyceria borealis* (70.6), *Fontinalis antipyretica, Eleocharis palustris, Carex utriculata*
14	K15-1, K43-1, K77-1	*Polytrichum commune* (95.2)	
18	K20-1, K44-1, K41-1, N161-1, K25-1, N65-2, K37-1, K38-1, K52-1, N62-1	Mixed moist meadow – dominants vary.	*Polygonum bistortoides, Eleocharis quinqueflora* (52.2), *Muhlenbergia filiformis* (24.3), *Dodecatheon alpinum, Philonotis fontana, Tofieldia glutinosa, Carex luzulina* var. *ablata, Ranunculus gormanii, Carex echinata* ssp. *echinata* (37.2)*, *Mimulus primuloides* var. *primuloides**, *Carex scopulorum* var. *bracteosa**, *Carex aquatilis* var. *dives**

Table 15. Vegetation-based wetland communities of CRLA derived by statistical processing of data from 100 wetland plots (continued).

Group #	Plots included in group	Dominant species	Subordinate species
19	K21-1, K46-1, K50-1, K60-1, K81-1	*Senecio triangularis*	*Mimulus guttatus* (24.6), *Veronica wormskjoldii, Viola macloskeyi, Carex lenticularis, Carex luzulina* var. *ablata, Aconitum columbianum* var. *viviparum, Polygonum bistortoides*
20	K21-2, N54-1	*Picea engelmannii* – tall (61), *Vaccinium membranaceum* (84.7),	*Vaccinium scoparium* (57.7), *Lupinus latifolius, Ligusticum grayi, Equisetum arvense, Senecio triangularis*
21	K22-1, K120-2, K49-2, N120-1, K51-1, K55-1, N146-1	*Senecio triangularis, Mimulus primuloides* var. *primuloides* (35.9)	*Carex luzulina* var. *ablata* (36.8)*, Ranunculus gormanii* (19.8)*, Muhlenbergia filiformis, Hypericum anagalloides, Polygonum bistortoides, Trifolium longipes* ssp. *hansenii* (35.8)
26	K28-3, K83-2	*Lotus oblongifolius* var. *oblongifolius* (76.6), *Philonotis fontana* (31.2)	*Luzula multiflora* ssp. *multiflora* (35), *Allium validum* (48.4)*, *Marchantia polymorpha**
27	K29-1, K53-1, K71-1, K34-2, K45-1	*Carex aquatilis* var. *dives, Caltha leptosepala* ssp. *howellii* (76.5), *Vaccinium uliginosum* - low	*Hypericum anagalloides, Senecio triangularis, Oxypolis occidentalis, Picea engelmannii* – medium, *Lotus oblongifolius* var. *oblongifolius, Equisetum arvense, Carex luzulina var. ablata, Polygonum bistortoides, Platanthera stricta*
29	K31-1, N233-1	*Carex leporinella* (98.4)	
39	K42-1, N147-2	*Vaccinium uliginosum* – low (49.6)	*Pinus contorta* var. *murrayana* – tall (33.6), *Pinus contorta* var. *murrayana* – medium, *Equisetum arvense, Mitella pentandra*
58	K61-2, N128-3	*Carex utriculata* (77.1)	*Eleocharis quinqueflora*
63	K76-1, N188-1, K85-2	*Salix commutata* – medium (90.4)	*Carex neurophora, Abies lasiocarpa* var. *lasiocarpa* – medium, *Viola macloskeyi, Calamagrostis canadensis*
82	N126-2, N126-3	*Lupinus latifolius* (54.8), with either *Populus tremuloides* OR *Populus balsamifera* ssp. *trichocarpa* in overstory	*Fragaria virginiana* (50.3), *Solidago canadensis var. salebrosa* (94.7), *Carex athrostachya* (100), *Osmorhiza berteroi* (62.9), *Melica subulata* (60.3), *Rosa gymnocarpa* (100)
85**	N128-2	*Carex limosa, Eriophorum gracile, Carex aquatilis* var. *dives*	*Menyanthes trifoliata, Hypericum anagalloides, Philonotis fontana*

* Taxon has <70% consistency, but is occasionally has high to very high (30 – 90%) cover within a group.
** Group only has one member, so not included in the indicator species analysis. However, *Carex limosa, Eriophorum gracile,* and *Menyanthes trifoliata* were found only in this plot and can be considered indicator species for this type.
+ Consistency value was 90%.

The following pertains to the groups in Table 15, comparing them with the wetlands vegetation classification of Murray (2000).

Group1: This community type is somewhat similar to the *Scirpus microcarpus* association described from lower elevations in Oregon by Murray, except that *Saxifraga oregana*, a perfect indicator species for this group at CRLA, is not mentioned in the description. *Glyceria elata* and *Senicio triangularis* are often present in this community type in both classifications, but each of these species is somewhat ubiquitous in CRLA's wetlands, so are not good indicators for the type.

Group 4: At CRLA, this community is dominated by *Alnus viridis* ssp. *sinuata*, with low cover of *Dicentra formosa* in the understory. Murray describes several communities with the same overstory component, but none of them mention *D. formosa.* However, *Maianthemum stellatum* and *Viola glabella* – less ubiquitous understory components at CRLA – are mentioned as occurring in the lower elevation wetlands.

Group 7: This was a common community type encountered at CRLA and is characterized by a moderate to dense cover of the shrubby alder, *Alnus incana* ssp. *tenuifolia.* It is very similar to the *Alnus incana / Senecio triangularis* community described by Murray. Both types describe *Glyceria elata* and *Senecio triangularis* as being important components of the understory, but again, these species are extremely common in many of CRLA's wetlands. There is a moderate amount of overlap in the subordinate species.

Group 8: This type is similar to the *Calamagrostis canadensis* community described by Murray, but *C. canadensis* typically co-dominates with *Glyceria elata* and *Senecio triangularis* at CRLA, while these species occur as subordinate species in the lower elevation wetlands.

Group 10: At CRLA, this group is characterized by very high cover (>60%) of *Carex aquatilis* var. *dives*, often with moderate to high cover of various shrub species, especially *Vaccinium uliginosum*. Murray describes two herbaceous communities with the same dominant species, one of which is co-dominated by *Eleocharis quinqueflora,* a species not found in the CRLA type. *Spiraea douglasii* and *V. uliginosum*, two species sometimes occurring with high cover at CRLA, are mentioned as sometimes occurring with low to moderate cover at the lower elevation wetlands. Murray also describes a *V. uliginosum / (C. aquatilis* var. *dives)* shrub community, but it shares very few subordinate species with the communities observed at CRLA.

Group 13: This group shares the same dominant with the *Nuphar lutea* ssp. *polysepalum* community described by Murray, but the subordinate species are different.

Group 18: This was a very common and highly variable mixed wet meadow/fen community that always has moderate to high cover of various moss species (especially *Philonotis fontana*) and low to moderate cover of *Polygonum bistortoides*. Many species in this type have lower consistency values, but occasionally occur as the dominant species with moderate to high cover. A few of these are *Eleocharis quinqueflora, Carex lenticularis,* and *Carex aquatilis* var. *dives.* These stands may be similar to the *C. aquatilis* var. *dives, C. lenticularis,* and *C. aquatilis* var. *dives – E. quinqueflora* communities described by Murray, but *P. bistortoides* is mentioned as occurring only occasionally in these types.

Group 27: *Vaccinium uliginosum, Caltha leptosepala* ssp. *howelli,* and *Carex aquatilis* var. *dives* dominate this community at CRLA. Murray describes several communities that have *C. aquatilis* var. *dives* as a dominant species, but *V. uliginosum* occurs in them inconsistently, and *C. leptosepala* ssp.

howelli, a species with a high indicator value for this community at CRLA, is absent. A *V. uliginosum* / (*C. aquatilis* var. *dives)* community is also described, but again, *C. leptosepala* ssp. *howelli* is not mentioned. A *C. leptosepala* community is included in the Murray classification, but *C. aquatilis* var. *dives* and *V. uliginosum* are not mentioned.

Group 58: This type is dominated by *Carex utriculata* and is uncommon at CRLA. Communities dominated by this sedge appear to be more common in the wetlands examined by Murray at lower elevations, and have a different mix of subordinate species than those seen at CRLA.

Group 63: This group is characterized by high cover of the shrubby willow *Salix commutata.* A community with the same dominant is described by Murray, but the subordinate species are different.

3.6 Valued Ecological Services of CRLA Wetlands

"Ecological services" are the things that wetlands do, such as intercept and store water. As the phrase is used in the context of resource management, ecological services are similar to what has historically been termed "functions and values." Wetlands perform dozens of ecological services recognized as directly useful to society. Just nine are addressed in this document. These are described below.

The degree to which a wetland performs many ecological services often has less to do with the wetland's health (ecological condition or naturalness) than with intrinsic features, such as underlying soil, elevation, size, and native vegetation communities that are adapted naturally to the site. High-functioning wetlands (those that perform many ecological services at a high level) are not necessarily the healthiest wetlands, and the healthiest wetlands are not necessarily high-functioning, depending partly on how one defines "health."

It is not feasible to measure health or ecological services directly, so typically, managers use rapidly-estimable features that scientists believe, to varying degrees, may be indicators of *relative* health or capacity to support ecological services (see Adamus et al. 1992). To arrive at an estimate for each of a wetland's ecological services and its overall ecological condition, estimates of the component indicators must somehow be combined. Heuristic models, also known as "criteria" or narrative "rules-of-thumb," are commonly used for this purpose. They should be tailored to the environmental conditions and data sources specific a region, and can include customized versions of many of the variables and models identified, documented, and applied previously (e.g., Adamus and Field 2001, Bartoldus 1998, Fennessey et al. 2004, Adamus and Bartlett 2008). Currently, the US Environmental Protection Agency, in collaboration with the Oregon Department of State Lands, is funding the development and testing of a rapid method for assessing wetland condition and ecological services throughout Oregon, for release in 2009. Because that is anticipated to become the standard method for assessing Oregon wetlands, this report does not propose a separate method to rank the condition and services of individual wetlands within CRLA. Rather, the generic types of features useful for assessing each wetland service are described broadly in the following paragraphs.

Natural Water Storage and Slowing of Infiltration

This ecological service concerns the capacity of a wetland or riparian area to store or delay the downslope movement of surface water for long or short periods, and in doing so to potentially influence the height, timing, duration, and frequency of inundation in downstream or downslope areas. This usually has positive economic, social, and ecological implications for the affected areas downstream or downslope. In some cases, water stored by wetlands early in the growing season can help maintain local water tables and in doing so, may sometimes sustain streamflow for longer into the summer, increasing habitat available to fish, amphibians, and aquatic plants. This service tends to be greatest in wetlands that are not sloping, are depressional, lack surface water outlets, and whose permanently-wet area is less than their seasonally-wet area.

Intercepting and Stabilizing Suspended Sediments

This concerns the capacity of a wetland to intercept suspended inorganic sediments, reduce current velocity, resist erosion of underlying sediments, stablize slopes, and/or minimize downstream or downslope erosion that otherwise would result from direct rainfall, sheet flow, flow in degrading channels, or wave action. This ecological service is of economic and social interest because excessive suspended sediment (turbidity) in water is usually considered to be a pollutant, partly because unnatural rates of bank erosion can adversely affect survival of aquatic life, vegetation, and property. However, excessive rates of sediment retention can eventually eliminate the wetland that is doing the retaining. This service tends to be greatest in wetlands that have high levels of the previously described storage function.

Processing Nutrients, Metals, and Other Substances

This describes the capacity of a wetland to retain and/or remove any forms of phosphorus, nitrate, metals, pesticides, oil, or other substances considered in excess to be pollutants. This ecological service is valued because these substances otherwise can adversely affect aquatic life located in water bodies to which the wetland drains. The capacity of most wetlands to remove excessive nitrate (by converting it to nitrogen gas) appears to be almost unlimited. However, excessive retention of some substances can harm aquatic life within the wetland doing the retaining. Also, the capacity of wetlands to process some substances effectively for years and decades may be finite. This service tends to be greatest in wetlands that have high levels of the storage function, and in the case of ability to retain heavy metals, that also have soils which are predominantly organic, e.g., peat or muck.

Sequestering Carbon

This describes the capacity of a wetland to remove and store on a net basis for long periods (100+ years) carbon from the atmosphere, such as by photosynthesis. This ecological service is valued because gaseous carbon is causing global climate change. Carbon fixed through photosynthesis also is vital to food webs. This service tends to be greatest in wetlands that have high levels of the storage function, contain deep organic soils and mostly stable water levels, and have predominantly woody (especially tree) vegetation cover.

Maintaining Surface Water Temperatures

This describes the capacity of a wetland to maintain ambient temperatures of surface waters and ground-level microclimate by acting as a conduit for discharge of usually-cooler ground waters or by providing shade from sun and shelter from severe winds. This ecological service is valued because many fish, amphibians, and aquatic invertebrates are highly sensitive to temperature and soil moisture extremes as well as to too frequent fluctuations in these factors. This service is provided mainly by wetlands that are either fed by coolwater springs or contain surface water shaded by vegetation throughout the summer.

Supporting Diversity of Native Invertebrates

This describes the capacity of a wetland to support the life requirements of many invertebrate species characteristic of wetlands in this region, for example, midges, freshwater shrimp, some caddisflies, some mayflies, some butterflies, water beetles, shore bugs, snails, and aquatic worms. Such organisms contribute importantly to regional biodiversity and are essential as food for fish, amphibians, and birds. This service tends to be greatest in wetlands that have surface water at least seasonally, and high internal variation in vegetation and microtopography (e.g., many small depressions from upturned trees), or which have a set of conditions favored by a particular rare species or assemblage of invertebrates. Wetlands in which alder shrubs adjoin pools or channels may support especially productive invertebrate communities.

Supporting Native Fish
This describes the capacity of a wetland to support the life requirements of fish species characteristic of wetlands or their receiving waters. The primary determinant of whether a wetland is used by fish is physical access. Fish are likely to be absent from depressional and slope wetlands that do not retain surface water during the driest time of year, and which lack even an intermittent connection to other surface waters. When present in CRLA wetlands, fish are perhaps most likely to occur during seasonal flooding of floodplain wetlands along gentle-gradient streams, and amid the underwater plants of wetlands that border deeper ponds.

Supporting Native Amphibians and Reptiles
This concerns the capacity of a wetland to support the life requirements of several species of amphibians and reptiles that inhabit the park. These species (see list in Appendix I) are critically dependent on the park's wetlands and contribute importantly to regional biodiversity, as well as helping cycle energy within and between aquatic and terrestrial ecosystems. Amphibians occur in a wide variety of CRLA wetland types, and are especially likely to be found in those that are inaccessible to fish, are in meadows or on gentle slopes, and have many pools, partly submerged vegetation, relatively stable water levels, and extensive downed wood.

Supporting Native Birds and Mammals
This concerns the capacity of a wetland to support the life requirements of a variety of birds and mammals that inhabit the park. Those that are believed to depend the most on wetlands are listed in Appendix J and Appendix K. These species contribute importantly to regional biodiversity, as well as helping cycle energy within and between aquatic and terrestrial ecosystems. Wetlands in which willow or alder shrubs adjoin pools or channels may be especially productive as feeding sites for many songbirds. Also important are wetlands that have high internal variation in vegetation, many large snags, and/or which have a set of conditions favored by a particular rare species or assemblage of species. Although this study was not designed to inventory any animals, signs of the more recognizable animals were recorded incidental to other activities (Table 16).

Table 16. Incidental observations of animals in CRLA wetlands, summer 2006.

Observed	# of visited wetlands where noticed	% of visited wetlands where noticed	Locations (if <10)
Deer	58	76%	
Butterfly spp.	52	68%	
Dragonfly spp.	47	62%	
Frog spp.	31	41%	
Black Bear	19	25%	
Elk	17	22%	
Pacific Tree Frog	11	14%	
Cascades Frog	9	12%	K11, K21, K41, K44, K48, K57, K75, K84, NR79
Garter Snake spp.	4	5%	K13, K20, K37, NR147
Fairy Shrimp	3	4%	K15, K21, NR233
Fish sp.	2	3%	K76, NR233
Long-toed Salamander	2	3%	K80, NR79
Beaver	1	1%	NR147
Coyote	1	1%	K45
Yellow-bellied Marmot	1	1%	K3
Pika	1	1%	NRC1
Raccoon	1	1%	NRC1
Western Skink	1	1%	K25
Western Toad	1	1%	NRC1

4.0 Discussion

4.1 Implications for Wetlands Management in CRLA

The results of this study have several practical applications to routine operations at CRLA and beyond:

Avoidance of Impacts

Where warranted, greater consideration may be given in the future to minimizing potentially harmful activities near the rarer wetland types defined in this report, e.g., by managing visitor use patterns, relocating structures or trails, and ensuring that any fire control activities do not cause undue disturbance. Specifically, disturbance should be minimized to the greatest degree near wetlands *that are the most sensitive (e.g., high-elevation and depressional wetlands), have the healthiest or most unusual vegetation communities, and/or which appear to provide the highest levels of ecosystem services*. Among the wetlands visited in 2006, these are K3, K9, K20, K21, K34, K38, K41, K49, K52, K61, K76, K77, K83, NR54, NR65, NR126, NR147, NR174, NR187 and NR244. These are described as follows, starting with the most unique wetlands:

NR65 (Sphagnum Bog east) and **NR128** (Sphagnum Bog west): Perhaps the best-known of the park's wetlands, this large complex of fens is noted for its relatively high species richness, lack of non-native species, and presence of a rare sedge (*Carex diandra*) and grass (*Torreyochloa erecta*), plus another species of possible regional importance, *Epilobium palustre.* Seyer (1979) also reported the rare *Utricularia minor* from this site. The wetland includes an unusual fen community dominated by *Carex limosa, Eriophorum gracile,* and *Menyanthes trifoliata,* the only location where these species were observed during our surveys. The wetland has been designated a Research Natural Area, and is fairly flat with small pools scattered throughout. As implied by its name, this wetland has abundant moss (including *Sphagnum*) and a relatively rich carnivorous plant flora. *Lycopodium annotinum*, a new species (as well as a new Family) for the park, was found adjacent to the Bog in moist forest habitat. This represents a slight range extension to the south for this species. Most of the site is open with trees (mainly *Pinus contorta* and *Picea engelmannii*) around the edges and on scattered small islands. Drier areas also are dominated by *Vaccinium uliginosum* shrubland. The wetter areas (particularly those with standing water) are dominated by mainly by *Carex aquatilis* var. *dives*, with *Calamagrostis canadensis* also being important. Many intermittent streams flow through the wetland and empty into a large creek on the northern edge. See section 3.4.2 for additional details.

Figure 12. Wetlands NR65 (left) and NR128 (right), part of the Sphagnum Bog complex.

NR187 (Humongo): A large wetland on a moderate to steep north-facing slope, this site has a relatively large number of species, including *Hydrophyllum fenderli* and the rare sedge, *Carex abrupta*. Conifers appear to be encroaching. Small ephemeral channels bisect the herb-dominated area of wetland, and larger channels bisect dense thickets of *Alnus incana*.

Figure 13. Wetland NR187.

K20 (Mud Pot) and **K52** (Frank): These wetlands adjoin each other in the Bybee Creek drainage. They are notable not only because they represent a mix of wet meadow / fen habitat, but also because they were documented days before the surrounding forest burned to varying degrees of severity in the Bybee Fire. K20 is a spring-fed boggy meadow with relatively extensive cover of moss (including *Sphagnum*), important because of its carbon sequestration role. K20 also has a large number of perennial graminoids (including the uncommon *Torreyochloa erecta*), and has no non-native species. Edges and a few small internal patches are dominated by a mix of conifer saplings and the dwarf shrubs *Vaccinium uliginosum* and *Kalmia microphylla*. There are several patches of open water; some are muddy bottomed, others have emergent sedges and moss. On the downhill side, several small channels converge and exit the wetland as one channel. K52 has more woody vegetation, including mature conifers, and was more directly affected by the fire.

Figure 14. Wetlands K20 and K52, after the Bybee Creek fire.

K38 (Hamaker Butte). A moderate-sized slope wetland with extensive moss cover, no non-native species, and the regionally uncommon *Sorbus california*. This wetland also hosts CRLA's only known *Saxifraga odontoloma*. The carnivorous plant, *Drosera rotundifolia*, was also common. Most of the wetland is *Vaccinium uliginosum* dwarf shrubland with scattered saplings, and vegetation forms are well-intermixed. Several springs are at the top of the slope, forming small pools and several small streams that run throughout the wetland.

Figure 15. Wetlands K38 (left) and K41 (right).

K41 (Blueberry). A high-elevation slope wetland with both significant moss cover and several perennial graminoids. This wetland contains several ephemeral spring-fed creeks, and the State-listed Cascades Frog was noted. *Alnus incana* dominates along the creeks and herbaceous vegetation is on the surrounding flats and in a few small sloped areas. A small pool with tadpoles was found in the upper end of the site.

K61 (Dragonfly): A depressional wetland with several species that were found in few other park wetlands, and with no non-native species. Rarities (for CRLA) include *Potamogeton gramineus* and *Eleocharis palustris*. About half of this wetland is a pond dominated by *Nuphar lutea*, with the edges dominated by *Carex utriculata, Carex exsiccata, Eleocharis palustris*, and *Polygonum amphibium*.

Figure 16. Wetlands K61 (left) and K49 (right).

K49 (Alder Alley): This depressional wetland hosts the very rare *Collomia mazama*, the rare *Stellaria umbellata*, and generally supports an exceptional number of plant species. Areas of woody (*Alnus incana*) and herbaceous vegetation are spatially distinct.

K9 (Crater Creek south): A long narrow wetland on a slight (5-8%) slope that also hosts the very rare *Collomia mazama*. A small ephemeral stream meanders through this riverine and slope wetland.

Figure 17. Wetlands K9 (left) and K3 (right).

K3 (Talus Spring): A wetland on a steep talus slope under a cliff face. This has many species that were found in few other park wetlands, and no non-native species. Upper slopes of the wetland are dominated by *Alnus viridis* with a few talus chutes and small herbaceous patches. The lower slope is dominated mostly by *Arnica longifolia* with large patches of barren talus. *Sambucus racemosa* occurs in patches in both the shrub and herb dominated vegetation. Two ephemeral creeks traverse the wetland.

K76 (Maintenance): A small riverine wetland dominated by the willow, *Salix commutata*, and with no non-native species. This wetland is one of three CRLA wetlands that host the rare sedge, *Carex abrupta*.

Figure 18. Wetland K76.

K77 (Shag). A small depressional bog almost completely blanketed with concentric circles of the moss, *Polytrichum commune*, and with widely scattered conifer seedlings.

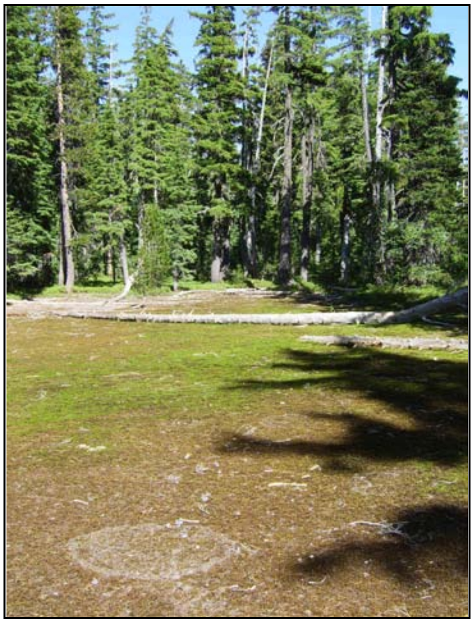

Figure 19. Wetland K77.

NR174 (Annie Alcove): A riverine wetland, one of the lowest in the park. It contains many species that were found in few other park wetlands, and has several perennial graminoids and no non-native species. Species richness at the plot scale was high. This was one of two wetlands where we found the rare (in CRLA) *Bromus ciliatus*. *Alnus incana* is the dominant shrub, and the south end has some open areas dominated by *Calamagrostis canadensis*. The floodplain extends to about 0.5 m above an adjacent creek, and the terrace containing much of the wetland is 1-2 m higher.

Figure 20. Wetland NR174.

NR244. This high-elevation wetland is part of a cluster of small wetlands that all were floristically unique among those we visited. These wetlands are fed primarily by snowmelt, and may be particularly vulnerable to climate change and bioaccumulation of airborne contaminants. *Lycopodium sitchense,* a new species (as well as a new Family) for CRLA, was discovered here and represents a slight range extension to the south for this species.

Figure 21. Wetland NR244 (left) and NR126 (right).

NR126 (Panhandle) This medium-sized, relatively low elevation wetland is located in the Panhandle and is unusual because of the presence of a small mixed stand of aspen-cottonwood (*Populus tremuloides* and *Populus balsamifera* ssp. *trichocarpa*). The latter is declining throughout its range and is uncommon in CRLA. This stand appears to be regenerating, however, as evidenced by the presence of aspen in multiple strata and high percent cover of saplings. Also rare (for CRLA) was *Stellaria borealis*.

K34 (Oasis Springs). This large and heterogeneous wetland is remote and seldom visited, and appeared to be in near-pristine condition.

Figure 22. Wetland K34.

K83. This wetland adjacent to Castle Creek is unusual due to the presence of a large seep discharging down a steep slope, and the high gravel content of the soils. This characteristic of the soil makes the slope where the seep is discharging extremely unstable and susceptible to damage even with light visitation. This area of the wetland also had an unusually high cover of thallose liverworts. This wetland is floristically noteworthy also because of the rare *Hydrophyllum fenderli* and an unidentified species of *Mitella*, which may also be new to the park. A very small, rare grove of aspen is present but appears to be declining. Of potential concern, this wetland has several non-native species.

Figure 23. Wetlands K83 (left) and NR54 (right).

NR54 (Floating Pumice): A riverine and slope wetland with no non-native species. It was the only CRLA site found to host the rare sedge, *Carex nervina*. The majority of the wetland is dominated by *Picea engelmannii*, with understory dominated by *Glyceria elata* and *Scirpus microphyllus*. Most of the wetland is seep-fed and more than a meter above the creek, but some is almost at water level.

K21 and NR147. These are located in the low-elevation Thousand Springs wetland complex and are considered together because they are hydrologically connected. Because of the heterogeneity of their habitat and the presence of a network of small perennial creeks, this area provides excellent habitat for many wildlife species, including the State-listed Cascades Frog. The rare (for CRLA) shrub *Vaccinium ovalifolium* is present. These wetlands are lightly visited despite being near a dirt road.

Figure 24. Wetlands NR147 (left) and K21 (right).

To only a slightly lesser degree, the following visited wetlands meet the criteria described above: K1, K2, K4, K7, K11, K17, K22, K28, K29, K30, K37, K42, K43, K48, K51, K58, K68, K71, K84, K85, NR62, NR120, NR129, NR146, and NR188. Other wetlands that deserve heightened protection due to their particular sensitivity include those supporting uncommon wildlife communities or species (e.g., Cascades Frog) and those with uncommon mosses and lichens.

Monitoring of Change
A statistically-valid, quantitative baseline has now been established for CRLA wetlands, mainly using vegetation. This serves as one indicator of the health or condition of the wetlands. Future changes in CRLA wetlands in general can be quantified by revisiting the same wetlands at some future time, relocating the markers and sample plots we georeferenced and photographed, and re-assessing their vegetation and other characteristics using the exact protocols described in this report (Appendix G). Whether arising from factors originating within CRLA or externally, those changes in wetland vegetation can alert managers of potentially impacting disturbances, such as altered drainage in the wetland's contributing basin. Interpretation of which changes are significant, and the diagnoses of their causes, must take into account the fact that the species composition of vegetation in wetlands is to some degree naturally dynamic.

Education
Part of the Park Service's mission is to help educate visitors about the natural world, and instill an appreciation for the public resources of the nation's parks. This study has assisted that mission by providing a detailed characterization of CRLA's wetlands based on systematically-collected data. This new information may be excerpted for use in interpretive signs and brochures, and incorporated into internet (web) material and public presentations by park staff.

Restoration
We noted past disturbances by humans in very few visited wetlands, and those wetlands appeared to be recovering or adapting to the mostly minor disturbances quite well, so hands-on restoration is not urgently needed. If unforeseen future events or activities cause additional disturbances that require restoration, then the "reference wetland" information from this study (e.g., Table 17) can be used to help establish performance standards useful for monitoring the progress of the restoration. Specifically, this study has defined 23 wetland plant communities (Table 15) that could provide reference targets for restoration, where any future need is noted for restoring wetlands in CRLA or in similar settings in the surrounding region.

4.2 Broader Applications

Regional Wetland Benchmarks

In the past two centuries, the Klamath Basin and much of western Oregon has lost thousands of acres of wetlands, and the condition of many remaining wetlands is questionable. Resolving questions about the condition of high-elevation wetlands requires comparing them to wetlands of the same type that are known or expected to be the least-altered. For comparisons among wetlands in the southern Cascades, the relatively undisturbed wetlands of CRLA can serve as excellent reference points.

Sampling Approach

For the first time in a national park, this study has demonstrated the practicality and efficiency of park-wide use of a new spatially-balanced probabilistic sampling design for assessing wetlands – the GRTS algorithm. This allows valid statements to be made about the condition of a resource throughout a park, rather than just individual sites that may or may not be assumed to be representative. Moreover, in situations where field efforts are significantly constrained by time and resources, this study uniquely demonstrates how a GIS-based cluster analysis procedure can be used to augment and complement the GRTS approach for selecting sites to visit and assess.

Table 17. Normative ranges for selected characteristics of CRLA wetlands.

Note: The wetland-scale numbers in this table were based on data only from the original 56 randomly-selected wetlands. The plot-scale numbers were from the 101 plots encompassing all visited wetlands. See other report sections for definitions of the metrics. "Plot" refers to measurement of the indicator in a 100 m^2 plot. The three normative categories are based simply on the division of our data into three categories (defined by the 30th and 70th percentiles), with number of wetlands in each category being about the same. "Above Norm" generally reflects a healthier condition, and "Below Norm" the opposite. However, the categories do not necessarily reflect impacts from humans, or needs for any corrective actions. They should not be considered synonymous with "Proper Functioning Condition." They are intended for use as reference points only in comparisons involving other wetlands within CRLA specifically. The bounds of these categories might just as easily be the result of natural constraints of geology, climate, and other factors – this could not be determined from our data, and cannot be accounted for by hydrogeomorphic (HGM) class alone. Due to these natural constraints, no wetland should be expected to be Above Norm for all metrics. Ideally, with additional data (larger sample sizes) in the future these ranges could be customized to particular wetland types, elevations, and other settings.

Metric	Scale	Above Norm	Normative for CRLA	Below Norm
Total number of species (species richness)	wetland*	>53	45	<35
	plot	>30	24	<18
Number of plant families	wetland*	>24	21	<18
	plot	>17	15	<13
# of non-native species	wetland*	<1	2	>2
	plot	0	0	>0
# of perennial graminoid species	wetland	>11	9	<5
	plot	>7	5	<4
Moss percent cover	wetland	>2	2	<1
Frequency Index (among wetlands)	wetland*	<23	25	<27
	plot	<25	28	>30
Frequency Index (among plots)	wetland	<18	20	>22
	plot	<20	23	>25
Dominance (% of species comprising >25% of cover)	plot	0	2	>2
Dominance (maximum % cover of any species)	plot	<42	61	>75
Prevalence (Moisture) Index	wetland**	<2.36	2.52	>2.66
	plot	<1.75	2.06	>2.24

* Potentially biased by a wetland's acreage.
** At a wetland scale, this metric was not weighted by species percent cover as it normally is.

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Appendix A. Data Dictionary Introduction

The following files have been created in Excel and are provided separately on electronic media. Most can be linked or joined using the field, "SiteID." A full listing of the variables each file contains is provided by the DataDictionary.doc file on the accompanying electronic media. In addition, we have provided to the National Park Service (Klamath Network Office, Ashland, OR) a shapefile containing all joined NWI wetland polygons, revised wetland boundaries based on field visits to 76 wetlands, and point data for benchmarks and plots in wetlands. Also available from the Network Office are georeferenced panoramic photographs we took at each site and a sketch map of each site showing key features.

Name	Description
Form B	data on plots and their vegetation, and overall wetland polygon vegetation (data collected using the form in Appendix F and protocols in Appendix G)
Form S	soil profile measurements and characterization
Form F	data on physical characteristics of the wetland polygon, e.g., surface hydrology, channels, dead wood, microtopography
Form C	data on potential stressors and disturbances
Benchmarks	data on location of permanent marker placed in each wetland

Appendix B. Wetland Plant Species of CRLA

This list includes wetland species found in CRLA wetlands by this study, as well as wetland species (FAC or wetter status, shaded) not found by this study but on the official plant list of CRLA, and species not officially listed as occurring regularly in wetlands but found in wetlands surveyed by this study (bolded).
Indicator status: see Table 14.

Plant Scientific Name	Species Code	Indicator Status*	Frequency (# of visited wetlands of 76)	Frequency (# of plots of 101)
Abies amabilis	ABIAMA	FACU	4	2
Abies concolor	ABICON	NI	4	2
Abies grandis	ABIGRA	FACU-	1	1
Abies lasiocarpa	ABILAS	FACU	54	34
Abies x shastensis	ABISHA	NOL	12	3
Achillea millefolium	ACHMIL	FACU	9	2
Achlys triphylla	ACHTRI	NOL	8	3
Achnatherum nelsonii	ACHNEL	NOL	1	0
Aconitum columbianum	ACOCOL	FACW	48	42
Actaea rubra	ACTRUB	NI	4	3
Adenocaulon bicolor	ADEBIC	NOL	2	2
Adiantum aleuticum	ADIALE	FAC	0	0
Agoseris aurantiaca	AGOAUR	FACU	9	2
Agrostis exarata	AGREXA	FACW	17	16
Agrostis gigantea	AGRGIG	FAC	0	0
Agrostis humilis	AGRHUM	FACW	0	0
Agrostis idahoensis	AGRIDA	FACW	6	5
Agrostis scabra	AGRSCA	FAC	5	4
Agrostis thurberiana	AGRTHU	FACW	31	27
Agrostis variabilis	AGRVAR	NI	3	1
Allium amplectens	ALLAMP	NOL	1	1
Allium validum	ALLVAL	OBL	7	4
Alnus incana	ALNINC	FACW	17	12
Alnus viridis	ALNVIR	FACW	5	6
Alopecurus aequalis	ALOAEQ	OBL	1	0
Alopecurus pratensis	ALOPRA	FACW	0	0
Amelanchier alnifolia	AMEALN	FACU	3	0
Amelanchier utahensis	AMEUTA	NI	1	1
Anaphalis margaritacea	ANAMAR	NOL	9	8
Anemone deltoidea	ANEDEL	NOL	3	2
Anemone oregana	ANEORE	FACU	1	0
Angelica genuflexa	ANGGEN	FACW	0	0
Antennaria media	ANTMED	NI	2	2
Aquilegia formosa	AQUFOR	FAC	9	4
Arabis glabra	ARAGLA	NOL	1	1
Arnica amplexicaulis	ARNAMP	FACW	3	3
Arnica longifolia	ARNLON	FACW	3	2
Arnica mollis	ARNMOL	FAC	18	7
Arnica x diversifolia	ARNDIV	FACW	0	0
Asarum caudatum	ASACAU	FACU	2	2
Aster eatonii	ASTEAT	FAC+	0	0
Aster foliaceus	ASTFOL	FACW-	13	10
Aster occidentalis	ASTOCC	FAC	6	3
Athyrium filix-femina	ATHFIL	FAC	15	11
Athyrium americanum	ATHAME	FAC	0	0

Plant Scientific Name	Species Code	Indicator Status*	Frequency (# of visited wetlands of 76)	Frequency (# of plots of 101)
Aulocomnium palustre	AULPAL	NOL	2	2
Barbarea orthoceras	BARORT	FACW+	0	0
Bidens cernua	BIDCER	FACW+	0	0
Botrychium lanceolatum	BOTLAN	FACW	0	0
Botrychium multifidum	BOTMUL	FAC	6	3
Botrychium simplex	BOTSIM	NOL	1	0
Boykinia major	BOYMAJ	FACW	0	0
Bromus carinatus	BROCAR	NOL	8	4
Bromus ciliatus	BROCIL	FAC	2	2
Bromus inermis	BROINE	FAC	0	0
Bromus orcuttianus	BROORC	NOL	5	2
Bromus suksdorfii	BROSUK	NOL	3	2
Bromus vulgaris	BROVUL	UPL	2	1
Calamagrostis canadensis	CALCAN	FACW+	48	41
Calamagrostis stricta	CALSTR	NOL	2	0
Callitriche verna	CALVER	OBL	1	0
Calocedrus decurrens	CALDEC	NOL	2	0
Calochortus elegans	CALELE	NOL	1	0
Caltha leptosepala	CALLEP	OBL	12	10
Calypso bulbosa	CALBUL	FAC+	0	0
Camassia leichtlinii	CAMLEI	FACW-	11	8
Canadanthus modestus	CANMOD	NOL	17	15
Cardamine pensylvanica	CARPEN	FACW	6	2
Carex abrupta	CARABR	NI	3	2
Carex angustata	CARANG	FACW+	3	2
Carex aquatilis	CARAQU	OBL	25	28
Carex athrostachya	CARATH	FACW	2	2
Carex bolanderi	CARBOL	FAC	1	1
Carex breweri	CARBRE	NOL	1	0
Carex canescens	CARCAN	FACW+	1	1
Carex crawfordii	CARCRA	FAC	0	0
Carex cusickii	CARCUS	OBL	0	0
Carex diandra	CARDIA	OBL	1	0
Carex disperma	CARDIS	FACW	6	5
Carex echinata	CARECH	OBL	14	14
Carex exsiccata	CAREXS	OBL	2	2
Carex halliana	CARHAL	NI	1	0
Carex heteroneura	CARHET	FAC	0	0
Carex hoodii	CARHOO	FAC	1	1
Carex illota	CARILL	FAC	9	5
Carex inops	CARINO	NOL	1	1
Carex integra	CARINT	NOL	2	2
Carex jonesii	CARJON	FACW+	7	5
Carex laeviculmis	CARLAE	FACW	20	15
Carex lenticularis	CARLEN	FACW+	39	33
Carex leporinella	CARLEPO	NI	5	4
Carex leptopoda	CARLEPT	FAC	8	9
Carex limosa	CARLIM	OBL	1	1
Carex luzulina	CARLUZ	OBL	42	39
Carex mertensii	CARMER	FAC	2	2
Carex microptera	CARMIC	FAC+	4	2
Carex multicostata	CARMUL	FAC+	0	0
Carex nervina	CARNER	FACW-	1	0

Plant Scientific Name	Species Code	Indicator Status*	Frequency (# of visited wetlands of 76)	Frequency (# of plots of 101)
Carex neurophora	CARNEU	FACW	30	27
Carex nigricans	CARNIG	FACW	6	5
Carex pachystachya	CARPAC	FAC	2	1
Carex preslii	CARPRE	FACU	7	6
Carex rossii	CARROS	NOL	2	1
Carex scopulorum	CARSCO	FACW	15	13
Carex spectabilis	CARSPE	FACW	7	5
Carex straminiformis	CARSTR	NOL	2	2
Carex subfusca	CARSUB	FACU	14	15
Carex utriculata	CARUTR	OBL	6	8
Castilleja miniata	CASMIN	FACU	9	2
Castilleja suksdorfii	CASSUK	FACW	3	0
Cerastium fontanum	CERFON	FACU	3	1
Chamaecyce nutans	CHANUT	FAC	0	0
Chenopodium album	CHEALB	FAC	0	0
Chimaphila menziesii	CHIMEN	NOL	1	0
Chimaphila umbellata	CHIUMB	NOL	3	3
Cinna latifolia	CINLAT	FACW	27	21
Circaea alpina	CIRALP	FAC	11	13
Cirsium arvense	CIRARV	FAC-	2	0
Cirsium vulgare	CIRVUL	FACU	4	1
Cistanthe umbellata	CISUMB	NOL	1	0
Claytonia lanceolata	CLALAN	FAC-	3	0
Claytonia perfoliata	CLAPER	FAC	0	0
Claytonia sibirica	CLASIB	FAC-	1	1
Clintonia uniflora	CLIUNI	NOL	16	11
Collinsia parviflora	COLPAR	NOL	2	2
Collomia linearis	COLLIN	FACU	2	0
Collomia mazama	COLMAZ	NOL	2	1
Comarum palustre	COMPAL	OBL	0	0
Corallorhiza mertensiana	CORMER	NOL	1	1
Cornus canadensis	CORCAN	FAC-	2	0
Cornus sericea	CORSER	FACW	1	1
Cryptantha torreyana	CRYTOR	FACW+	0	0
Cystopteris fragilis	CYSFRA	FACU	6	7
Danthonia intermedia	DANINT	FACU+	11	4
Delphinium glaucum	DELGLA	FACW	2	0
Deschampsia caespitosa	DESCAE	FACW	10	8
Deschampsia danthonioides	DESDAN	FACW-	0	0
Deschampsia elongata	DESELO	FACW-	3	1
Dicentra formosa	DICFOR	FACU	8	10
Dodecatheon alpinum	DODALP	FACW+	31	25
Drosera anglica	DROANG	OBL	3	0
Drosera rotundifolia	DROROT	OBL	6	4
Eleocharis bella	ELEACI	OBL	1	0
Eleocharis palustris	ELEPAL	OBL	2	3
Eleocharis quinqueflora	ELEQUI	OBL	19	19
Elymus elymoides	ELYELY	FACU-	1	0
Elymus glaucus	ELYGLA	FACU	32	25
Elymus trachycaulus	ELYTRA	FAC	1	0
Epilobium anagallidifolium	EPIANA	FACU-	2	2
Epilobium angustifolium	EPIANG	FACU+	20	14
Epilobium ciliatum	EPICIL	FACW-	31	29

Plant Scientific Name	Species Code	Indicator Status*	Frequency (# of visited wetlands of 76)	Frequency (# of plots of 101)
Epilobium glaberrimum	EPIGLA	FACW	6	3
Epilobium halleanum	EPIHAL	FACW	6	5
Epilobium hornemannii	EPIHOR	FACW-	29	24
Epilobium lactiflorum	EPILAC	FACW	0	0
Epilobium minutum	EPIMIN	NI	3	1
Epilobium oregonense	EPIORE	FACW	8	10
Epilobium palustre	EPIPAL	OBL	1	1
Equisetum arvense	EQUARV	FAC	37	42
Equisetum hyemale	EQUHYE	FACW	0	0
Erigeron acris	ERIACR	FAC	0	0
Erigeron coulteri	ERICOU	FACW	0	0
Erigeron peregrinus	ERIPER	FACW	18	12
Eriogonum nudum	ERINUD	FACW	0	0
Eriophorum gracile	ERIGRA	OBL	2	1
Erythronium grandiflorum	ERYGRA	FACU	1	1
Festuca rubra	FESRUB	FAC+	0	0
Festuca subulata	FESSUB	FACU+	4	2
Fontinalis antipyretica	FONANT	NOL	2	3
Fragaria vesca	FRAVES	NI	6	4
Fragaria virginiana	FRAVIR	FACU	13	10
Frangula purshiana	FRAPUR	FAC-	1	0
Galium aparine	GALAPA	FACU	5	4
Galium bifolium	GALBIF	NOL	13	12
Galium trifidum	GALTRIFI	FACW+	10	7
Galium triflorum	GALTRIFL	FACU	29	26
Gaultheria humifusa	GAUHUM	FACW	12	4
Gaultheria ovatifolia	GAUOVA	FAC	4	4
Gentianopsis simplex	GENSIM	FACW	8	5
Geum macrophyllum	GEUMAC	FAC+	9	9
Gilia capillaris	GILCAP	NI	1	0
Glyceria borealis	GLYBOR	OBL	2	3
Glyceria elata	GLYELA	FACW+	38	33
Gnaphalium palustre	GNAPAL	FAC+	2	0
Gnaphalium uliginosum	GNAULI	FAC+	0	0
Hackelia californica	HACCAL	FAC+	0	0
Hackelia micrantha	HACMIC	NI	14	10
Helenium bigelovii	HELBIG	FACW+	2	0
Heracleum maximum	HERMAX	FAC+	12	10
Heterocodon rariflorum	HETRAR	FACW	0	0
Hieracium albiflorum	HIEALB	NOL	3	3
Hieracium gracile	HIEGRA	NI	5	2
Hippuris vulgaris	HIPVUL	OBL	0	0
Holcus lanatus	HOLLAN	FAC	0	0
Holodiscus discolor	HOLDIS	NI	1	0
Hordeum brachyantherum	HORBRA	FACW-	6	4
Hydrophyllum fendleri	HYDFEN	FAC	2	2
Hypericum anagalloides	HYPANA	OBL	45	40
Hypericum perforatum	HYPPER	UPL	1	0
Hypericum scouleri	HYPSCO	FAC-	5	3
Juncus balticus	JUNBAL	OBL	2	1
Juncus drummondii	JUNDRU	FACW-	15	9
Juncus effusus	JUNEFF	OBL	6	3
Juncus ensifolius	JUNENS	FACW	23	20

Plant Scientific Name	Species Code	Indicator Status*	Frequency (# of visited wetlands of 76)	Frequency (# of plots of 101)
Juncus howellii	JUNHOW	NOL	24	15
Juncus mertensianus	JUNMER	OBL	18	9
Juncus mexicanus	JUNMEX	FACW	0	0
Juncus orthophyllus	JUNORT	FACW	0	0
Juncus parryi	JUNPAR	FAC+	0	0
Kalmia microphylla	KALMIC	OBL	11	9
Kelloggia galioides	KELGAL	NOL	1	0
Lathyrus nevadensis	LATNEV	NOL	7	6
Lemna minor	LEMMIN	OBL	0	0
Lewisia triphylla	LEWTRI	UPL	5	2
Ligusticum grayi	LIGGRA	NI	52	44
Lilium pardalinum	LILPAR	OBL	1	1
Linanthus harknessii	LINHAR	NOL	1	1
Linnaea borealis	LINBOR	FACU-	5	2
Listera convallarioides	LISCON	FAC	1	1
Listera cordata	LISCOR	FAC	3	2
Lolium perenne	LOLPER	FAC	0	0
Lonicera caerulea	LONCAE	FAC	2	3
Lonicera conjugialis	LONCON	FAC	1	1
Lonicera involucrata	LONINV	FAC+	3	1
Lonicera involucrata	LONINVI	FAC+	0	0
Lonicera utahensis	LONUTA	FAC	0	0
Lotus oblongifolius	LOTOBL	OBL	11	9
Luetkea pectinata	LUEPEC	FACU-	2	2
Lupinus latifolius	LUPLAT	FACW	18	15
Lupinus lepidus	LUPLEP	NOL	1	0
Lupinus polyphyllus	LUPPOL	FAC+	0	0
Luzula congesta	LUZCON	FAC	0	0
Luzula divaricata	LUZDIV	NOL	3	1
Luzula multiflora	LUZMUL	FACU	17	13
Luzula parviflora	LUZPAR	FAC-	16	11
Lycopodium annotinum	LYCANN	FAC	0	0
Lycopodium sitchense	LYCSIT	NOL	1	1
Lysichiton americanum	LYSAME	OBL	5	4
Madia bolanderi	MADBOL	NOL	18	7
Maianthemum racemosum	MAIRAC	NI	1	1
Maianthemum stellatum	MAISTE	FAC-	12	9
Marchantia polymorpha	MARPOL	NOL	1	1
Melica subulata	MELSUB	NOL	5	5
Menyanthes trifoliata	MENTRI	OBL	1	1
Mertensia paniculata	MERPAN	FACW-	3	4
Mertensia platyphylla	MERPLA	NOL	1	0
Mimulus alsinoides	MIMALS	OBL	0	0
Mimulus breweri	MIMBRE	NI	3	0
Mimulus guttatus	MIMGUT	OBL	47	39
Mimulus lewisii	MIMLEW	FACW+	12	5
Mimulus moschatus	MIMMOS	FACW+	25	21
Mimulus primuloides	MIMPRI	FACW+	35	30
Mimulus tilingii	MIMTIL	OBL	3	3
Mitella breweri	MITBRE	FAC	3	2
Mitella ovalis	MITOVA	OBL	0	0
Mitella pentandra	MITPEN	FAC	34	26
Montia chamissoi	MONCHA	OBL	2	1

Plant Scientific Name	Species Code	Indicator Status*	Frequency (# of visited wetlands of 76)	Frequency (# of plots of 101)
Montia parvifolia	MONPAR	FACW-	0	0
Muhlenbergia andina	MUHAND	FAC	0	0
Muhlenbergia filiformis	MUHFIL	FACW-	44	37
Myriophyllum verticillatum	MYRVER	OBL	0	0
Nothocalais alpestris	NOTALP	NOL	2	0
Nuphar lutea	NUPLUT	OBL	2	2
Oplopanax horridus	OPLHOR	FAC	0	0
Orobanche uniflora	OROUNI	FACU	1	0
Orthilia secunda	ORTSEC	FACU	9	4
Orthocarpus imbricatus	ORTIMB	NOL	1	0
Osmorhiza berteroi	OSMBER	NI	7	7
Osmorhiza depauperata	OSMDEP	FAC+	0	0
Osmorhiza purpurea	OSMPUR	FAC+	7	5
Oxypolis occidentalis	OXYOCC	OBL	31	31
Oxyria digyna	OXYDIG	FACU-	1	0
Parnassia fimbriata	PARFIM	OBL	3	3
Parnassia palustris	PARPAL	OBL	0	0
Pedicularis groenlandica	PEDGRO	OBL	26	17
Pedicularis racemosa	PEDRAC	NOL	1	0
Penstemon davidsonii	PENDAV	NOL	1	0
Penstemon rupicola	PENRUP	NOL	1	0
Penstemon rydbergii	PENRYD	FACU	1	0
Perideridia gairdneri	PERGAR	FAC	2	2
Phacelia hastata	PHAHAS	NOL	1	1
Phacelia mutabilis	PHAMUT	FACW	0	0
Phalaris arundinacea	PHAARU	FACW	1	0
Philonotis fontana	PHIFON	NOL	22	21
Phleum alpinum	PHLALP	FAC+	16	7
Phlox diffusa	PHLDIF	NOL	1	0
Phlox gracilis	PHLGRA	FACU	2	1
Phyllodoce empetriformis	PHYEMP	FACU	3	3
Picea engelmannii	PICENG	FAC	20	15
Pinus contorta	PINCON	FACU	42	22
Pinus monticola	PINMON	FACU	15	8
Pinus ponderosa	PINPON	FACU-	1	1
Piperia unalascensis	PIPUNA	FAC	0	0
Plagiomnium insigne	PLAINS	NOL	1	1
Plantago major	PLAMAJ	FAC	0	0
Platanthera leucostachys	PLALEU	NI	30	19
Platanthera stricta	PLASTR	FACW+	42	29
Pleuropogon refractus	PLEREF	NOL	3	2
Poa bolanderi	POABOL	NOL	1	1
Poa leptocoma	POALEP	FACW+	1	1
Poa pratensis	POAPRA	FAC	0	0
Polemonium californicum	POLCAL	NOL	2	1
Polemonium occidentale	POLOCC	FACW	9	7
Polemonium pulcherrimum	POLPUL	NOL	1	1
Polygonum amphibium	POLAMP	OBL	1	2
Polygonum bistortoides	POLBIS	FACW	48	52
Polygonum davisiae	POLDAV	NI	1	0
Polygonum douglasii	POLDOU	FACU	11	4
Polygonum lapathifolium	POLLAP	FACW	0	0
Polygonum minimum	POLMIN	FACU+	2	2

Plant Scientific Name	Species Code	Indicator Status*	Frequency (# of visited wetlands of 76)	Frequency (# of plots of 101)
Polygonum polygaloides	POLPOL	NI	2	1
Polystichum imbricans	POLIMB	NOL	1	0
Polystichum lonchitis	POLLON	NOL	5	2
Polystichum munitum	POLMUN	FACU	1	1
Polytrichastrum alpinum	POLALP	NOL	1	1
Polytrichum commune	POLCOM	NOL	4	4
Populus balsamifera	POPBAL	FAC	2	2
Populus tremuloides	POPTRE	FAC+	3	1
Potamogeton gramineus	POTGRA	OBL	1	2
Potamogeton natans	POTNAT	OBL	0	0
Potamogeton pectinatus	POTPEC	OBL	0	0
Potamogeton pusillus	POTPUS	OBL	0	0
Potentilla drummondii	POTDRU	FAC	3	2
Potentilla flabellifolia	POTFLA	FAC	7	6
Potentilla glandulosa	POTGLA	FAC-	3	3
Prunella vulgaris	PRUVUL	FACU+	3	1
Pseudotsuga menziesii	PSEMEN	FACU	2	0
Pteridium aquilinum	PTEAQU	FACU	4	2
Pyrola asarifolia	PYRASA	FACW-	8	4
Pyrola minor	PYRMIN	FACU+	1	0
Pyrola picta	PYRPIC	NOL	3	2
Ranunculus eschscholtzii	RANESC	FAC	0	0
Ranunculus flammula	RANFLA	OBL	2	0
Ranunculus gormanii	RANGOR	FACW+	45	44
Ranunculus occidentalis	RANOCC	FAC	4	1
Ranunculus populago	RANPOP	FACW	0	0
Ranunculus trichophyllus	RANTRI	OBL	0	0
Ranunculus uncinatus	RANUNC	FAC	1	1
Rhizomnium nudum	RHINUD	NOL	1	1
Ribes cereum	RIBCER	FAC	0	0
Ribes erythrocarpum	RIBERY	NOL	3	3
Ribes inerme	RIBINE	FAC	0	0
Ribes lacustre	RIBLAC	FAC+	21	10
Ribes viscosissimum	RIBVIS	FAC	2	0
Rorippa curvisiliqua	RORCUR	OBL	1	0
Rosa gymnocarpa	ROSGYM	FACU	1	2
Rubus lasiococcus	RUBLAS	NI	25	13
Rubus leucodermis	RUBLEU	NI	4	0
Rudbeckia occidentalis	RUDOCC	FAC-	16	8
Rumex crispus	RUMCRI	FAC+	0	0
Sagina saginoides	SAGSAG	FACW-	9	5
Salix boothii	SALBOO	FACW+	11	7
Salix commutata	SALCOM	OBL	11	6
Salix eastwoodiae	SALEAS	FACW	0	0
Salix exigua	SALEXI	OBL	0	0
Salix lemmonii	SALLEM	FACW+	0	0
Salix lucida	SALLUC	FACW+	4	1
Salix scouleriana	SALSCO	FAC	0	0
Salix sitchensis	SALSIT	FACW	15	4
Sambucus racemosa	SAMRAC	FACU	4	6
Saxifraga ferruginea	SAXFER	FAC	2	1
Saxifraga mertensiana	SAXMER	FACW	0	0
Saxifraga nidifica	SAXNID	FACW	0	0

Plant Scientific Name	Species Code	Indicator Status*	Frequency (# of visited wetlands of 76)	Frequency (# of plots of 101)
Saxifraga odontoloma	SAXODO	FACW+	1	1
Saxifraga oregana	SAXORE	FACW+	4	3
Scirpus congdonii	SCICON	FACW	15	7
Scirpus microcarpus	SCIMIC	OBL	17	12
Scrophularia californica	SCRCAL	FACW-	0	0
Scrophularia lanceolata	SCRLAN	FAC	1	1
Sedum oregonense	SEDORE	NOL	1	0
Senecio pseudaureus	SENPSE	FACW	0	0
Senecio triangularis	SENTRI	FACW+	65	64
Sidalcea oregana	SIDORE	FACW-	2	1
Silene menziesii	SILMEN	FAC	1	1
Silene uralensis	SILURA	FACW-	0	0
Sisyrinchium californicum	SISCAL	FACW+	0	0
Sisyrinchium idahoense	SISIDA	FACW	3	0
Solidago canadensis	SOLCAN	FACU	6	3
Sonchus asper	SONASP	FAC-	1	1
Sorbus californica	SORCAL	NOL	2	2
Sorbus scopulina	SORSCO	FACU	5	2
Sparganium angustifolium	SPAANG	OBL	0	0
Sparganium natans	SPANAT	OBL	2	2
Sphagnum squarrosum	SPHSQU	OBL	2	2
Sphenosciadium capitellatum	SPHCAP	FACW	0	0
Spiraea douglasii	SPIDOU	FACW	12	7
Spiraea splendens	SPISPL	NOL	13	8
Spiranthes romanzoffiana	SPIROM	FACW	8	5
Stachys cooleyae	STACOO	FACW	2	2
Stachys palustris	STAPAL	FACW-	0	0
Stachys rigida	STARIG	FACW	19	15
Stellaria borealis	STEBOR	FACW-	2	2
Stellaria calycantha	STECAL	FACW	5	4
Stellaria crispa	STECRI	FAC+	12	8
Stellaria longifolia	STELONF	FACW	7	4
Stellaria longipes	STELONP	FACW-	1	0
Stellaria obtusa	STEOBT	FACW	2	2
Stellaria umbellata	STEUMB	FACW	3	1
Streptopus amplexifolius	STRAMP	FAC-	7	4
Streptopus lanceolatus	STRLAN	NOL	21	14
Symphoricarpos mollis	SYMMOL	NOL	1	1
Taraxacum officinale	TAROFF	FACU	11	6
Thalictrum sparsiflorum	THASPA	FAC	1	1
Tiarella trifoliata	TIATRI	FAC-	10	7
Tofieldia glutinosa	TOFGLU	OBL	14	11
Torreyochloa erecta	TORERE	OBL	16	12
Torreyochloa pallida	TORPAL	OBL	5	5
Trifolium hybridum	TRIHYB	FAC	0	0
Trifolium longipes	TRILON	FAC-	17	17
Trifolium productum	TRIPRO	NI	1	0
Trillium ovatum	TRIOVA	FACU	3	2
Trisetum canescens	TRICAN	FACU	5	5
Trisetum spicatum	TRISPI	UPL	2	0
Trisetum wolfii	TRIWOL	FACU	5	2
Tsuga heterophylla	TSUHET	FACU+	4	4
Tsuga mertensiana	TSUMER	FACU	54	24

Plant Scientific Name	Species Code	Indicator Status*	Frequency (# of visited wetlands of 76)	Frequency (# of plots of 101)
Urtica dioica	URTDIO	FAC+	1	0
Utricularia intermedia	UTRINT	OBL	2	1
Utricularia macrorhiza	UTRMAC	OBL	1	1
Utricularia minor	UTRMIN	OBL	0	0
Vaccinium cespitosum	VACCES	FAC	5	3
Vaccinium membranaceum	VACMEM	FACU	17	8
Vaccinium ovalifolium	VACOVA	UPL	2	1
Vaccinium scoparium	VACSCO	FACU-	30	10
Vaccinium uliginosum	VACULI	FACW	22	17
Vahlodea atropurpurea	VAHATR	FACW	11	4
Valeriana californica	VALCAL	OBL	0	0
Valeriana sitchensis	VALSIT	FAC	3	2
Vancouveria hexandra	VANHEX	NOL	14	12
Veratrum viride	VERVIR	FACW	50	26
Veronica americana	VERAME	OBL	20	13
Veronica serpyllifolia	VERSER	FAC	10	3
Veronica wormskjoldii	VERWOR	FACW-	35	24
Vicia americana	VICAME	FAC	10	9
Viola adunca	VIOADU	FACW-	17	10
Viola glabella	VIOGLA	FAC	32	32
Viola macloskeyi	VIOMAC	OBL	42	38

Appendix C. Prevalent Plant Species in Visited Wetlands of CRLA

Table C-1. Prevalent herbaceous (emergent) species in visited wetland polygons of CRLA.

Plant Species	Wetland Indicator Status	# of wetlands where found	Mean % cover within stratum where found	Maximum percent cover within stratum
Calamagrostis canadensis	FACW+	33	19	60
Senecio triangularis	FACW+	32	17	40
Carex aquatilis	OBL	17	37	80
Ranunculus gormanii	FACW+	15	10	25
Mimulus primuloides	FACW+	14	13	30
Philonotis fontana	NOL	13	20	40
Glyceria elata	FACW+	12	19	55
Veratrum viride	FACW	12	11	20
Caltha leptosepala	OBL	8	16	30
Lupinus latifolius	FACW	8	13	35
Scirpus microcarpus	OBL	8	18	30
Carex luzulina	OBL	7	8	10
Trifolium longipes	FAC-	7	15	25
moss spp.		7	14	35
Carex lenticularis	FACW+	6	23	45
Muhlenbergia filiformis	FACW-	6	7	10
Viola macloskeyi	OBL	5	8	15
Carex neurophora	FACW	4	10	10
Carex nigricans	FACW	4	35	50
Carex scopulorum	FACW	4	31	70
Oxypolis occidentalis	OBL	4	9	15
Poaceae sp.		4	14	20
Polygonum bistortoides	FACW	4	7	15
Rudbeckia occidentalis	FAC-	4	24	35
Camassia leichtlinii	FACW-	3	4	5
Dicentra formosa	FACU	3	10	20
Dodecatheon alpinum	FACW+	3	6	7
Elymus glaucus	FACU	3	7	10
Equisetum arvense	FAC	3	11	25
Hypericum anagalloides	OBL	3	6	10
Polytrichum commune	NOL	3	49	100
Potentilla flabellifolia	FAC	3	37	50
Arnica longifolia	FACW	2	75	80
Carex angustata	FACW+	2	5	7
Carex echinata	OBL	2	25	40
Carex exsiccata	OBL	2	16	20
Carex laeviculmis	FACW	2	5	5
Carex leporinella	NI	2	49	58
Carex microptera	FAC+	2	24	32
Carex preslii	FACU	2	13	20
Carex spectabilis	FACW	2	9	10
Carex subfusca	FACU	2	37	64

Plant Species	Wetland Indicator Status	# of wetlands where found	Mean % cover within stratum where found	Maximum percent cover within stratum
Carex utriculata	OBL	2	18	20
Cinna latifolia	FACW	2	6	7
Deschampsia caespitosa	FACW	2	8	10
Eleocharis quinqueflora	OBL	2	9	10
Ligusticum grayi	NI	2	2	2
Mimulus guttatus	OBL	2	13	20
Nuphar lutea	OBL	2	25	30
Achlys triphylla	NOL	1	7	7
Actaea rubra	NI	1	10	10
Allium validum	OBL	1	7	7
Athyrium filix-femina	FAC	1	5	5
Carex jonesii	FACW+	1	15	15
Carex sp.		1	10	10
Carex straminiformis	NOL	1	30	30
Circaea alpina	FAC	1	20	20
Delphinium glaucum	FACW	1	5	5
Drosera rotundifolia	OBL	1	2	2
Eleocharis acicularis	OBL	1	5	5
Eleocharis palustris	OBL	1	30	30
Epilobium hornemannii	FACW-	1	15	15
Galium triflorum	FACU	1	10	10
Hackelia micrantha	NI	1	5	5
Heracleum maximum	FAC+	1	20	20
Juncus balticus	OBL	1	3	3
Juncus drummondii	FACW-	1	15	15
Juncus sp.		1	30	30
Lotus oblongifolius	OBL	1	5	5
Luetkea pectinata	FACU-	1	5	5
Lupinus lepidus	NOL	1	25	25
Mimulus lewisii	FACW+	1	15	15
Mimulus moschatus	FACW+	1	20	20
Phleum alpinum	FAC+	1	3	3
Polemonium californicum	NOL	1	10	10
Polygonum amphibium	OBL	1	5	5
Ranunculus occidentalis	FAC	1	17	17
Scirpus congdonii	FACW	1	5	5
Sphagnum sp.	OBL	1	15	15

Table C-2. Prevalent shrub species in visited wetland polygons of CRLA.

Plant Species	Wetland Indicator Status	# of wetlands where found	Mean % cover within stratum where found	Maximum percent cover within stratum
Alnus incana	FACW	21	74	100
Vaccinium uliginosum	FACW	21	50	100
Ribes lacustre	FAC+	10	32	100
Salix commutata	OBL	10	50	100
Vaccinium scoparium	FACU-	10	77	100
Kalmia microphylla	OBL	9	35	95
Salix sitchensis	FACW	9	32	95
Salix boothii	FACW+	8	48	100
Spiraea splendens	NOL	6	21	85
Alnus viridis	FACW	5	77	89
Salix lucida	FACW+	4	21	40
Sambucus racemosa	FACU	4	12	30
Spiraea douglasii	FACW	4	39	99
Vaccinium membranaceum	FACU	4	41	99
Phyllodoce empetriformis	FACU	3	100	100
Salix sp.		3	22	45
Holodiscus discolor	NI	1	1	1
Lonicera caerulea	FAC	1	2	2
Sorbus scopulina	FACU	1	1	1

Table C-3. Prevalent tree species in visited wetland polygons of CRLA.

Plant Species	Wetland Indicator Status	# of wetlands where found	Mean % cover within stratum where found	Maximum percent cover within stratum
Abies lasiocarpa	FACU	53	41	100
Tsuga mertensiana	FACU	44	28	100
Pinus contorta	FACU	37	40	98
Picea engelmannii	FAC	18	44	97
Abies x shastensis	NOL	9	34	85
Pinus monticola	FACU	6	12	32
Tsuga heterophylla	FACU+	4	7	10
Abies amabilis	FACU	3	9	15
Populus tremuloides	FAC+	3	33	60
Abies concolor	NI	2	38	45
Pseudotsuga menziesii	FACU	2	28	30
Abies grandis	FACU-	1		
Populus balsamifera	FAC	1	45	45

Table C-4. Prevalent plant species within 100 m^2 plots among all CRLA wetlands visited in 2006.

Dominant Species	Plots Where Dominant	Plots Where Found	Maximum % cover within stratum	Mean % cover within stratum where found	Sum of Cover, All Plots
Carex aquatilis	12	28	98	40	1206
Alnus incana	8	12	97	30	659
Calamagrostis canadensis	7	41	85	18	729
Senecio triangularis	7	64	80	12	751
Vaccinium uliginosum	5	17	90	23	437
Alnus viridis	4	6	100	43	342
Carex lenticularis	4	33	75	10	332
Philonotis fontana	4	21	58	22	463
Scirpus microcarpus	4	12	85	28	334
Salix commutata	3	6	94	36	327
Arnica longifolia	2	2	87	81	162
Carex luzulina	2	39	32	5	212
Carex nigricans	2	5	85	30	152
Carex scopulorum	2	13	87	18	232
Carex subfusca	2	15	42	5	74
Glyceria elata	2	33	70	15	484
Mimulus primuloides	2	30	60	10	298
Nuphar lutea	2	2	60	58	116
Abies lasiocarpa	1	34	65	3	159
llium validum	1	4	70	18	70
Caltha leptosepala	1	10	40	24	238
Carex angustata	1	2	40	22	43
Carex echinata	1	14	65	10	139
Carex jonesii	1	5	30	15	74
Carex leporinella	1	4	66	21	84
Carex limosa	1	1	70	70	70
Carex utriculata	1	8	80	23	180
Cinna latifolia	1	21	45	6	121
Eleocharis palustris	1	3	70	26	77
Eleocharis quinqueflora	1	19	75	8	144
Elymus glaucus	1	25	35	3	70
Equisetum arvense	1	42	33	3	106
Heracleum maximum	1	10	23	5	47
Kalmia microphylla	1	9	22	3	27
Lotus oblongifolius	1	9	36	8	74
Lupinus latifolius	1	15	45	15	219
Picea engelmannii	1	15	35	4	119
Pinus contorta	1	22	55	4	164
Polygonum bistortoides	1	52	38	2	113
Polytrichum commune	1	4	98	34	134
Populus tremuloides	1	1	70	27	82
Potentilla flabellifolia	1	6	41	18	110
Salix boothii	1	7	80	17	135
Vaccinium membranaceum	1	8	35	5	38

Appendix D. Vegetation Metrics

Table D-1. Vegetation metrics for entire wetland (including plots), by wetland.

PolyID	# of Plots	HGM Class	Wet Score	# of Species	# of Families	# of Non-Natives	Emergent % Cover, max	Shrub % Cover, max	Tree % Cover, max	% Annuals	% Perennial Graminoids	Frequency Index, Polygon	Frequency Index, Plots
K1	1	S	2.85	36	20	0	3	35	0	3%	14%	21.87	17.74
K2	1	S	3.16	26	14	1	32	0	70	8%	12%	24.22	21.43
K3	2	S	3.49	41	21	0	70	65	0	2%	15%	13.77	13.38
K4	1	D	2.57	55	21	0	30	99	35	7%	31%	27.54	22.02
K6	1	S	2.90	50	28	0	15	0	20	4%	12%	25.40	20.36
K7	1	S	3.25	51	25	1	20	100	30	8%	18%	14.35	11.94
K9	1	R	2.64	55	27	0	25	100	60	5%	18%	24.93	20.05
K10	1	S	2.76	22	12	0	50	100	100	0%	36%	18.30	13.18
K11	2	S	2.42	38	19	0	80	45	88	8%	13%	29.00	23.58
K13	2	D	1.79	29	17	0	30	0	0	10%	28%	23.44	21.38
K15	1	D	3.67	4	3	0	64	100	0	0%	50%	21.75	15.50
K17	1	S	2.70	56	22	0	20	90	5	5%	14%	26.26	20.86
K18	1	S	2.56	30	20	0	80	85	40	7%	7%	34.78	27.97
K19	1	S	2.87	33	20	0	20	89	85	6%	15%	21.94	18.82
K20	1	D	2.34	55	21	0	40	60	35	5%	33%	25.76	20.93
K21	2	S	2.81	55	27	0	10	20	10	4%	15%	21.84	18.86
K22	1	D	2.61	21	16	0	15	100	40	10%	5%	33.92	28.08
K25	1	S	2.12	35	18	0	10	85	5	6%	23%	30.57	25.24
K26	1	R	3.25	24	13	0	30	100	97	0%	38%	17.38	15.35
K28	3	S	3.07	78	32	0	30	70	50	12%	15%	19.54	15.61
K29	1	S	2.62	53	24	0	40	78	25	6%	21%	27.18	21.88
K30	1	S	2.86	58	26	0	35	99	35	12%	24%	21.18	18.20
K31	1	D	2.80	13	7	0	58	0	0	0%	31%	28.57	18.93
K33	1	S	2.56	55	24	0	40	80	40	4%	20%	23.59	19.56
K34	2	D	2.58	50	21	1	7	98	75	6%	22%	25.28	20.63
K35	1	R	2.26	40	21	0	30	99	50	5%	20%	29.24	23.76
K37	1	S	2.55	60	24	0	7	60	40	3%	18%	25.70	20.98
K38	1	R	2.80	50	25	0	30	80	50	6%	12%	25.43	19.49
K39	1	S	2.45	50	23	0	25	45	45	8%	28%	26.37	21.50

PolyID	# of Plots	HGM Class	Wet Score	# of Species	# of Families	# of Non-Natives	Emergent % Cover, max	Shrub % Cover, max	Tree % Cover, max	% Annuals	% Perennial Graminoids	Frequency Index, Polygon	Frequency Index, Plots
K41	2	S	2.45	68	27	1	10	92	70	7%	31%	25.07	20.25
K42	1	S	2.75	41	22	0	10	90	40	5%	10%	25.28	22.12
K43	1	D	3.00	13	6	0	45	100	82	0%	62%	17.29	10.36
K44	1	S	2.18	35	16	0	70	0	40	6%	34%	33.03	26.92
K45	1	S	2.51	44	22	0	50	40	20	7%	20%	28.19	22.96
K46	3	S	2.66	63	25	0	20	70	30	6%	22%	22.57	18.27
K48	1	R	2.51	40	18	0	60	0	50	8%	35%	26.81	22.52
K49	2	S	2.75	62	28	1	30	95	30	11%	10%	23.27	19.43
K50	1	R	2.68	53	27	0	30	95	20	9%	9%	27.77	21.79
K51	1	S	2.28	59	22	0	20	60	50	5%	24%	27.15	22.08
K52	1	D	2.41	43	18	0	40	89	30	5%	26%	27.74	21.85
K53	1	R	2.66	52	25	0	30	99	44	4%	21%	24.98	20.19
K55	1	R	2.42	45	21	0	20	95	20	13%	27%	26.56	22.11
K57	1	D	2.21	36	18	0	25	50	35	8%	22%	29.75	23.75
K58	1	S	2.82	35	20	0	30	75	0	9%	11%	19.03	16.81
K60	1	R	2.27	46	21	0	40	100	65	11%	24%	30.35	24.33
K61	2	D	1.50	20	14	0	30	0	0	5%	40%	10.29	9.47
K68	1	S	2.42	51	25	1	30	85	50	10%	25%	25.78	21.88
K71	2	S	2.37	61	26	0	30	50	25	3%	20%	25.76	20.85
K75	1	S	2.66	41	16	0	35	0	40	7%	27%	26.52	22.12
K76	1	R	2.36	39	19	0	20	100	65	8%	23%	31.20	25.40
K77	1	D	4.33	3	2	0	100	0	95	0%	0%	33.33	16.67
K80	1	D	2.52	51	22	2	30	100	35	10%	22%	24.06	20.02
K81	1	S	2.57	27	17	0	25	100	50	4%	26%	25.13	17.77
K83	2	R	2.77	45	26	4	10	99	25	9%	16%	15.42	14.49
K84	1	S	2.52	31	19	0	40	100	55	10%	35%	32.25	25.75
K85	2	S	2.57	58	26	1	30	55	60	3%	19%	25.25	19.62
NR054	1	S	2.88	45	21	0	30	40	80	0%	16%	21.15	16.65
NR062	1	S	2.49	48	20	1	25	45	40	0%	27%	24.84	18.96
NR065	3	D	1.96	48	20	0	65	95	8	8%	33%	23.50	20.84
NR073	1	S	2.37	31	17	0	45	0	35	13%	13%	32.89	27.92
NR079	1	D	2.52	25	14	0	30	99	30	12%	24%	20.04	21.11
NR120	2	D	2.58	41	21	1	30	0	63	12%	22%	25.33	20.73
NR126	3	D	3.14	64	24	2	35	99	30	8%	17%	15.16	13.05

PolyID	# of Plots	HGM Class	Wet Score	# of Species	# of Families	# of Non-Natives	Emergent % Cover, max	Shrub % Cover, max	Tree % Cover, max	% Annuals	% Perennial Graminoids	Frequency Index, Polygon	Frequency Index, Plots
NR128	3	D	2.44	83	32	0	50	55	45	5%	20%	21.83	17.42
NR129	1	D	2.53	33	16	0	30	0	60	3%	39%	28.60	22.54
NR146	1	R	2.78	53	20	0	30	50	30	11%	28%	25.97	19.48
NR147	2	R	2.45	34	17	0	25	100	5	6%	15%	21.87	18.63
NR161	1	S	2.47	59	22	0	15	95	45	7%	25%	25.80	20.97
NR164	1	R	2.59	30	12	0	20	100	80	7%	27%	26.00	22.09
NR174	1	S	2.75	62	27	0	55	95	0	6%	27%	16.74	14.37
NR187	2	S	3.23	67	26	3	5	100	0	4%	19%	18.17	14.37
NR188	1	R	2.10	24	13	0	20	99	40	8%	29%	31.31	26.76
NR233	1	D	2.60	8	7	0	45	85	0	0%	25%	27.89	22.11
NR241	1	R	2.46	40	19	0	40	0	50	8%	33%	28.93	24.73
NR244	1	S	2.60	17	11	0	50	100	100	0%	24%	19.50	14.00
NRC	2	S	3.05	40	21	2	80	86	0	8%	18%	17.16	14.30

Table D-2. Vegetation metrics for 100 m^2 plots only, by wetland.

Legend:
For site locations see Table 1, or supporting digital spatial data. See section 3.3.2 for definitions of plant metrics in this table.

Wetland	Plot	Plot Dimen-sions	Date	# of Species	# of Families	Prevalence Index	Mean Species Frequency (among wetlands)	Mean Species Frequency (among all plots)	# of Non-natives	# of Annuals	Percent Cover Maximum (any species)
K1	1	10x10	7/1/2006	30	20	2.20	23.16	18.81	0	1	85
K2	1	10x10	7/13/2006	18	13	2.31	25.57	19.48	1	1	30
K3	1	10x10	8/8/2006	9	9	2.44	9.09	8.45	0	0	87
K3	2	10x10	8/8/2006	6	6	2.25	8.17	6.50	0	0	55
K4	1	10x10	8/11/2006	35	15	2.11	33.30	27.70	0	3	85
K6	1	10x10	7/12/2006	38	22	2.74	24.34	19.10	0	1	45
K7	1	10x10	7/24/2006	33	20	2.21	16.76	14.09	1	1	60
K9	1	5x20	7/24/2006	41	24	1.93	25.55	21.93	0	3	60
K10	1	10x10	8/21/2006	16	12	2.38	19.76	14.00	0	0	41
K11	1	10x10	7/25/2006	13	11	1.38	33.93	32.43	0	2	85
K11	2	10x10	7/25/2006	11	8	1.26	32.17	30.17	0	1	98

Wetland	Plot	Plot Dimen-sions	Date	# of Species	# of Families	Prevalence Index	Mean Species Frequency (among wetlands)	Mean Species Frequency (among all plots)	# of Non-natives	# of Annuals	Percent Cover Maximum (any species)
K13	1	10x10	8/1/2006	19	11	1.47	31.38	29.05	0	3	75
K13	2	10x10	8/1/2006	7	6	0.99	2.38	2.88	0	0	60
K15	1	10x10	8/23/2006	3	2	4.11*	19.00	17.33	0	0	16
K17	1	10x10	7/5/2006	42	20	1.77	28.70	22.75	0	3	40
K18	1	10x10	7/13/2006	13	12	1.30	35.27	33.27	0	2	90
K19	1	10x10	8/14/2006	11	11	2.20	17.62	16.77	0	0	98
K20	1	10x10	8/15/2006	24	15	2.42*	25.15	23.15	0	2	65
K21	1	5x20	6/30/2006	21	16	1.88	29.56	25.52	0	2	54
K21	2	10x10	6/30/2006	28	17	2.85	23.48	19.29	0	0	35
K22	1	10x10	7/7/2006	19	16	1.45	35.09	28.86	0	2	26
K25	1	10x10	7/24/2006	19	13	1.54	30.10	27.19	0	2	43
K26	1	10x10	8/21/2006	15	9	1.99	20.18	15.24	0	0	43
K28	1	10x10	8/9/2006	29	15	2.35	23.57	20.43	0	4	80
K28	2	10x10	8/9/2006	18	15	2.09	23.44	20.06	0	1	100
K28	3	10x10	8/24/2006	44	24	2.07	21.24	16.78	0	7	70
K29	1	10x10	8/1/2006	40	21	1.90	28.89	23.70	0	2	42
K30	1	10x10	8/8/2006	21	15	1.90	28.17	24.74	0	1	65
K31	1	10x10	8/23/2006	2	1	0.14	30.33	33.33	0	0	66
K33	1	10x10	8/23/2006	31	17	1.53	29.52	24.88	0	1	60
K34	1	10x10	7/31/2006	18	13	2.06	27.16	22.53	0	0	80
K34	2	10x10	7/31/2006	25	17	1.52	27.88	24.65	0	2	65
K35	1	10x10	8/31/2006	30	17	1.31	28.77	25.03	0	2	60
K37	1	10x10	7/10/2006	42	23	1.79	28.00	23.05	0	2	32
K38	1	10x10	7/7/2006	39	23	2.27	25.83	20.51	0	3	12
K39	1	10x10	8/31/2006	24	13	2.83	30.12	26.68	0	3	35
K41	1	10x10	8/9/2006	28	19	2.51	29.47	25.77	0	5	40
K41	2	10x10	8/9/2006	21	13	1.89	28.92	25.44	0	2	97
K42	1	10x10	7/6/2006	19	14	2.08	29.65	24.43	0	1	55
K43	1	10x10	9/7/2006	5	2	2.19*	12.80	13.00	0	0	40
K44	1	10x10	7/26/2006	19	12	2.58	31.10	28.65	0	2	75
K45	1	10x10	8/2/2006	27	18	1.52	29.48	26.76	0	3	75
K46	1	10x10	8/10/2006	25	14	1.61	30.10	26.45	0	1	62
K46	2	10x10	8/10/2006	17	12	3.62	26.50	20.65	0	0	65

Wetland	Plot	Plot Dimen-sions	Date	# of Species	# of Families	Prevalence Index	Mean Species Frequency (among wetlands)	Mean Species Frequency (among all plots)	# of Non-natives	# of Annuals	Percent Cover Maximum (any species)
K46	3	10x10	8/10/2006	25	14	1.89	27.31	22.23	0	0	55
K48	1	10x10	9/7/2006	31	17	2.08	29.24	25.27	0	2	68
K49	1	10x10	7/11/2006	35	21	2.17	26.41	22.76	0	0	38
K49	2	10x10	7/11/2006	32	17	1.93	25.19	21.78	1	5	75
K50	1	5x20	7/12/2006	36	23	2.12	27.45	23.63	0	4	20
K51	1	10x10	8/17/2006	31	16	1.46	31.66	27.44	0	2	32
K52	1	10x10	8/15/2006	32	17	2.17	30.32	24.74	0	2	22
K53	1	5x20	8/1/2006	47	24	2.36	26.29	21.02	0	2	40
K55	1	10x10	8/22/2006	29	14	2.25	31.38	27.76	0	4	60
K57	1	10x10	8/29/2006	22	16	1.21	32.41	28.45	0	2	89
K58	1	10x10	8/21/2006	27	18	2.65	22.10	20.17	0	3	23
K60	1	5x20	8/22/2006	26	16	2.30	29.92	25.42	0	1	40
K61	1	10x10	8/28/2006	8	7	1.73	2.25	3.13	0	0	56
K61	2	10x10	8/28/2006	8	5	2.21*	4.38	5.25	0	0	70
K68	1	10x10	9/5/2006	31	15	1.43	29.09	25.59	0	4	40
K71	1	10x10	8/28/2006	34	18	1.29	28.11	22.97	0	1	53
K71	2	10x10	8/28/2006	28	17	1.87	33.31	27.52	0	2	80
K75	1	10x10	8/29/2006	22	11	1.99	27.70	25.48	0	1	62
K76	1	5x20	8/24/2006	34	19	1.69	34.25	27.33	0	3	56
K77	1	10x10	8/30/2006	3	2	5.00*	33.33	16.67	0	0	98
K80	1	10x10	8/29/2006	31	15	2.00	27.06	22.88	0	4	71
K81	1	10x10	8/30/2006	16	12	1.68*	26.28	22.22	0	1	17
K83	1	10x10	8/24/2006	23	17	1.89	21.26	19.56	0	3	93
K83	2	10x10	8/24/2006	17	12	2.86*	12.21	10.26	1	1	36
K84	1	10x10	9/5/2006	18	13	2.88*	26.89	23.94	0	2	85
K85	1	5x20	9/6/2006	25	18	2.24	30.59	26.04	1	1	40
K85	2	10x10	9/6/2006	17	13	1.50	29.18	25.35	0	0	70
NR054	1	10x10	8/14/2006	25	13	2.66	20.26	16.11	0	0	35
NR062	1	10x10	8/8/2006	23	17	2.25	26.38	21.63	0	0	87
NR065	1	10x10	8/1/2006	22	14	1.12	32.21	28.25	0	1	94
NR065	2	10x10	8/1/2006	16	10	1.83	25.29	24.12	0	1	75
NR065	3	5x20	8/1/2006	2	2	1.55	16.33	15.67	0	0	90
NR073	1	10x10	7/25/2006	20	12	1.18	32.25	29.75	0	1	65

Wetland	Plot	Plot Dimen-sions	Date	# of Species	# of Families	Prevalence Index	Mean Species Frequency (among wetlands)	Mean Species Frequency (among all plots)	# of Non-natives	# of Annuals	Percent Cover Maximum (any species)
NR079	1	10x10	8/17/2006	6	3	1.36	11.50	10.00	0	0	78
NR120	1	10x10	7/27/2006	23	16	2.08	29.44	25.32	0	4	50
NR120	2	10x10	7/27/2006	22	14	3.04	28.79	23.50	0	2	55
NR126	1	10x10	7/17/2006	25	15	2.51	22.65	20.08	1	1	42
NR126	2	10x10	7/17/2006	24	15	2.55	15.72	13.44	0	0	45
NR126	3	10x10	7/26/2006	32	14	2.63	15.79	13.29	2	3	70
NR128	1	10x10	8/1/2006	22	15	1.85	33.52	28.13	0	0	65
NR128	2	10x10	8/2/2006	15	9	1.06	17.17	16.61	0	3	70
NR128	3	5x20	8/2/2006	21	14	1.27	25.64	23.55	0	1	80
NR129	1	10x10	9/11/2006	28	14	1.84	31.17	25.00	1	0	38
NR146	1	10x10	8/11/2006	30	13	2.37	28.71	24.03	1	4	30
NR147	1	10x10	6/29/2006	24	16	1.95	25.37	22.33	0	2	33
NR147	2	10x10	6/29/2006	16	9	2.29	21.61	17.28	0	0	88
NR161	1	10x10	8/16/2006	37	17	2.85*	29.18	24.92	0	4	58
NR164	1	10x10	9/11/2006	22	10	1.90	24.73	21.81	0	1	80
NR174	1	5x20	7/26/2006	51	26	2.33	18.32	15.21	0	3	80
NR187	1	10x10	7/25/2006	43	19	1.85	19.39	14.96	1	2	32
NR187	2	10x10	7/25/2006	29	19	2.61	19.81	17.58	0	0	85
NR188	1	10x10	9/14/2006	24	13	1.10	31.31	26.76	0	2	94
NR233	1	10x10	7/20/2006	2	1	1.20	22.00	18.50	0	0	27
NR241	1	10x10	9/6/2006	37	17	2.24	28.49	25.11	0	3	65
NR244	1	5x20	8/30/2006	16	10	2.38	17.47	13.41	0	0	85
NRC	1	10x10	9/13/2006	18	16	2.20	19.33	14.62	0	0	78
NRC	2	10x10	9/13/2006	17	14	2.10	20.18	14.41	0	1	75

* Conditions were probably wetter than suggested by this high prevalence index value because more than 25% of the cover in this plot was comprised of species whose wetland indicator status is unknown

Appendix E. Comparison of Species Found Independently by Three Investigators in the “Sphagnum Bog” Wetland Complex

1= found, 0= not found

Scientific Name	Seyer 1979	BioBlitz 2006	This study (2006) *			
			NR65	NR128	K2	K18
Abies lasiocarpa	1	0	1	1	1	1
Abies X shastensis	1	0	0	0	0	0
Achillea millefolium	0	0	0	1	0	0
Aconitum columbianum	1	1	1	1	1	1
Agrostis exarata	0	1	0	0	0	0
Agrostis idahoensis	1	1	1	0	0	0
Agrostis thurberiana	1	1	0	1	0	0
Alnus incana	1	1	0	1	0	1
Arnica mollis	1	1	1	0	0	0
Aster foliaceus	0	1	1	1	0	0
Aster occidentalis	1	1	0	1	0	0
Bidens cernua	1	0	0	0	0	0
Botrychium multifidum	1	1	0	1	0	0
Calamagrostis canadensis	0	1	1	1	0	0
Calochortus elegans	0	0	0	0	1	0
Caltha leptosepala	1	1	1	1	0	1
Camassia leichtlinii	1	0	0	1	0	0
Canadanthus modestus	0	1	0	1	0	0
Cardamine pensylvanica	1	0	0	0	0	0
Carex angustata	0	1	0	0	0	0
Carex aquatilis	1	1	1	1	0	1
Carex athrostachya	0	1	0	0	0	0
Carex buxbaumii	0	1	0	0	0	0
Carex canescens	0	1	0	0	0	0
Carex cusickii	1	1	0	0	0	0
Carex diandra	0	0	1	0	0	0
Carex disperma	1	1	1	1	0	0
Carex echinata	0	1	1	1	0	0
Carex jonesii	1	1	0	0	0	0
Carex lenticularis	1	0	0	0	0	0
Carex limosa	1	1	0	1	0	0
Carex luzulina	0	1	1	0	0	0
Carex microptera	0	1	0	0	1	0
Carex neurophora	0	1	1	0	0	0
Carex simulata	1	1	0	0	0	0
Carex straminiformis	0	0	0	0	1	0
Carex subfusca	0	0	0	0	0	1
Carex utriculata	1	1	1	1	0	0
Castilleja miniata	1	1	0	1	0	0
Cinna latifolia	0	0	0	1	0	0
Clintonia uniflora	1	1	0	1	0	0
Comarum palustre	0	1	0	0	0	0
Cornus unalaschkensis	0	1	0	0	0	0

Scientific Name	Seyer 1979	BioBlitz 2006	This study (2006) *			
			NR65	NR128	K2	K18
Danthonia intermedia	0	0	0	1	0	0
Deschampsia caespitosa	1	1	1	1	0	0
Dodecatheon alpinum	1	1	1	1	0	1
Drosera anglica	1	1	1	1	0	0
Drosera rotundifolia	1	1	1	1	0	0
Eleocharis quinqueflora	1	1	1	1	0	0
Elymus glaucus	0	1	0	1	0	0
Epilobium angustifolium	1	1	0	1	0	0
Epilobium ciliatum	1	1	1	1	0	1
Epilobium minutum	0	0	0	1	0	0
Epilobium oregonense	1	1	1	1	0	0
Epilobium palustre	1	1	0	1	0	0
Equisetum arvense	1	1	1	1	0	1
Eriophorum gracile	1	1	1	1	0	0
Festuca subulata	0	0	0	1	0	0
Fragaria virginiana	0	1	0	1	0	0
Galium trifidum	1	1	0	1	0	0
Galium triflorum	1	0	0	1	0	0
Gaultheria humifusa	1	1	0	0	0	0
Gaultheria ovatifolia	0	1	0	0	0	0
Gentianopsis simplex	1	0	0	0	0	0
Glyceria borealis	1	0	0	0	0	0
Glyceria elata	1	1	1	1	0	0
Hippuris vulgaris	1	0	0	0	0	0
Hypericum anagalloides	1	1	1	1	0	1
Juncus effusus	0	0	0	1	0	0
Juncus ensifolius	1	1	1	0	0	0
Juncus howellii	0	1	1	1	0	1
Juncus orthophyllus	1	1	0	0	0	0
Kalmia microphylla	1	1	1	1	0	0
Ligusticum grayi	1	1	0	1	1	0
Linnaea borealis	1	1	0	0	0	0
Lonicera caerulea	1	1	0	0	0	0
Lonicera involucrata	1	0	0	0	0	0
Luzula multiflora	0	1	1	0	1	0
Luzula parviflora	0	1	0	0	0	0
Madia bolanderi	1	1	1	0	0	0
Melica subulata	0	1	0	0	0	0
Menyanthes trifoliata	1	0	0	1	0	0
Mimulus guttatus	1	1	1	1	0	0
Mimulus moschatus	1	1	0	0	0	0
Mimulus primuloides	1	1	1	1	1	1
Mitella pentandra	1	1	1	1	0	1
Montia chamissoi	1	1	1	0	0	0
Muhlenbergia filiformis	1	1	1	1	1	1
Nuphar lutea	1	0	0	0	0	0
Orthilia secunda	0	1	0	0	0	0
Oxypolis occidentalis	1	1	0	1	0	0
Pedicularis groenlandica	1	1	0	1	0	1
Penstemon rydbergii	0	0	0	0	1	0

Scientific Name	Seyer 1979	BioBlitz 2006	This study (2006) * NR65	NR128	K2	K18
Phleum alpinum	0	0	0	0	1	0
Phlox diffusa	0	0	0	0	1	0
Phlox gracilis	0	0	0	0	1	0
Picea engelmannii	1	1	0	1	0	1
Pinus contorta	1	1	0	1	1	1
Pinus monticola	0	1	0	1	0	0
Platanthera leucostachys	1	0	1	1	0	1
Platanthera stricta	1	1	1	1	0	1
Pleuropogon refractus	0	1	0	0	0	0
Polygonum bistortoides	1	1	1	1	1	1
Potamogeton gramineus	1	0	0	0	0	0
Potamogeton pusillus	1	0	0	0	0	0
Potentilla drummondii	1	0	0	1	0	0
Prunella vulgaris	0	0	0	1	0	0
Pyrola asarifolia	1	1	1	0	0	0
Pyrola minor	1	0	0	0	0	0
Ranunculus gormanii	1	0	1	0	1	1
Ranunculus occidentalis	0	0	0	0	1	0
Ribes lacustre	1	1	0	1	0	0
Rubus lasiococcus	1	1	0	0	0	1
Rudbeckia occidentalis	0	1	0	1	1	0
Salix boothii	1	1	1	1	0	0
Salix commutata	1	0	1	0	0	0
Salix sitchensis	0	0	0	1	0	0
Scirpus congdonii	1	1	0	1	0	0
Scirpus microcarpus	0	0	1	0	0	0
Senecio triangularis	1	1	1	1	1	1
Sisyrinchium idahoense	0	1	0	0	0	0
Sorbus sitchensis	1	0	0	0	0	0
Sparganium natans	1	0	0	0	0	0
Sphenosciadium capitellatum	1	0	0	0	0	0
Spiraea douglasii	1	1	0	0	0	0
Spiraea splendens	1	1	0	1	0	0
Spiranthes romanzoffiana	1	1	0	1	0	0
Stachys rigida	1	1	0	1	1	0
Stellaria calycantha	1	0	0	0	0	0
Stellaria longifolia	1	0	0	1	0	0
Streptopus lanceolatus	1	0	0	1	0	1
Taraxacum officinale	0	0	0	0	1	0
Tiarella trifoliata	0	1	0	0	0	0
Tofieldia glutinosa	1	1	0	1	0	0
Torreyochloa erecta	0	0	0	1	0	0
Torreyochloa pallida	1	1	0	0	0	0
Trisetum canescens	0	1	0	0	0	0
Tsuga mertensiana	0	1	0	1	1	1
Utricularia intermedia	1	1	1	1	0	0
Utricularia minor	1	0	0	0	0	0
Vaccinium cespitosum	0	1	0	0	0	0
Vaccinium scoparium	1	1	0	0	0	1
Vaccinium uliginosum	1	1	1	1	0	1

Scientific Name	Seyer 1979	BioBlitz 2006	This study (2006) *			
			NR65	NR128	K2	K18
Vahlodea atropurpurea	1	0	0	0	0	0
Vancouveria hexandra	0	1	0	1	0	0
Veratrum californicum	0	1	0	0	0	0
Veratrum viride	0	1	0	1	1	1
Veronica americana	1	1	1	1	0	0
Veronica serpyllifolia	1	0	0	0	1	0
Veronica wormskjoldii	1	1	0	1	0	0
Vicia americana	1	1	0	1	1	0
Viola adunca	1	1	0	0	1	0
Viola glabella	1	0	0	1	0	0
Viola macloskeyi	1	0	0	1	0	1

* NR65 is closest to Bioblitz “Fen 16.” NR128 is closest to Bioblitz “Fen 9.” K2 is closest to Bioblitz “Fen 12.”

Appendix F. Field Data Sheets

Form C. Collective Assessment Data Form
Wetland Assessment - Crater Lake National Park 2006
file= Stressors. Red #'s refer to variable descriptions in the Data Dictionary that accompanies this report

Point Code:__1,2___ Wetland Polygon Code: ___3____ Polygon Name: _______________4_____
Date: _________5___ Time Begin: ____6_____ a.m. p.m.

1. Signs of Human Presence:

Indicate: 1= minor 2= extensive	On-site recent	On-site old	Off-site recent	Off-site old	Closest Distance & Direction to Centerpoint
Bridge/ culvert	7				26
Building	8				27
Cairn/ tailings	9				28
Dig	10				29
Ditch	11				30
Fence	12				31
Fill	13				32
Fire ring	14				33
Firefighting paraphernalia	15				34
Fish hooks/ line	16				35
Flagging. other markers	17				36
Footprints/ trail	18				37
Grazing: browsed veg	19				38
Grazing: cattle present	20				39
Grazing: gullies, headcuts	21				40
Plantings	22				41
Saw/ axe mark	23				42
Tiremark/ compaction*	24				43
Trash	25				44

* increase in soil bulk density of >15% or macropore reduction of >50%

2. Major Natural Disturbances:

Indicate: 1= minor 2= extensive	On-site recent	On-site old	Off-site recent	Off-site old
Insect/ disease damage to veg	45			
Rockfall	46			
Landslide/ sedimentation	47			
Avalanche damage	48			
Fire	49			
Flooding, beaver-related	50			
Flooding, storm events	51			
Wind damage	52			
Other: __________________	53			

3. Signs of possible damage. If uncertain, photograph these for later diagnosis.

54_Unnaturally incised or headcut channel
55_Hydrophytes with blotched/discolored foliage
56_Sediment or oil coatings on foliage
57_Severe growths of aquatic algae
58_Unnatural water color or odor (H_2S)
59 Very high water marks despite small contributing area
60 Extensive mud, suggesting recent sudden drawdown
61 Extensive blowdown/ windthrow of trees
62 Non-rocky soils very difficult to penetrate
63 Soils with reddish upper horizons due to hot burn

4. Review the file of polygon characteristics derived from existing spatial data layers.
Do your observations contradict anything reported? Explain: ____________________________
____
____
____

5. Review the 1988 natural-color airphoto. Do your observations contradict anything apparent? In particular:
percent-expansion of conifers into the wetland: ______%
percent-expansion of all woody vegetation into the wetland: ______%
evidence of human disturbance not currently present? ____________________________
other (explain): ____

6. What else distinguishes this wetland from others you've seen so far in this Park?
____
____

7. Condition. Relative to other Lassen wetlands, how would you rate its overall ecological integrity?
(*just a gut feeling – this will not supercede future results from models and data analysis*) **64**

1	**2**	**3**	**4**	**5**
less-functional		→		more functional

8. Incidental Observations or Signs

Indicate Type of Detection

x= observed	L= claw
A= auditory	N= nest
B= burrow/ tree cavity	S= scat
C= carcass, kill	T= track
D= den, lodge, dam	

65 Deer	74 **Frog**	83 Duck (note if **Bufflehead**)
66 Bear	75 Newt, Rough-skinned	84 Heron/ Bittern
67 Beaver	76 Salamander, Long-toed	85 Sandpiper/ Dipper
68 Coyote/ dog	77 Snake	86 Kingfisher
69 Otter	78 Lizard	87 **Eagle, Bald**
70 Bat	79 Toad, Western	88 Hawk
71 Raccoon	80 Fish	89 **Flycatcher, Willow**
72 Rabbit	81 Ant hill	**90** Dragonfly
73 Muskrat	82 Gopher Mound	**91** Butterfly

List other identifiable animal species & type of detection:

Time End: __________________________**92**_________________

Form F. Physical Features Data Form
Wetland Assessment - Crater Lake National Park 2006
file= PhysChar. Red #'s refer to variable descriptions in the Data Dictionary file that accompanies this report.

Point Code:__1_& 2_ Wetland Polygon Code: ____3___ Polygon Name: _______4_____________
Date: ______5______ Time Begin: _____6____ a.m. p.m. Quad Sheet: ______________________
Size (*from database*): ______acres Crew: ________7___________________

Point locations	Latitude	Longitude	Direction to CP	Distance to CP	Offset Direction from CP	Offset Distance from CP
Target Center Point	9	10			11	12
Actual Center Point (CP)	13	14				
Photo Point	15	16	17	18		
Benchmark. Tag #: ___8__	19	20	21	22		
Main Xsec	23	24	25	26		
Releve Plot 1	27	28	29	30		
Releve Plot 2	31	32	33	34		
Releve Plot 3	35	36	37	38		

Mark approximate locations of these on the sketch map and airphoto.

Detailed description of benchmark location (height, facing direction, type of tree, etc.):

____

1. Landscape Position (of most of the wetland polygon; multiple entries are allowed)
39__ midslope 40___toe slope 41 __lake fringe 42___floodplain 43___ interfluve 44___depression/flat

2. Hydrologic Connectivity: (check all that apply)
45__ No inlet, no outlet
46__ Outlet channel, flowing
47__ Outlet channel, currently no flow
48__ Inlet channel, flowing
49__ Inlet channel, currently no flow

Is this a *source wetland*? (i.e., outflow-only)50 ___ yes ___no
If yes, is the channel *head* (initiation point) an abrupt vertical break? 51 ___ yes ___no

3. Outlet Blockage
52__ none 53__ beaver-impounded _54__ slide-impounded _55__ natural debris impounded (log etc.)
56 __natural constriction _57 __artificial

4. Channel Patterns
58__ no channel 59 __% confined entrenched 60 __% confined meander _61__% braided 62 ___% diffuse

5. Stream Order (maximum, include only channels with permanent water): ___63______

6. Indicate height of **water marks** above today's wetted edge, if any found:

	in channel	outside channel
Type of indicator*	**64**	**65**
Maximum height above today's wetted edge	**66**	**67**

*Debris, Stain, Ice abrasion, Algae

7. Estimate the **maximum depth** of surface water (<6 ft deep) as it would exist:

	During wettest 2 weeks annually	During driest 2 weeks annually
Standing water	**68**	**69**
Flowing water	**70**	**71**

* do so by considering the basin or channel morphology, elevation, contributing area, and today's water depth

8. Percent of wetland polygon that is*:

Inundated continuously only for 2-4 weeks per year	_72_____%	___76____m^2
Inundated longer but not continuously year-round	_73_____%	___77____m^2
Inundated year-round without interruption	_74_____%	___78____m^2
Almost never, but soil is saturated for >2 weeks/yr	_75_____%	___79____m^2
	100 %	

* estimate area (m^2) of the zone only if it occupies <100 m^2

9. Are there defined channels that convey water **less often than once per year**? **80** ___ yes ____no

10. Springs/ Seeps (report whether thermal or non-thermal and describe evidence: temperature, conductivity, rust deposits, colored precipitates, dispersible oil sheen, "boils," shallow pools not supported by recent rain or snowmelt, etc.)
___________81_________________________________

11. Estimated Water Sources (late summer):

_82____% Subsurface Inflow (springs etc.)
_83____% Surface Inflow (channels, overland runoff)
_84____% Detained Direct Precipitation
100%

12. Overall Wetland Gradient (as percent of vegetated part of polygon):
no observable gradient: _85____% slight (1-5%):_86___% very obvious (>5%)_87____%

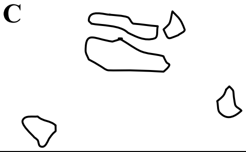
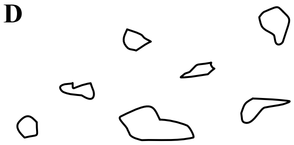
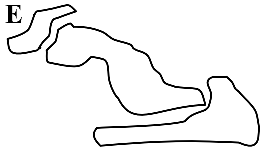
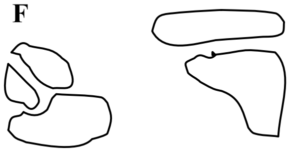
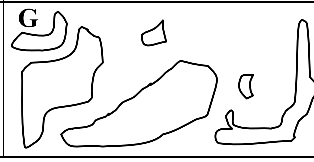
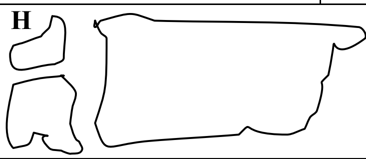
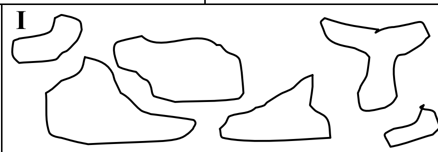
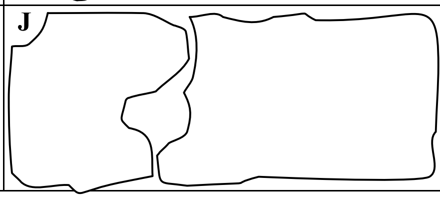
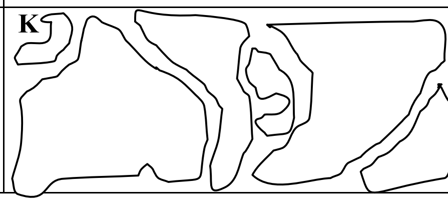
13. Predominant Aspect (circle one): **88** N NE E SE S SW W NW

14. Terrain Microtopography (excluding logs and temporary objects) **89**

1	2	3	4	5
minimal	→			extensive

15. Percent that is shaded at mid-day:
__90______% of standing water _____91____% of flowing water

16. Standing Water Interspersion -- water with vegetation: **92**

Percent & distribution of pools			
	Pools are few & are mostly clumped together	Pools somewhat scattered, more common	Pools numerous, scattered evenly, & highly intermixed with vegetation
None **A**			
1-30% of polygon is pools	**B** 	**C** 	**D** 
30-60% of polygon is pools	**E** 	**F** 	**G** 
60-90% of polygon is pools	**H** 	**I** 	
>90% of polygon is pools	**J** 	**K** 	

17. Snags within wetland

Estimated number: #: 0= none; Rare= 1 to 10; Uncommon= 11-20; Abundant= >20

	barked	hard	soft
4-12”	**93**	**97**	
12-18”	**94**	**98**	
18-24”	**95**	**99**	
>24”	**96**	**100**	

minimum height = 10 ft.

dispersion: **1** concentrated **2** **3** → **4** **5** **101** dispersed

18. Downed Wood: size and decay class

Categorical # of pieces: 0= none; Rare= 1 to 10; Common = >10

	barked	hard	soft
4-8”	**102**	**106**	
9-14”	**103**	**107**	
15-30”	**104**	**108**	
>30”	**105**	**109**	

minimum length = 6 ft.

dispersion: **1** concentrated **2** **3** → **4** **5** **110** dispersed

19. Channel Dimensions. Locate the largest wadeable channel within the polygon. Measure 3 cross-sections, beginning at the widest point and 1 each at a distance upstream and downstream equal to 10 times this width.

	Distance from widest	Wetted Width (today)	Bankfull Width	Floodprone Width (estimated)	Water Depth (today)	Bank Height	Flood Height (estimated.)
Widest	----	111	112	113	114	115	116
Upstream	117	118	119	120	121	122	123
Downstream	124	125	126	127	128	129	130

20. Channel Bank Characteristics.
Percent of the polygon's channel network with channel banks that are:
(Each row must add to 100%. Combine both sides of the channel)

undercut:_131___% steep (>30% slope): 132_____% gradual: 133____%

bare rock: 134____% bare soil_135__% alder:_136___% other vegetated/ downed wood:_137___%
no distinct bank: _138__% benched 139_____% naturally leveed 140_____%

21. Specific Conductance and Temperature.

	Standing Water	Flowing Water
Specific Conductance (µS/cm)	141	142
Water Temperature (C)	143	144
Air Temperature (C)	145	146

Ending Time: ____147________________ a.m. p.m.

Form S. Soil Assessment Sheet
Wetland Assessment - Crater Lake National Park 2006
file= SoilsForm. Red #'s refer to variable description in the Data Dictionary that accompanies this report

Pit #1 Pit Type ___**5**
Location relative to benchmark: Direction: ___**6**__ᵒ Distance: _____**7**__
Distance to surface water if any: _______ Slope: ____________
Dominant Veg.(50-20 rule):_______**8**______________________________________
Texture & Indicators by depth:

	Color	Texture	Saturation	Indicators**
depth1: **9** - **10**	**11**	**12**	**13**	**14**
depth2: **15** - **16**	**17**	**18**	**19**	**20**
depth3: **21** -**22**	**23**	**24**	**25**	**26**
depth4: **27** -**28**	**29**	**30**	**31**	**32**

** **M**ottled, **G**leyed, **C**hroma 1-2, **O**rganic streaks in sandy soils, **S**ulfidic odor, **SW**= shrink-swell cracks
Also indicate any charred layer (**B**) or hardpan/ spodic horizon (**H**)

Pit #2 Pit Type ___**33**
Location relative to benchmark: Direction: ___**34**__ᵒ Distance: _____**35**__
Distance to surface water if any: _______ Slope: ____________
Dominant Veg.(50-20 rule):_______**36**______________________________________Location relative to benchmark: Direction: _____ᵒ Distance: _______
Distance to surface water if any: _______ Slope: ____________
Dominant Veg.50-20 rule:____________________
Texture & Indicators by depth:

	Color	Texture	Saturation	Indicators
depth1: **37** - **38**	**39**	**40**	**41**	**42**
depth2: **43** - **44**	**45**	**46**	**47**	**48**
depth3: **49** -**50**	**51**	**52**	**53**	**54**
depth4: **55** - **61**	**57**	**58**	**59**	**60**

Pit #3 Pit Type ___**61**
Location relative to benchmark: Direction: ___**62**__ Distance: _____**63**__
Distance to surface water if any: _______ Slope: ____________
Dominant Veg.(50-20 rule):_______**64**______________________________________
Location relative to benchmark: Direction: _____ᵒ Distance: _______
Distance to surface water if any: _______ Slope: ____________
Dominant Veg.50-20 rule:____________________
Texture & Indicators by depth:

	Color	Texture	Saturation	Indicators
depth1: **65** - **66**	**67**	**68**	**69**	**70**
depth2: **71** - **72**	**73**	**74**	**75**	**76**
depth3: **77** -**78**	**79**	**80**	**81**	**82**
depth4: **83** - **84**	**85**	**86**	**87**	**88**

Pit #4 Pit Type ___**89**

Location relative to benchmark: Direction: ___**90**__ Distance: _____**91**__

Distance to surface water if any: _______ Slope: ____________

Dominant Veg.(50-20 rule):_______**92**______________________________________

Location relative to benchmark: Direction: _____° Distance: _______

Distance to surface water if any: _______ Slope: ____________

Dominant Veg.50-20 rule:_____________________

Texture & Indicators by depth:

	Color	Texture	Saturation	Indicators
depth1: **93** - **94**	**95**	**96**	**97**	**98**
depth2: **99** - **100**	**101**	**102**	**103**	**104**
depth3: **105** -**106**	**107**	**108**	**109**	**110**
depth4: **111 - 112**	**113**	**114**	**115**	**116**

etc. for Pit #5, #6

Form B. Botanical Data Form

Red #'s refer to variable numbers in the Data Dictionary that accompanies this report; similar data with different variable #'s [1-94] were collected for the polygon as well)

Point Code:_**1&2**____ Wetland Polygon Code: __**5**_____ Polygon Name: _______**6**_______________
Date: _____**6**_______ Time Begin: _______**8**__ a.m. p.m. Releve Plot #: ___**3**________

PART A: Releve Plot Data

A1. Growth Form of Releve Plot *(check dominant one)* 4
Moss__**9**__ Herb (<0.5 m)__**10**__ Shrub (0.5-4m)__**11**__ Tree (>4m)__**12**__

A2. Plot Location and Dimensions
Length____**13.1**__ Width_**13.2**_____ Long axis bearing__**13.3**___ Short axis bearing___**13.4**_
UTM E_________**14.1**______UTM N________**14.2**_____ Accuracy __**14.3**__m Method: **14.4**
Direction to benchmark_____**15.1**___º Distance to benchmark ___**15.2**____m
Narrative of location: **15.3**

A3: Environmental Description
Slope: _____**16**__º Aspect _____**17**____ º Elevation _____**18**_____m
Topographic Position (*choose from list*): **19**
Landform (*choose from list*): **20**
Surficial Geology: (*choose from list*) **21**
Cowardin Classification: **22**
Hydrologic Modifier: (*choose from list*) **23**

A4. Percent of plot that (during most years) is:
Inundated continuously only for 2-4 weeks per year (short) ___**24**___%
Inundated longer but not continuously year-round ___**25**___%
Inundated year-round without interruption ___**26**___%
Almost never, but soil is saturated for >2 weeks/yr ___**27**___%
100 %

A5. Plot Cover & Dispersion
(*for each, indicate:* **A**: <1%, **B**: 1-5%, **C**: 5-25%, **D**: 25-50%, **E**: >50% as ground cover):
Herb_**28**__ Moss:_**29**__ Fern:_**30**__ Litter_**31**__ Wood:_**32**__ Rock:_**33**__ Other Bare:_**34**__
(*for each, indicate:* ***C**ontinuous, **S**parse/Scattered, or **N**one*)
Tree (>4m)_**35**___ Shrub (0.5-4m)__**36**__ Herb (<0.5 m)__**37**_ _ Moss_**38**___ Bare_**39**______

Canopy Shade (densiometer, record # of dots per quadrant if plot is mainly shrub/tree):

	Quadrant 1	Quadrant 2	Quadrant 3	Quadrant 4
Point 1	**40**	**43**	**46**	**49**
Point 2	**41**	**44**	**47**	**50**
Point 3	**42**	**45**	**48**	**51**

A6. Detailed Height Strata in the Plot (indicate cover class: **1** (<1%), **2** (1-25%), **3** (25-60%), **4** (>60%)

Height	**Name**	**% Cover**	**Main Species.** Measure **max. diameter** of main tree species.
---	Submersed Aquatic	**51.1**	**61.1**
---	Floating Aquatic	**51.2**	**61.2**
0-.25m	Moss/Lichen	**52**	**62**
0-.25m	Low Herb.	**53**	**63**
.25-.50m	Medium Herb	**54**	**64**
.50-1m	Low Shrub	**55**	**65**
1-2m	Herb/ Medium Shrub	**56**	**66**
2-5m	High Shrub	**57**	**67**
5-10m	Low Tree	**58**	**68**
10-20m	Medium Low Tree	**59**	**69**
20-30m	Medium High Tree	**60**	**70**
>30m	High Tree	**61**	**71**

A7. Full Species **List for Plot** (one row for each combination of species-height-cover class)

Height classes: **L**: <0.5m tall, **M**: 0.5-4m, **T**: >4m **BsppPlot file**
Cover classes**: r =**single plant, **1** = <1%, **2** = 1-5%, **3** = 5-25%, **4** = 25-50%, **5** = 50-75%, **6** = 75-100%

Circle any dominant **non**-wetland species (50-20 rule) if it's at a spot appearing to have prolonged (>2 wks) inundation or hydric soil indicators. Denote photographed species with *

SpCode	HtCl	CovCl

SpCode	HtCl	CovCl	FieldID	Coll. #

PART B: Overall Polygon Vegetation

B1a) Emergent Vegetation (Em) & moss

Em as % of polygon area:_______**72**___%

Em as % of:

permanently-inundated standing water area:_____**73**___%
seasonally-inundated standing water area:__**74**______%
permanently-inundated flowing water area:____**75**____%
seasonally-inundated flowing water area:____**76**____%
saturated-only area:____**77**_____%

Em cumulative edge-length with flowing permanent water (estimated): ___**78**____

Invasives as % of Em area: __**79**___%

Sphagnum moss as % of Em area: __**80**__%

Top 5 EM species	% of EM area	Depth Max.
81	**82**	**83**
84	**85**	**86**
87	**88**	**89**
90	**91**	**92**
93	**94**	**95**

Area threshold: 1% of EM zone or 9 m^2, whichever smaller

B1b) Underwater Herbaceous Vegetation (UHV):

UHV as % of standing permanent water area <2 m deep: ______**96**______%

Area (approx.) of standing permanent water area <2 m deep in polygon: __**97**______sq. m.

Top 5 UNV species	% of UHV area
98	**99**
100	**101**
102	**103**
104	**105**
106	**107**

Area threshold: 1% of EM zone or 9 m^2, whichever smaller

B1c) Shrubs, Seedlings, and Saplings (SS)

SS as % of polygon: ____108________________

SS as % of: permanently-inundated standing water area:___109_____%
seasonally-inundated standing water area:_____110_____%
permanently-inundated flowing water area:____111_____%
seasonally-inundated flowing water area:_____112______%
saturated-only area: _____113______%

Shrub cumulative edge-length with permanent water (estimated): ___114____m

Maximum width of shrub patch, perpendicular to permanent* water: __115_____m

* if no permanent water, use max. dimension of largest shrub patch

Invasive shrubs as % of shrub canopy: __116___%

Percent of stems dead (circle one): 117 <1% 1-25% >25%

What is under the shrub drip line?

	% of shrub understory
herbaceous	118
water – flowing	119
water – lentic	120
bare	121

Top 5 shrub species	% of shrub area
122	123
124	125
126	127
128	129
130	131

B1d) Trees (T)

Trees as % of polygon: __________132__________

Tree cumulative edge-length with permanent water (estimated): __133_____m

Maximum width of tree patch, perpendicular to permanent* water: __134_____m

* if no permanent water, use max. dimension of largest shrub patch

Invasive tree species as % of tree canopy: _135____%

Percent of trees dead or severely stressed (approx.) _136____%

What is under tree drip line?

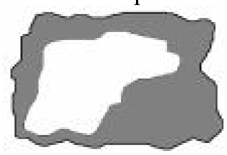
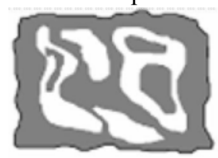
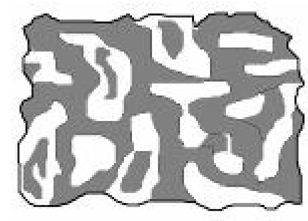
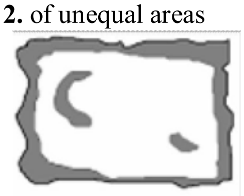
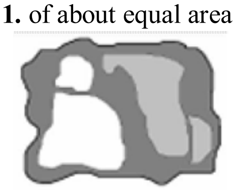
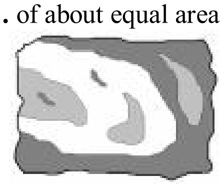
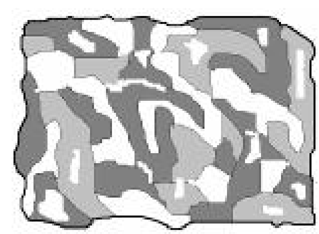
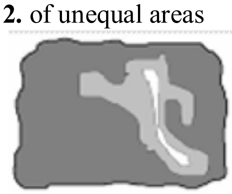
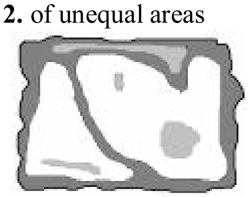
	% of subcanopy
shrubs	137
herbaceous	138
water – flowing	139
water – lentic	140
bare	141

Top 5 tree species-height classes	height class	% of treed area
142	143	144
145	146	147
148	149	150
151	152	153
154	155	156

height classes: SA= sapling (<6"), P= pole (6-11"), ST= small tree (11-24"), LT= large tree (>24")

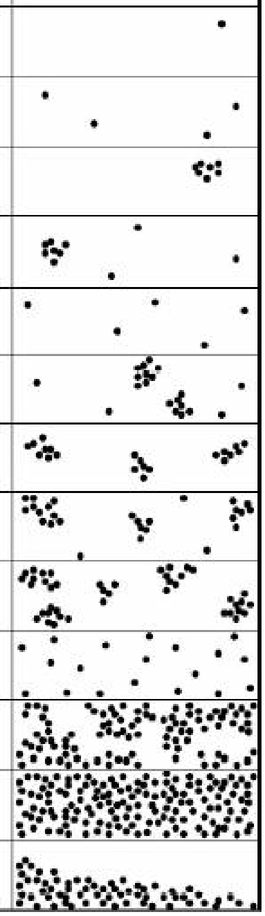
Area threshold: 1% of EM zone or 9 m^2, whichever smaller

B2. Overall Vegetation Pattern/ Zonation: 157

Number & distribution of vegetation forms **Forms**= herb, shrub, tree.			
	Veg forms are mostly in discrete, quite homogeneous zones or patches:	Zones/patches are recognizable but not homogeneous, and are:	Forms are highly intermixed; zones are mostly not recognizable; no patch >20% of polygon
Only ONE vegetation form = **A**			
Two forms …	**B 1.** of about equal area 	**C 1.** of about equal area 	**D** 
	B 2. of unequal areas 	**C 2.** of unequal areas 	
ll three forms …	**E 1.** of about equal area 	**F 1.** of about equal area 	**G** 
	E 2. of unequal areas 	**F 2.** of unequal areas 	

B3. Invasive vegetation pattern (circle one) 158

CLASS	DESCRIPTION OF ABUNDANCE	DISTRIBUTION PATTERN
0	No invasive plants on the polygon	
1	Rare occurrence	
2	A few sporadically occurring individual plants	
3	A single patch	
4	A single patch plus a few sporadically occurring plants	
5	Several sporadically occurring plants	
6	A single patch plus several sporadically occurring plants	
7	A few patches	
8	A few patches plus several sporadically occurring plants	
9	Several well spaced patches	
10	Continuous uniform occurrence of well spaced plants	
11	Continuous occurrence of plants with a few gaps in the distribution	
12	Continuous dense occurrence of plants	
13	Continuous occurrence of plants associated with a wetter or drier zone within the polygon.	



Names of Non-native Species: 159

B4. Plot General Description (continue on back if necessary):

B5. In hindsight, how **representative** do you feel the releve plot was of the entire polygon? 160

1	2	3	4	5
unique		→		similar

Ending Time: _______161_____________ a.m. p.m.

B5. Plant species found only outside the plot(s) BsppPoly file

<u>Circle</u> any dominant non-wetland species ("50-20 rule") if it's at a spot appearing to have prolonged inundation or hydric soil. Determine GPS coordinates of any rare species. Denote with * if photographed.
<u>Height Class</u>: **L**: <0.5m tall **M**: 0.5-4m **T**: >4m
<u>Relative Extent</u>: **<u>R</u>**are= only 1 plant noticed; **<u>U</u>**ncommon= a few; **<u>C</u>**ommon= extensive; **<u>A</u>**bundant= one of the "50-20 rule" species

SpCode	HtCl	CovCl

SpCode	HtCl	CovCl	FieldID	Coll. #

Appendix G. Field Data Collection Protocols

Wetland Field Data Collection Protocol

June 14, 2005 revised version

Two types of areas will be visited: areas identified as wetlands from existing NWI maps (coded "K") and areas identified as "possible wetlands" based on terrain analysis modeling (coded "NW"). Depending on the indicator being assessed, field estimates of indicators will be made at the scale of centerpoint, plot, polygon (site), and/or polygon buffer:.

A ***polygon*** is the entire contiguous wetland, usually separated from similar polygons by upland or deepwater (>6 ft deep).

A ***centerpoint*** is the point that represented the polygon during the site selection process and has specific coordinates which have a precision of about 40 ft. It is not necessarily located in the center of a wetland polygon.

A ***plot*** is a releve plot of variable dimensions but standard area in which detailed vegetation data may be collected.

A ***buffer*** is the upland (non-wetland) zone mostly extending 50m upslope from the polygon's outer edge. This distance is doubled up any polygon tributaries, and may be contracted if an impervious runoff barrier (e.g., tall berm or levee) is present before the 50m distance is reached.

Basic tasks that must be accomplished each day are:

- Navigate to and from the centerpoint of a wetland that's been targeted for assessment (those with a "K" prefix in the parkwide map of sample points)
- Determine if the site is a wetland.
- If the site is a wetland, place one unobtrusive marker (***benchmark***) at or within a measured distance and direction of the centerpoint. The marker will be an unflagged nail driven into a tree at eye level, with at least 0.5 inch protruding. No other permanent markers or lasting evidence of our visit will remain in any wetland. Locations of most data collected in the wetland will be referenced to this benchmark. It could serve as a basis for linking our data to future "vital signs" data and trends monitoring.

Record data from the following tasks

- Dig at least four 12-inch (30 cm) deep pits, determine coordinates using a GPS, and evaluate soil indicators and vegetation. Replace soil. If the wetland is smaller than 100 square meters, a smaller number of pits may be used.
- Survey plants in a standard-sized plot, as well as while walking as much of the wetland as time and physical access allow.
- Observe and assess vegetation structure, distribution of water, signs of human presence, and other indicators of ecological services and condition as shown in the data forms (Appendix B).
- Take one series of panoramic shots from a fixed point with a digital camera (document the location and direction by including a labeled whiteboard in the picture). For consistency, shoot the photos from left to right (clockwise).
- On an airphoto or grid sheet, sketch the approximate polygon boundary and key points.

On a given day, field tasks will proceed in approximately the following order. Tasks will be conducted by the Plant Scientist (**PS**), Soil Scientist (**SS**), or both together (Both). Tasks performed simultaneously but independently by the PS and SS have an a, b suffix below. Even when the PS and SS are operating independently in different parts of a wetland, they may stay in touch through use of their walkie-talkies.

1. **Person PS**. Before leaving camp:

- Review the checklist (Appendix A) to ensure all needed supplies are packed.
- Decide which centerpoint to visit and plan the route. Identify alternative wetlands or survey points that may be visited if the primary target is unsuitable or inaccessible, or if sufficient time remains in the day to assess these after assessing the primary target. Set waypoints on the GPS unit as necessary.
- Be sure all electronics are charged

2. **(Both persons).** Upon arriving at the **centerpoint**, determine if the point is a wetland by virtue of its indicators related to vegetation, soil, and/or hydrology (>14 continuous days of saturation). For this project, channels that lack a predominance of wetland vegetation should be considered wetlands if they convey flow at least once annually. If the point is a wetland, proceed to #3. If not, spend 20 minutes searching (mainly in a downhill direction) for such wetland indicators. If found, establish a centerpoint and record the GPS coordinates (decimal degrees, NAD 83). Continue with #3. If none found, proceed to the alternative point selected for today.

3a. **Person PS**. Establish the **benchmark** at or near the centerpoint. Reference its exact location by measuring distance and direction from the centerpoint, as well as with GPS and by marking on the airphoto or grid sheet. Provide a detailed description.

3b. **Person SS.** At the **centerpoint** or in the **plot** (see below), dig one shallow pit (shovel width) and assess soil and vegetation features as requested in the field sheet (Data Form S). Measure the minimum depths to indicators such as gleying, mottles, changes in texture or color, and note the dominant vegetation. If subsurface water is encountered, record the depth and do not dig any deeper. Do not attempt to dig a pit where water, waterlogged soils, or hard rock is apparent at the surface, or where rare plants or archaeological relicts are noted. In such cases, move the point to the closest location where conditions permit digging a 12-inch (30 cm) deep pit. Measure and record the pit's distance and direction to the centerpoint. Also take panoramic series of photos from the centerpoint, or from a point referenced to the centerpoint. Additional photos should be taken of any human-related site disturbances that are noted. If archaeological relicts are discovered record their location with GPS and on the sketch map, and leave them in place.

4. **(Both).** Using the meter tape, lay out the boundaries of the **plot**, which will be square or rectangular with one corner anchored at the centerpoint[4]. Lay out the plot in a configuration that more or less conforms with the topography and appears to provide the most homogeneity of vegetation form, e.g., doesn't mix large patches of shrubs within a herbaceous plot or vice versa. For plots that are primarily **herbaceous, the contiguous area must be exactly 100 square meters** (e.g., 10m x 10m, or 20m x 5m, etc.). For plots that are primarily **shrub or tree, the plot must cover exactly 400 square meters**. Every shrub/tree plot **must** contain a 100 square meter herb plot within its boundaries, but not every herb plot will conversely include a shrub/tree plot.

To the extent such areas can be avoided, the plots should be configured to exclude unvegetated water areas (e.g., deep streams and ponds), bare rock, and areas dominated by non-wetland plant species, i.e., upland. **If a wetland is too small to contain a plot of 100 square meters**, measure its exact dimensions and survey whatever plants and soils are within it.

5a. **Person PS**:

- Conduct a complete releve-style survey within the plot. Identify all species possible and assign cover class to each within each height stratum. Photograph and place the few unknowns in a baggie with label. As needed, consult the list of plants known to occur in LAVO. Record data in part A of Data Form B, using the approved codes.
- Lay out and survey a second releve plot if necessary (i.e., if shrubs are a major component of the polygon but the first plot was herb-focused, or vice versa). In very large and diverse wetlands, survey additional plots as time allows. Locate any additional releve plots based on (a) whether it is dominated by a plant association not encountered up to this point in the field season, and secondarily, (b) its perceived representativeness of the wetland in which it is located. For shrub/tree plots, use the spherical densiometer to estimate canopy shade at 3 representative points within the plot.
- After completing the above, walk the remainder of the polygon (wetland), visiting all microhabitats while you build a cumulative list of any plant species not found in the plot(s). Continue as time allows or until species-accumulation curve seems to level off. Record time spent. As you walk around, also fill out part B of Data Form B.
- Identify all species possible. Photograph all species once during the field season, i.e., "voucher photo." Include the whiteboard in the picture to label what you're calling the plant in the image. Take multiple images if necessary to illustrate key diagnostic features. Then check off on the master list to indicate the species has been photographed, and denote the date and location. Be especially sure to photograph and label any unknowns, and place them in a baggie with label to work on back at camp or under the dissecting scope.

5b. **Person SS**. Walk the remainder of the polygon (as much as time allows). During this time:

- Evaluate soils in a minimum of 2 more pits (and no more than 12) located to represent different geomorphic and/or vegetation associations within the polygon. Assess at least one pit in the adjoining upland for sake of reference. Record the data in Data Form S.
- If a channel is present, measure 3 cross-sections as prescribed on Data Form F, and measure specific conductance (electrical connectivity).
- Fill out all remaining sections of Data Form F, which deals with hydrologic features.
- Sketch the approximate wetland boundary on the gridded sheet (Form G) and airphoto.
- Photograph the channel cross-section (upstream, down) and any signs of prior human activity there or elsewhere in the polygon.

[4] But if the centerpoint is in a plant association that already was surveyed as a releve plot in another wetland on a previous day, the centerpoint should be shifted such that the plot covers a new association.

6. **(Both).** Before leaving the polygon, review each others' data sheets, add any species or features overlooked by the partner, and resolve any differing interpretations.

7. **Person PS:** Upon completing the day's field work:

- Transfer the day's digital photos to a computer. After checking to be sure they've been saved, erase them from the camera's memory.
- Charge batteries (radio, GPS). If you'll be away from a power source for more than a day (i.e., packing in overnight), be sure to bring along extra charged-up batteries.
- Identify or press unidentified plants
- Check weather and plan route for next day
- On a semi-daily basis, fax or mail me copies of all completed data forms. Please be sure they're legible and complete.
- At least once every 2 weeks, burn a CD with the digital photos and send it to me

Supplemental Guidance

Locating the Centerpoint

1. Don't rely on the printed map or airphoto to locate the centerpoint -- their precision is not great. Instead rely on the GPS, assuming an adequate signal is obtained.
2. If you can't obtain an adequate GPS signal initially, search for the point in the approximate area indicated by the map and airphoto, while constantly looking for wetland plant species to narrow the search area, and repeatedly checking the GPS to see if signal interception has improved. Once the GPS signal is adequate, collect required data at that point, and separately note the occurrence and GPS coordinates (if available) of wetland plants you found elsewhere while searching if their distribution is not contiguous to the survey point. If no adequate GPS signal is obtained after about 20 minutes, and if you've found no predominance of wetland plants while searching in the vicinity, proceed to the next survey point.

Deciding When to Do Additional Releves at a Site

1. First priority: Do a releve at the designated sample point IF it is a wetland. If not, see above.
2. Second priority: Do one in the same wetland if it represents a different vegetation form than found elsewhere onsite, or if it is a different plant association than found at any other wetland that's been assessed up to this point in the field season.
3. Third priority – ONLY if time allows. Do one where there has been a major localized human disturbance, e.g., road crossing, or if you see a wetland plant association not encountered at any other site you visited up to this point in the field season.

Priorities for Field Surveys

Priority 1. Points labeled "K" (random points mapped as wetlands by NWI). Must survey all 50 before end of field season. All other considerations being equal, survey the lower-numbered K points first and proceed upwards in numeric sequence. Be sure the highest-elevation points are covered before autumn snowfall

Priority 2. Points labeled "NW" (random points predicted to be wetlands but not mapped as such). Survey these only during "remainder of day" after surveying one "K" point and there is not enough time to survey a second "K" point during that day. And/or survey these late in the season after all 50 "K" points have been surveyed. The goal is to survey 25 NW's and 25 T's before end of the season.

Priority 3. Points labeled "T" (random points predicted to be terrestrial). The goal is to survey 25 T's before end of the season.

Priority 4. Points labeled "NRS" (points mapped as wetlands by NWI but selected *non-randomly* to encompass geomorphic or stressor conditions not covered by the randomly-selected sites). The goal is to survey as many as possible before end of the season, without compromising any of the above priority goals. It's likely that I will select additional NR points during the first month of field work, and substitute for ones that haven't been covered as of that time.

If time remains in a day and it is equally convenient to survey either of two NW or T points, survey the one with the lower number first. The NR points may be surveyed in any order, but at a lower priority than K, NW, and T points.

Worst Case: If you arrive at a point and find (a) no wetland there, or you cannot safely access the wetland, and (b) there are no unsurveyed points anywhere in the vicinity, and (c) your chances are slim of being able to get to other unsurveyed points with enough time to survey adequately before dark, THEN survey whatever undesignated wetland(s) you can find in the vicinity or along the way back, so the day is not a total waste. Give each undesignated wetland a unique number preceded by the prefix "NRF" (non-random found, as opposed to non-random selected).

When such unmapped "NRF" wetlands are encountered opportunistically (e.g., while hiking to designated points), note their GPS coordinates (just one point) and record their predominant plant species in each vertical stratum, but do not allow this to hinder accomplishment of the above priorities.

While Traveling To and From Target Wetlands:

If the most efficient route to the target wetland intercepts another *mapped but unvisited wetland*, as you pass it by, briefly record its apparently dominant vegetation, Cowardin type, and HGM type (and identify it by its polygon code on our map). While en route to a target wetland IF you notice:

(a) a very rare wetland plant species or association not encountered previously in your surveys,
(b) a channel, or
(c) an unmapped wetland, i.e., an area of any size dominated by wetland indicator species, or
(d) surface water occupied by plants, even if the dominant species are not on the list of those officially designated as wetland indicators,

THEN: get a GPS reading and note the lat-long, along with the date and the dominant species. If it's a rare plant, also take photographs and estimate the number of individuals.

Appendix H. Locational Data for Permanent Reference Markers (Benchmarks) Placed in 76 CRLA Wetlands

Site	TAG ID #	Benchmark UTM Easting	Benchmark UTM Northing	Benchmark Location Description
K1	303	558411	4747671	5 ft up on PICENG on south side
K2	417	561208	4760729	PINCON 4 ft up on E side of tree on NW side of polygon
K3	338	576040	4750455	TSUMER 4 Ft up on S side tree on NE edge of polygon by road
K4		564904	4751830	PINCON 5 ft up on the N Side tree in upland on S side of polygon
K6	377	560029	4763538	ABILASL 5 ft up on W side ~1.7m diameter
K7	411	573766	4740814	facing S on 28" PICO
K9	308	560681	4758983	PICENG 4 ft up at 300 deg tree on N side of wetland
K10	440	568317	4757633	TSUMER 4 ft up on W side tree on E side of polygon
K11	413	569194	4745554	1.8 m height east side of tree on PINMON
K13	414	560196	4759710	PINCON 5 ft up on W side of tree tree on E side of polygon
K15	306	565514	4747432	TSUMER 5 ft up on NE side of tree, WSW side of wetland
K17	405	559318	4747431	TSUMER 5 ft up on NNE side
K18	355	561108	4761039	PINCON 5 ft up on W side of tree on SE edge of wetland
K19	420	576780	4750917	ABISHA 5 ft up on E side tree on NE edge of wetland
K20	436	565259	4752625	TSUMER 6 ft up on SW side tree on NE side of wetland
K21	342	558844	4748474	NW side of 10 m tall ABISHA
K22	419	561212	4767744	5 ft up PINCON west edge of meadow
K25	351	560833	4758423	PICENG on NW side 4 ft up tree on SE side of wetland
K26	438	568177	4757831	TSUMER about 5 ft up on SW side, tree on SE edge of wetland
K28	386	570082	4749399	ABISHA 5 ft up on NW Side, tree in center of polygon
K29	309	560422	4759882	PICENG 4 ft up on N side tree on SW side of polygon
K30		571254	4748096	TSUMER 4 ft up on N side, tree on E side of polygon
K31	363	565578	4747134	PINCON, 5 ft up
K33	307	560549	4752485	POPTRE 4 ft up on NE side of tree, tree on NW edge of polygon
K34	418	561286	4764742	PINCON 4 ft up on side of tree, tree on side of wetland
K35	450	570867	4746090	ABILASL on E side, tree on E edge of wetland
K37	423	559509	4757291	PINCONM 5 ft up at 40 degrees near southern edge of wetland
K38	416	560025	4768043	PINMON 6 ft up on NE edge of wetland, tag on SSW side of tree
K39	492	574766	4746202	5 ft up on SW side. Tree on N edge of wetland
K41	409	560681	4762793	ABILASL 4 ft up on W side, tree on E side of polygon
K42	404	562629	4768676	100 degrees E side of ABILASL 5 ft up w/in 5 m of river
K43	495	566686	4743403	facing east, 4 ft up TSUMER
K44	364	567627	4749393	ABILASL 4 ft up
K45	372	559783	4760526	PICENG 5 ft up on NW side, tree on E side of wetland
K46	297	573699	4749572	ABILASL 5 ft up on W side, tree on south central part of polygon
K48	447	564907	4739044	PINCON 5 ft up on N side, tree near S edge of wetland
K49	305	561048	4753247	PICENG 4 ft up on SSE side in upland island in middle of polygon

Site	TAG ID #	Benchmark UTM Easting	Benchmark UTM Northing	Benchmark Location Description
K50	408	560758	4764278	PINCONM 5 ft up on south side of plot, tag on N side of tree
K51	437	573453	4747707	ABILASL 5 ft up on N side, tree on E side of wetland
K52	426	565221	4752683	PINCON 4 ft up on SE side, tree in center of polygon near NE side
K53	415	560129	4759092	PICENG 5 ft up on NW side, tree on E side of polygon
K55	383	569200	4747427	ABILASL 5 ft up on E side of tree, tree on SW edge of wetland
K57		559862	4759759	PICENG 5 ft up on N side, tree in middle of wetland
K58	370	570931	4748824	ABILASL 4 ft up on E side, tree on SW edge of wetland near road
K60	412	567575	4749175	PINCON 5 ft up on W side of tree, tree on S side of wetland
K61	490	559594	4759724	PINCON 5 ft up on SW side, tree on NW edge
K68	441	560448	4764126	ABILASL 5 ft up on S side, tree on N edge of wetland
K71		561285	4758598	PICENG 5 ft up on E side, tree on N edge of wetland
K75	456	560150	4759617	ABILASL 5 ft up on Sw side, tree on N edge of wetland
K76		570534	4749567	6 ft up on N side, on W edge of wetland
K77	486	565479	4747200	TSUMER
K80		560703	4760167	PINCON 5 ft up on S side, tree on N edge
K81	444	577680	4751621	PINCON 4 ft up on W side, tree on E edge of wetland
K83	488	559269	4751166	Fir 5 ft up on S side of tree, tree on SE edge of wetland
K84	433	561132	4767986	TSUMER 5 ft up on E side, tree on W edge
K85	428	571756	4742107	ABILASL 5 ft up on W side, tree on E edge of polygon
NR54	357	582048	4744702	PICENG on N side of tree 5 ft up, tree in middle of wetland
NR62	384	570341	4750463	ABISHA on SE side of tree, tree on NW side of wetland near road
NR65	406	561050	4760539	ABILASL 5 ft up on NE side, tree on S side of polygon
NR73	387	568909	4745935	~1.75 m north facing PINCON
NR79	430	558801	4753354	ABILASL 5 ft up on E side, tree on SW edge of wetland
NR120	407	570201	4748615	PINCON 4 ft up tree on W side, tree on sw edge of polygon
NR126	361	575523	4738699	PINPON 4 ft up on NE side, W side of polygon
NR128	367	560608	4760766	very large western white pine on edge of wetland
NR129	431	576012	4750730	5 ft up on E side, tree on S edge of wetland
NR146	385	564960	4751927	PINCON N side of tree 5 ft up, tree on S side of polygon
NR147	421	558227	4748118	4 ft up on N side of PICENG
NR161	435	572613	4746949	PINCON 5 ft up on N side, tree near Sw border of polygon
NR164	429	578202	4749464	PINCON 5 ft up on W side, tree on E edge of wetland
NR174	382	575972	4738583	2 m above ground east side of Abies
NR187	356	560053	4763209	large PINMON 4 ft up on E side of tree, tree on SE side of wetland
NR188	0	570655	4749955	ABILASL 5 ft up on N side, tree in middle of willows
NR233	410	565355	4747404	PINCON 5 ft up on south side of tree. North side of wetland.
NR241	442	570641	4744929	ABILASL 5 ft up on E side, tree on W side of polygon
NR244	454	568345	4757572	TSUMER 5 ft up on NW side, tree on SE edge of wetland
NRC1	432	568378	4752930	ABIES on slope nearest lake. On north end of polygon

Appendix I. Amphibians and Reptiles of CRLA That Are Probably the Most Dependent on Wetlands, Riparian Areas, and Water Bodies

Interpreted from park list and published reports. Not based on data from this study.

Common Name	Scientific Name	Status
AMPHIBIANS		
Northwestern Salamander	*Ambystoma gracile*	Present in Park
Long-toed Salamander	*Ambystoma macrodactylum*	Present in Park
Clouded Salamander	*Aneides ferreus*	Unconfirmed
Tailed Frog	*Ascaphus truei*	Present in Park
Western Toad	*Bufo boreas*	Present in Park
Pacific Giant Salamander	*Dicamptodon tenebrosus*	Unconfirmed
Pacific Chorus Frog, Pacific Treefrog	*Pseudacris regilla*	Present in Park
Red-legged Frog	*Rana aurora*	Unconfirmed
Cascades Frog	*Rana cascadae*	Present in Park
Oregon Spotted Frog	*Rana pretiosa*	Unconfirmed
Rough-skinned Newt	*Taricha granulosa*	Present in Park
California Newt	*Taricha torosa*	Unconfirmed
REPTILES		
Western Terrestrial Garter Snake	*Thamnophis elegans*	Probably Present
Northwestern Garter Snake	*Thamnophis ordinoides*	Probably Present
Common Garter Snake	*Thamnophis sirtalis*	Present in Park

Appendix J. Mammals of CRLA That Are Probably the Most Dependent on Wetlands, Riparian Areas, and Water Bodies

Interpreted from park list and published reports. Not based on data from this study.

Scientific Name	Common Name	Status
Sorex palustris	Northern water shrew	Common
Zapus trinotatus	Pacific jumping mouse	Common
Procyon lotor	Raccoon	Rare
Lutra canadensis	River otter	Rare
Mustela vison	Mink	Rare
Aplodontia rufa	Mountain beaver	Uncommon
Castor canadensis	Beaver	Rare
Ondatra zibethicus	Muskrat	Rare
Lasionycteris noctivagans	Silver-haired bat	Common
Eptesicus fuscus	Big brown bat	Common
Myotis lucifugus	Little brown myotis	Common
Myotis evotis	Long-eared myotis	Uncommon
Myotis volans	Long-legged myotis	Common
Myotis yumanensis	Yuma myotis	Common
Myotis californicus	California myotis	Rare
Lasiurus cinereus	Hoary bat	Rare
Tadarida brasiliensis	Mexican free-tailed bat	Rare

Appendix K. Bird Species Regularly Present in CRLA and That May Be Associated Strongly with Wetlands, Riparian Areas, and Water Bodies

Habitat ratings (primary or secondary use by the named species) are based on technical literature and the author's experience in the western U.S. generally, not on field data from this study. Occurrence, abundance, and status data are from the official park list, updated with recent reports.

Species	Occurrence	Relative Abundance	Status	Pond/ Lake	Perennial Stream	Seasonal Marsh/ Meadow	Seasonal/ Riparian Shrub	Seasonal/ Riparian Tree
American Coot	Potential Visitant	Rare	Unknown	Primary				
American Dipper	Present in Park	Uncommon	Breeder	secondary	Primary			
American Goldfinch	Present in Park	Common	Breeder				Primary	
American Pipit	Potential Visitant	Rare	Unknown			Primary		
American Robin	Present in Park	Common	Breeder			secondary	Primary	secondary
American Wigeon	Potential Visitant	Rare	Unknown	Primary				
Bald Eagle	Present in Park	Uncommon	Resident	Primary				
Barn Swallow	Present in Park	Rare	Breeder	Primary		secondary		
Barred Owl	Present in Park	Common	Breeder					Primary
Barrow's Goldeneye	Present in Park	Rare	Breeder?	Primary		secondary		
Belted Kingfisher	Present in Park	Occasional	Unknown	Primary	secondary	secondary	secondary	
Black-backed Woodpecker	Present in Park	Uncommon	Breeder					Primary
Black-capped Chickadee	Present in Park	Uncommon	Breeder				secondary	Primary
Black-crowned Night-Heron	Present in Park	Rare	Visiting			Primary		
Black-headed Grosbeak	Present in Park	Uncommon	Breeder				secondary	Primary
Blue-winged Teal	Potential Visitant	Rare	Unknown	Primary				
Brewer's Blackbird	Potential Visitant	Rare	Unknown			Primary	secondary	
Brown Creeper	Present in Park	Common	Breeder					Primary
Brown-headed Cowbird	Present in Park	Unknown	Breeder			secondary	Primary	secondary
Bufflehead	Potential	Rare	Unknown	Primary				secondary

Species	Occurrence	Relative Abundance	Status	Pond/ Lake	Perennial Stream	Seasonal Marsh/ Meadow	Seasonal/ Riparian Shrub	Seasonal/ Riparian Tree
	Visitant							
Bushtit	Present in Park	Rare	Breeder				Primary	
California Gull	Present in Park	Common	Resident	Primary				
Calliope Hummingbird	Present in Park	Rare	Breeder			secondary	Primary	
Canada Goose	Present in Park	Occasional	Visiting	Primary				
Canvasback	Potential Visitant	Rare	Unknown	Primary				
Caspian Tern	Present in Park	Rare	Visiting	Primary				
Cassin's Finch	Present in Park	Common	Breeder				secondary	Primary
Cassin's Vireo	Present in Park	Rare	Unknown				Primary	secondary
Cedar Waxwing	Potential Visitant	Rare	Unknown			secondary	Primary	secondary
Cinnamon Teal	Potential Visitant	Rare	Unknown	Primary				
Cliff Swallow	Present in Park	Uncommon	Unknown	secondary	secondary	Primary		
Common Goldeneye	Potential Visitant	Rare	Unknown	Primary				secondary
Common Loon	Present in Park	Occasional	Visiting	Primary				
Common Merganser	Present in Park	Unknown	Unknown	Primary	secondary			
Common Raven	Present in Park	Common	Breeder					
Common Yellowthroat	Potential Visitant	Rare	Unknown			Primary	secondary	
Dark-eyed Junco	Present in Park	Abundant	Breeder			secondary	Primary	
Double-crested Cormorant	Present in Park	Uncommon	Unknown					
Downy Woodpecker	Present in Park	Common	Breeder				secondary	Primary
Dusky Flycatcher	Present in Park	Uncommon	Breeder				Primary	secondary
Eared Grebe	Present in Park	Rare	Unknown	Primary				
European Starling	Potential Visitant	Rare	Unknown					Primary
Forster's Tern	Present in Park	Rare	Resident	Primary				
Gadwall	Potential Visitant	Rare	Unknown	Primary				
Great Blue Heron	Present in Park	Rare	Unknown	Primary		secondary		

Species	Occurrence	Relative Abundance	Status	Pond/ Lake	Perennial Stream	Seasonal Marsh/ Meadow	Seasonal/ Riparian Shrub	Seasonal/ Riparian Tree
Great Egret	Present in Park	Rare	Visiting	Primary				
Great Horned Owl	Present in Park	Common	Breeder					Primary
Greater White-fronted Goose	Present in Park	Rare	Visiting	Primary				
Greater Yellowlegs	Potential Visitant	Rare	Unknown	Primary				
Hairy Woodpecker	Present in Park	Common	Breeder					Primary
Hermit Thrush	Present in Park	Common	Breeder					Primary
Hooded Merganser	Present in Park	Unknown	Unknown	Primary				secondary
House Wren	Present in Park	Rare	Breeder				Primary	
Killdeer	Potential Visitant	Rare	Unknown	Primary				
Lesser Scaup	Potential Visitant	Rare	Unknown	Primary				
Lewis' Woodpecker	Potential Visitant	Rare	Unknown					Primary
Lincoln's Sparrow	Present in Park	Uncommon	Breeder			Primary	secondary	
MacGillivray's Warbler	Present in Park	Uncommon	Breeder				Primary	secondary
Mallard	Present in Park	Rare	Visiting	Primary	secondary	secondary		
Marsh Wren	Potential Visitant	Rare	Unknown			Primary		
Mountain Bluebird	Present in Park	Common	Breeder				secondary	Primary
Mountain Chickadee	Present in Park	Common	Breeder					Primary
Nashville Warbler	Present in Park	Rare	Breeder				Primary	secondary
Northern Flicker	Present in Park	Common	Breeder					Primary
Northern Harrier	Present in Park	Rare	Unknown			Primary	secondary	
Northern Pintail	Potential Visitant	Rare	Unknown	Primary				
Northern Pygmy-Owl	Present in Park	Uncommon	Breeder					Primary
Northern Rough-winged Swallow	Potential Visitant	Rare	Unknown	Primary		secondary		
Northern Saw-whet Owl	Present in Park	Uncommon	Resident					Primary
Northern Shoveler	Potential Visitant	Rare	Unknown	Primary				

Species	Occurrence	Relative Abundance	Status	Pond/ Lake	Perennial Stream	Seasonal Marsh/ Meadow	Seasonal/ Riparian Shrub	Seasonal/ Riparian Tree
Olive-sided Flycatcher	Present in Park	Uncommon	Breeder					Primary
Orange-crowned Warbler	Present in Park	Rare	Breeder			secondary	Primary	
Osprey	Present in Park	Uncommon	Resident	Primary	secondary			
Pied-billed Grebe	Potential Visitant	Rare	Unknown	Primary		secondary		
Pine Siskin	Present in Park	Common	Breeder				secondary	Primary
Purple Finch	Present in Park	Uncommon	Breeder				secondary	Primary
Red-breasted Sapsucker	Present in Park	Rare	Breeder			Primary		
Redhead	Potential Visitant	Rare	Unknown	Primary				
Red-winged Blackbird	Potential Visitant	Rare	Unknown			Primary	secondary	
Ring-billed Gull	Present in Park	Rare	Resident	Primary				
Ring-necked Duck	Potential Visitant	Rare	Unknown	Primary		secondary		
Ruby-crowned Kinglet	Present in Park	Uncommon	Resident				Primary	secondary
Ruddy Duck	Present in Park	Unknown	Unknown	Primary				
Ruffed Grouse	Present in Park	Uncommon	Breeder				Primary	secondary
Rufous Hummingbird	Present in Park	Uncommon	Breeder			secondary	Primary	
Sandhill Crane	Potential Visitant	Rare	Unknown			Primary		
Savannah Sparrow	Present in Park	Rare	Breeder			Primary		
Sharp-shinned Hawk	Present in Park	Uncommon	Breeder					Primary
Snow Goose	Potential Visitant	Rare	Unknown	Primary				
Solitary Sandpiper	Present in Park	Unknown	Unknown	secondary		Primary		
Song Sparrow	Present in Park	Common	Breeder			secondary	Primary	
Sora	Potential Visitant	Rare	Unknown			Primary		
Spotted Sandpiper	Present in Park	Rare	Resident	Primary	secondary	secondary		
Steller's Jay	Present in Park	Common	Breeder					Primary
Swainson's Thrush	Present in Park	Uncommon	Breeder				Primary	secondary
Three-toed	Present in	Uncommon	Breeder					Primary

Species	Occurrence	Relative Abundance	Status	Pond/ Lake	Perennial Stream	Seasonal Marsh/ Meadow	Seasonal/ Riparian Shrub	Seasonal/ Riparian Tree
Woodpecker	Park							
Tree Swallow	Present in Park	Uncommon	Breeder	secondary	secondary	Primary	secondary	secondary
Turkey Vulture	Present in Park	Uncommon	Unknown			Primary	secondary	secondary
Varied Thrush	Present in Park	Common	Breeder				secondary	Primary
Vaux's Swift	Present in Park	Rare	Unknown			secondary	secondary	Primary
Violet-green Swallow	Present in Park	Rare	Unknown	secondary	secondary			
Warbling Vireo	Present in Park	Rare	Breeder				secondary	Primary
Western Bluebird	Present in Park	Rare	Breeder				secondary	Primary
Western Flycatcher	Present in Park	Uncommon	Breeder					Primary
Western Grebe	Potential Visitant	Rare	Unknown	Primary				
Western Screech-Owl	Present in Park	Uncommon	Breeder				secondary	Primary
Western Tanager	Present in Park	Uncommon	Breeder					Primary
Western Wood-Pewee	Present in Park	Uncommon	Breeder					Primary
White-breasted Nuthatch	Present in Park	Uncommon	Resident					Primary
Williamson's Sapsucker	Present in Park	Uncommon	Breeder					Primary
Willow Flycatcher	Potential Visitant	Rare	Unknown			secondary	Primary	
Wilson's Phalarope	Potential Visitant	Rare	Unknown	secondary		Primary		
Wilson's Snipe	Present in Park	Rare	Resident			Primary	secondary	
Wilson's Warbler	Present in Park	Uncommon	Breeder				Primary	secondary
Winter Wren	Present in Park	Uncommon	Breeder					Primary
Wood Duck	Potential Visitant	Rare	Unknown	Primary				secondary
Yellow Warbler	Potential Visitant	Rare	Unknown				Primary	secondary
Yellow-rumped Warbler	Present in Park	Common	Breeder					

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