

SUMMARY REPORT

SURVEY EFFORTS, RESULTING INTERIM CHECKLIST, AND VASCULAR PLANT DATABASE FOR THE NPSPECIES VASCULAR PLANT INVENTORY INITIATIVE

UNITED STATES NATIONAL PARK SERVICE UPPER COLUMBIA BASIN NETWORK (UCBN) CRATERS OF THE MOON NATIONAL MONUMENT AND PRESERVE (CRMO) PARK UNIT ARCO, IDAHO

**Prepared by Steve J. Popovich¹
Fulfills University of Idaho NPSpecies Contract Requirements for
RM-CESU Cooperative Agreement H1200040001**

January 15, 2008

WildHorse
CONSULTING



Vegetative Resource Specialists

**Submitted to:
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Executive Summary

This summary document reports accomplishments in fulfilling the National Park Service's NPSpecies Initiative for the 754,862-acre/305,489-hectare Craters of the Moon National Monument and Preserve Park Unit (park code CRMO). The national initiative has the goal of documenting at least 90% of known or suspected plant and animal taxa in all Park Units. In the mid-1990's, I and a team of qualified botanists began work under contract to University of Idaho to fulfill this goal for vascular plants. Work was divided into five strategies: 1) assemble and review all relevant literature and internal data forms concerning plant information for the Park Unit, and conduct limited herbaria searches and interviews with knowledgeable staff and local past collectors, 2) incorporate all pre-existing Popovich and other unaccessioned collections made in the past in the Park Unit, 3) conduct field surveys in the unit sufficient to reach 90% documentation of known or suspected plants and assign confidence in results, 4) create a properly-curated working herbarium in the Park Unit, and 5) populate the NPSpecies vascular plant electronic database for the unit, including all three sources of evidence – vouchers, observations, and references – and create an organized, thorough plant checklist that list all plants **present, probably present** (called “suspected” in the checklist, which is a more accurate term), **encroaching, unconfirmed, historic**, and **falsely reported** for the Park Unit (these assignments were followed as defined by the NPSpecies database rules).

From a total of about 180 references dated through 2004 for CRMO identified as possibly containing information relevant to this project, about 110 (61%) were further identified as potentially useful and were reviewed for CRMO, including **all** known references containing any species lists, plant names, or plant community names (except for the unit's various internal natural resources data forms that were determined to be unreliable). By far, all of the most promising references were reviewed, and it is doubtful that those not reviewed would yield additional new information. Substantial survey efforts were expended by myself and team members in CRMO during growing season 2002 and during growing season 2006. Efforts prior to and including field work in 2002 were called “Phase I;” efforts in 2003 through January, 2008, including the 2006 field season, were called “Phase II,” and constituted the final phase of this project. The meager historic collections residing at CRMO's working herbarium were annotated, and a greatly-expanded herbarium was completed.

Upon initiation of this project, the CRMO working herbarium contained about 705 specimen sheets representing about 348 taxa in about 47 families. As a result of Phase I, about 1,811 specimen records were added (including about 137 records for specimens known to be missing), and the total number of taxa known to be present almost doubled to about 657. Phase II added about 660 more specimen records and increased the total number of taxa known to occur in CRMO to about 752, a 14% increase over Phase I. It also confirmed about 35 taxa that were unconfirmed from Phase I.

I estimate that **90%** of known and suspected plants have been documented in the Park Unit, an accomplishment which meets initiative goals with high confidence, and a vascular plant working checklist has been developed. **The total number of vascular**

plant taxa (including subspecies, varieties, and forms) known to be present in CRMO based upon verified specimens is 752, representing 77 plant families. In addition, there are 96 taxa that are unconfirmed (many of which are unlikely to occur), five probably present, five encroaching, one historic, 34 falsely reported, and two with status unknown (the intended taxa are unclear, and are possibly invalid taxon names). The CRMO totals include all results from the final 2006 field season. Plant lists are never static or “final,” and more plants will surely be documented in the Park Unit with additional survey efforts or by invasion of new weedy species over time.

In the NPSpecies database, there are **1,366 total taxon records** for CRMO, including synonyms and false reports. **Regionally-preferred synonyms as well as all synonyms appearing in all references reviewed are included.** There are **3,176 voucher database records**. In addition to voucher (specimen) data, there are **54 linked plant observations**. Also, there are **65 linked plant bibliographic references**. Additionally, a *User’s Guide* was developed to allow global users to more effectively utilize the powerful NPSpecies database.

Of the 3,176 vouchers entered into the database, there are currently **3,015 plant specimen sheets** (vouchers) in the CRMO working herbarium, not counting a few unaccessioned study specimens collected by Paige Wolken. There are an additional 21 collections known to be housed elsewhere, another two with repositories unknown, one specimen is known to have been discarded, and 137 specimens are known to be missing. These numbers do not reflect the many duplicate specimens known to exist at Herbarium BRY collected in 2002 and 2006. There are without doubt additional specimens from CRMO that reside in other herbaria that are unknown to myself or the Park Unit.

Many self-contained products have resulted over the years from initiative efforts. The most important of these, including an interim 2006 CRMO vascular plant checklist, lists of undocumented suspected taxa for CRMO upon which to focus surveys in outyears, an electronic copy of the NPSpecies database and its *Guide*, full citations for all references reviewed and considered for review, field survey record books and maps, delineation of future survey areas for CRMO, herbarium user’s guides, and all lists and maps resulting from efforts to date, **form the substantive products of expended efforts**. Many of these have been included in this report. This summary report concludes formal efforts under this project. However, an additional **final report** will be submitted by myself to CRMO in May, 2008. That report will be performed gratis, and is largely already prepared. It may discuss results in more detail, will provide updated checklists of vascular plants for CRMO, and will contain additional important attachments, several of which were mentioned above. It will also contain products from a similar inventory effort conducted by my team for Hagerman Fossil Beds National Monument (park code HAFO) from 1994 to 2003 as part of this initiative. The final report will close 14 years of intermittent efforts involving over 30 individuals and expending roughly 4,000 total person-hours of vascular plant work for CRMO and HAFO under the initiative from 1994 through January, 2008. Following submission of the final report, it is hoped that the NPSpecies databases for CRMO and HAFO, the *User’s Guide*, and the CRMO and HAFO plant checklists will be posted on National Park Service sites on the World Wide Web.

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| Attachment 3. | CRMO 2006 interim checklist – full version with synonymy and notes of interest. Dated October 15, 2006. Word document. |
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- Attachment 48. CRMO working herbarium organization outline. Word document.
- Attachment 49. Briefing Report of Steve Popovich’s Phase II (2006) Field Season and overall NPSpecies accomplishments. Dated January 15, 2008. Word document.
- Attachment 50. Clarifications by Steve J. Popovich to N. Duane Atwood’s Progress Report of Phase II (2006) accomplishments, with Atwood’s progress report attached. Clarifications dated January 15, 2008. Word document.
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- Attachment 61. CRMO Boundary Antennaria Arcuata Huff Creek IDCDC Plant Element Occurrence (EO) as of 2-14-2005, Idaho Conservation Data Center (IDCDC) Database Printout Report. Dated February 14, 2005. PDF file.
- Attachment 62. Idaho State Noxious Weeds Rules, IDAPA 02 Title 06 Chapter 22 as of March 30, 2007. With listing of noxious weeds designations. PDF file.
- Attachment 63. Results of the Idaho Twenty-Third Annual Rare Plant Conference, sponsored by the Idaho Native Plant Society, February 13-14, 2007, Boise, Idaho. PDF file.

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About the Author

I am currently Forest Botanist, United States Forest Service, Arapaho and Roosevelt National Forests & Pawnee National Grassland, Supervisor's Office, Fort Collins, Colorado, where I serve as Program Manager for the Rare Plant and Noxious Weed programs. The Unit administers about 1.7 million acres/688,000 hectares of forest and grassland along Colorado's Front Range. I earned a Bachelor of Science degree in Range Ecology and a Minor in French in 1985 from Colorado State University. I earned a Master of Science degree in 1989 in Range Science, concentration in Plant Ecology, also from Colorado State University. My Master's thesis investigated synecological relationships between ponderosa pine (*Pinus ponderosa*) and surrounding understory vegetation along Colorado's Front Range (Popovich, 1989). My first federal work experience was in 1980 as a volunteer back-country Ranger for the Routt National Forest in Walden, Colorado. My career began in earnest in 1983 as a Park Technician in interpretation and natural resources for the National Park Service in Colorado National Monument, Fruita, Colorado. Subsequent positions have included Biological Technician for the US Fish & Wildlife Service in northern Idaho and southern British Columbia, Canada; Technician and Research Range Scientist for the USFS Rocky Mountain Research Station in Fort Collins and the Fraser Experimental Forest in Fraser, Colorado; Botanist for the Fremont National Forest in Paisley, Oregon; Plant Ecologist for the USFS Silviculture Lab in Bend, Oregon, in support of the Winema, Ochoco, Deschutes, and Fremont National Forests; Research Plant Ecologist for the USGS Biological Resources Division (FRESC) in Corvallis, Oregon; and Principle of a Sole Proprietorship as Private Consultant in Idaho. I have performed extensive government-to-government and NGO humanitarian aid assignments in developing countries, including India, Nepal-Tibet, Nigeria, Bolivia, El Salvador, Tajikistan, and Albania.

From 1991 to 1997, I was Botanist for the Bureau of Land Management's Shoshone Field Office in Shoshone, Idaho, located on the Snake River Plain, where I often worked as a shared resource with the National Park Service's nearby Craters of the Moon National Monument and Hagerman Fossil Beds National Monument Park Units, which had no Botanist or Vegetation Ecologist. I continued work in the locale as a USGS Plant Ecologist from 1997 to 1999. Nearly all of the area comprising the recently greatly-expanded CRMO unit was then under BLM-Shoshone management, so I had been formally "botanizing" much of what now constitutes CRMO for eight years when ownership and management was transferred to and co-mingled with the National Park Service in 2000. I conducted botanical inventories and collected extensively in these areas as well as across southern Idaho each year 1992 through 2002. I have numerous published and unpublished reports on Idaho flora, including in-depth field research on wildfire rangeland rehabilitation techniques in southern Idaho's sagebrush-steppe. I have extensive field survey and public land management experience, and have provided the leading research on four southern Idaho endemic rare plant species: *Pyrrocoma* (= *Haplopappus*) *insecticruris* (suspected in CRMO), *Astragalus oniciformis* (present in CRMO); *Astragalus atratus* var. *inseptus* (unconfirmed in CRMO), and *Oenothera psammophila* (endemic to the St. Anthony sand dunes). I greatly increased our understanding of, and species abundance and range descriptors for, the Owyhee Uplift's

Inside Desert populations of the rare endemic mustard *Lepidium papilliferum*. I have conducted intensive surveys for *Phacelia inconspicua*, the most globally-rare vascular plant known to occur in CRMO. I provided much research on the ecology and distribution of *Gymnosteris nudicaulis*, a plant occurring in CRMO and formerly tracked in Idaho by the Heritage Program's Idaho Conservation Data Center (IDCDC), but dropped from tracking in 1993-4 based largely upon study findings. My first published checklist was *Flora of the Fraser Experimental Forest, Colorado* (Popovich, 1993), which documented 441 plant taxa. A checklist of vascular plants of the Arapaho and Roosevelt National Forests & Pawnee National Grassland is due for release in 2010, and will document roughly 1250 forest taxa and 540 grassland taxa.

I have a keen working knowledge of the local flora in both CRMO and HAFO Park Units, and have conducted by far the most botanical work in CRMO and Shoshone BLM-administered areas of Idaho.

This NPSpecies project was completed while independent contractor to the University of Idaho, doing business as Wildhorse Consulting, Shoshone, Idaho. It was originally scheduled for completion in 2002, prior to acceptance of my current job position, but due to a temporary freeze of funds by Congress around that time and other client-generated postponing issues, it was not completed until this report. Allowance to fulfill previously-committed project obligations was approved by the Forest Service, and my participation was completely unrelated to my official government duties. No government time or equipment was expended.



The Author, 2007

Recommended Full Citation for this Report

Popovich, Steve J. 2008. *Survey Efforts, Resulting Interim Checklist, and Vascular Plant Database for the NPSpecies Vascular Plant Inventory Initiative, United States National Park Service, Upper Columbia Basin Network (UCBN), Craters of the Moon National Monument and Preserve (CRMO) Park Unit, Arco, Idaho*. Prepared for the National Park Service and University of Idaho under RM-CESU Cooperative Agreement H1200040001. 106pp. + 63 attachments including electronic databases and maps.

Steve J. Popovich

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Summary Report - NPSpecies Vascular Plant Inventory and Database - CRMO Park Unit, Idaho
January 15, 2008

Introduction

The National Park Service's (NPS) Craters of the Moon National Monument and Preserve (park code CRMO) is located in the shrub-grass cold desert of south-central Idaho. CRMO is about 754,862 acres/305,489 hectares (about 1,179 square miles/3,054 square kilometers) in size, which is roughly the same size as the State of Rhode Island, and which is almost three times larger than Rocky Mountain National Park in Colorado. It is located south-east of Sun Valley and north-east of Twin Falls, Idaho. Its Headquarters is about 20 air-miles/32 air-kilometers south-west of the town of Arco, Idaho. It lies within Blaine, Butte, Lincoln, and Minidoka Counties, and a very small amount of Power County. In the 1990's, CRMO was about 54,000 acres/21,854 hectares in size, which was the result of several expansions since its inception in 1924. In 2000, Presidential Proclamation 7373 under President Clinton formally expanded the Monument to its current size. The large expansion subsumed former BLM land (mostly within the former Shoshone District, now called the Shoshone Field Office) and co-mingled administration. The name "Craters of the Moon National Monument" was changed to "Craters of the Moon National Monument and Preserve" to indicate that some land remained under BLM administration and such land's retention of most pre-existing multiple uses, including livestock grazing, but not mining. Today, the NPS manages about 469,804 acres/190,127 hectares (62%) and the BLM manages about 285,058 acres/115,361 hectares (38%). Additionally, there are about 8,321 acres/3,368 hectares of State in-holdings and about 6,860 acres/2,776 hectares of private in-holdings.

CRMO is typified by vegetated as well as stark unvegetated vast lava flows of varying ages similar in appearance to those present in Hawaii, lava cones and tubes, gently undulating plains, and, along the north-western peripheries, steep foothills that transition to the true Idaho batholith of the Rocky Mountain Cordillera. Lava flows can exhibit rough, sharp lava called *aa* (ah-ah), or ropy, smoother lava called *pahoehoe* (pah-hoy-hoy), with other features present such as cinder gardens, spatter cones, lava bombs, tree molds, pressure ridges and blisters, depressions, and deep fissures. Within CRMO, there are many kipukas, which are vegetated areas of older soil or lava material surrounded by more recent lava flows. Often kipukas contain raised areas and knolls, which forced more recent low-lying lava flows to go around them. At roughly 240,000 acres/97,127 hectares in size, Laidlaw Park, a shrub-grass land surrounded by stark lava, may technically be considered the world's largest known kipuka. CRMO ranges in elevation from about 4,270 feet/1,302 meters along the southernmost boundary to 7,729 feet/2,356 meters in the foothills above Little Cottonwood Springs, with the vast majority being less than the 5,800 feet/1,768 meters at its Headquarters.

CRMO receives high visitation, especially in winter. Of note, CRMO is one of only three units in the National Park system that contain portions of the Oregon National Historic Trail. In CRMO, portions of the Goodale's Cutoff pass through the extreme northern boundaries. Trail ruts are still visible in the Park Unit.

Purpose of Study

This summary document reports accomplishments in fulfilling the National Park Service's NPSpecies Initiative for the Craters of the Moon National Monument and Preserve Park Unit. The national initiative has the goal of documenting at least 90% of known or suspected plant, animal, and other organismal taxa in all Park Units. Evidence of taxa occurring in a Park Unit can be recorded in three manners: verified voucher specimens, reference citations, or observations. The initiative began in the 1990's and is now ending. Most Park Units have completed inventories for vascular plants, animals, fish, and reptiles/amphibians, but inventory work for lower organisms and non-vascular plants has not been adequately performed in many units. CRMO currently employs a resources person, Mark Hutten, who specializes in non-vasculars, and who is working on their inventory.

Although past work had presented species lists, and a flora had been written in the 1960's, no thorough, systematic vegetation inventories had ever been conducted in CRMO. The Park Unit also recognized a lack of formal vegetation inventory associated with the significant expansion into BLM-administered land in 2000. As a result, formal field inventories throughout newly-defined CRMO unit became part of CRMO's goal to accomplish NPSpecies objectives, and all land under the expanded ownership was incorporated into inventory goals.

My tasks were to inventory, collect, and record 90% or more of all vascular plant taxa present in CRMO, to enter results into the NPSpecies database, to generate a plant checklist, and to create an up-to-date working herbarium for the Park Unit. This summary report overviews the NPSpecies efforts and findings for CRMO. The attachments are the principle products presented in this summary report, and form its main substance. More detailed discussions addressing efforts and results may be presented in a May, 2008 final report. Additional attachments will accompany the final report. It will also contain products from a similar inventory effort conducted by my team for Hagerman Fossil Beds National Monument (HAFO) from 1994 to 2002 as part of this initiative.

The Project Team

A "core team" of three botanists very well qualified with the area's flora and landscape was formed: Steve Popovich, Duane Atwood, and Michael Curto. I was the team leader, selected because of my keen knowledge of the local flora and landscape based on past experience in surveying CRMO and its newly-expanded areas while a BLM Botanist in the abutting Shoshone Field Office. Prior to this project, I had a very good working knowledge of the local flora, including rare plants and habitats, weeds, seeded species, missing gaps in species lists, and identification of particular areas or habitats needing more survey work. Dr. N. Duane Atwood, Collections Manager of Brigham Young University's Stanley L. Welsh Herbarium (Herbarium BRY), served as taxonomic and field logistics advisor on the team, and determined all plant collections other than grasses (Poaceae). Duane is highly competent in Intermountain Flora and southern Idaho plants,

and is a co-author of *A Utah Flora, Third Edition, Revised* (Welsh et al, 2003). Michael Curto (Herbaria UTC, OBI) has many years experience dealing specifically in taxonomy of Idaho and Western U.S. grasses. Mr. Curto studied under Mary Barkworth (Herbarium UTC), is highly skilled in grass taxonomy, and over the years has reviewed and annotated nearly all collections of grasses made in Idaho, including local collections that are deposited throughout Western U.S. herbaria and elsewhere. He determined all Poaceae and grass synonymy for this project, and helped form a list of addition grass taxa to survey for in outyears. Both Duane and I conducted the bulk of the field work under this project. Ms. Carol Blackburn, a local resident in Shoshone, assisted us in field work in 2002 and 2006 as an expanded team member. She was able to gain access across certain private properties that we could not secure, and is particularly knowledgeable in weedy and ornamental or horticultural species of the area, a valuable assist. For the Phase II 2006 field season, we also added Michael Mancuso as an expanded team member, a former Botanist for the Idaho Natural Heritage Program. He conducted surveys in focused areas. He is well qualified in plant identification in Idaho, including rare plants. Numerous other botanists and taxonomists well known in their specialized taxonomic area were consulted to identify problem specimens, including some of the authors of *Intermountain Flora, Vascular Plants of the Intermountain West, U.S.A.* (Cronquist et al, 1972-2005), and are identified under the *Specimen Identification and Verification Process* portion of the *Methods* section. This team therefore was comprised from among the most-qualified people anywhere to conduct vascular plant work in southern Idaho.

General Vegetation of CRMO

CRMO has four seasons, with cold winters usually bringing substantial precipitation in the form of snow, and summers that can be considerably hot and dry, with temperatures regularly exceeding 100° F/38° C in late summer. Annual precipitation in CRMO ranges from 8-12 inches/20-30 centimeters in the lower elevations and southern end to 12-16 inches/30-41 centimeters across much of its middle portions, and to 18 inches/46 centimeters or more in the northern end at greatest elevations in the foothills.

Floristically, CRMO is part of the Snake River Plain (also called Snake River Plains) Section of the Great Basin Division of the Intermountain Region (Cronquist et al. 1972), and can be considered a semiarid “cold desert.” The Snake River Plain is a vast stretch of flat or gently undulating shrub-grass landscapes on shallow basaltic soils overlaying thick basalt parent material, with occasional old, gently-sloped volcanic buttes and ephemeral drainage ways. Vegetation of the Snake River Plain is closely tied to soil types and precipitation, and potential rangeland vegetation composition believed to be represented historically based on soil and climate properties can be found in the area’s county soil surveys produced by the Natural Resources Conservation Service (NRCS), formerly Soil Conservation Service (SCS).

Vegetation in the Park Unit was historically shrub-steppe typical of the Intermountain Region. Communities include a dominant shrub, usually sagebrush (*Artemisia*), and associated grasses and herbs, and are typically rather open and sparsely vegetated. The

sagebrush-steppe of CRMO was formerly dominated by big sagebrush (*Artemisia tridentata* – mostly Wyoming big sagebrush, *Artemisia tridentata* var./ssp. *wyomingensis*, but also basin big sagebrush, *Artemisia tridentata* var./ssp. *tridentata*, and, in CRMO's foothills and lava flows, mountain big sagebrush, *Artemisia tridentata* var./ssp. *vaseyana*) – and various native bunchgrasses, principally Sandberg's bluegrass (*Poa secunda sensu stricto*, also called *Poa sandbergii* as applied to North American material), bluebunch wheatgrass (*Elymus spicatus*), and, in CRMO's foothills and Laidlaw Park, Idaho fescue (*Festuca idahoensis*). Other formerly-common bunch and rhizomatous native grasses include needlegrasses (mostly *Stipa comata* and *Stipa thurberiana*, but also *Stipa nelsonii* in the northern portions of CRMO), wheatgrasses (mostly *Elymus lanceolatus* and *Elymus smithii*), basin wildrye (*Elymus cinereus*), bottlebrush squirreltail (*Elymus elymoides*), and Indian ricegrass (*Stipa hymenoides*).

Much of the vegetation of the Park Unit not occurring on lava flows has been drastically altered since European exploration and settlement beginning in the mid-1800's. Presence of the Oregon Trail passing through CRMO resulted in localized intense livestock grazing and other uses. Long-term grazing pressure from sheep and cattle (and to some degree horses along historic trail ways and in some BLM-administered areas of CRMO) throughout most of the Park Unit has substantially reduced native grasses and herbs over time, and even shrubs preferred by livestock, such as winterfat (*Eurotia lanata*) and saltbush or shadscale (*Atriplex* spp.). During the 1900's, grazing, fire suppression, and concomitant invasion of non-native weedy plant species, especially the annual plant cheatgrass (*Bromus tectorum*) rapid increase in the 1940's onward, has produced low-diversity, decadent sagebrush stands and resulting wildfire fuel accumulations that can burn over large areas with fine, continuous fuels from cheatgrass and large unburned conterminous sagebrush blocks. As a result, in the latter half of the 1900's, wildfires increased dramatically in size, frequency, and intensity, with local fires sometimes exceeding 150,000 acres in size, eliminating or reducing big sagebrush presence and converting vast acreages to areas dominated by cheatgrass, weeds, Sandberg's bluegrass, and rabbitbrush (*Chrysothamnus nauseosus* and *Chrysothamnus viscidiflorus*), which tolerates disturbance and is a vigorous resprouter following fire, or, in areas administered by the BLM, non-native grass or grass-herb wildfire rehabilitation seedings usually dominated by crested wheatgrass (*Agropyron cristatum sensu amplo*).

The highly aggressive and weedy annual cheatgrass is by far the most common non-native vascular plant occurring in CRMO. The Park Unit also has a moderate presence of the weedy ally corn brome (*Bromus squarrosus*). Across southern Idaho and within CRMO, many thousands of acres/hectares have been converted to cheatgrass dominance or co-dominance due to repeated wildfires and livestock grazing. Additionally, many thousands of acres have been seeded in areas administered by the BLM across southern Idaho and within CRMO to non-native perennial crested wheatgrass in an attempt to check the spread of cheatgrass and wildfire, and to provide enhanced livestock forage. This has resulted in vast monocultures, or stands of crested wheatgrass codominant with native Sandberg's bluegrass, which, as with areas dominated by cheatgrass, lack much of their former rich native biological diversity. Great care has been taken to ensure that rangeland or wildfire rehabilitation occurring within all areas administered by the NPS within CRMO use native plant materials whenever feasible, and crested wheatgrass is

never used. In BLM-administered areas within CRMO, the incorporation of native plants is increasing, but non-native materials are still widely used.

Floristic Zones of CRMO

As part of the NPSpecies efforts, generalized floristic zones for CRMO were developed, and a map showing the zones has been derived (Attachment 5). For the purposes of this project, a floristic zone is defined simply as an area supporting the existing plant communities found in the zone that are more similar to themselves than to plant communities found in a different zone. More in-depth, formal vegetation types have been mapped by Day and Wright (1985) and the NPS (unpublished data on file with CRMO). Generally, CRMO is hottest and driest in the south, and becomes increasingly cooler and wetter with greater elevation and precipitation in the north. Its vegetation is well-correlated with this change in environmental attributes. Although much of CRMO's vegetation has been altered from its original state, many areas of CRMO still retain relatively less-disturbed, functioning diverse sagebrush-grass-herb communities, especially in the northern third. These vegetation communities have many values, among which is to serve as important ecological benchmark or scientific reference areas. As depicted in Attachment 5, vegetation in CRMO can be separated into nine broad floristic zones or groupings.

Floristic Zones 1 and 2 compromise the majority of CRMO. The first zone, occurring in non-lava areas in most of the southern portions of CRMO and on most land administered by the BLM, is characterized by undisturbed but more commonly moderately to severely disturbed sagebrush-steppe typical of the Snake River Plain. This includes large-scale non-native grass seedings and otherwise altered plant communities dominated by cheatgrass, weeds, rabbitbrush, crested wheatgrass, and Sandberg's bluegrass. Such communities are often homogenous and species poor. In areas administered by the BLM in these zones and throughout CRMO, non-native grass or grass-herb seedings are usually dominated by crested wheatgrass but may contain other non-native seeded species such as intermediate wheatgrass (*Elymus hispidus*), tall wheatgrass (*Elymus elongatus* ssp. *ponticus*), sainfoin (*Onobrychis viciifolia*), small burnet (*Sanguisorba minor*), blue flax (*Linum perenne*), and sometimes Russian wildrye (*Elymus junceus*) or alfalfa (*Medicago sativa*), which are weakly or not at all persistent. Many native species (albeit with seed sources that are often off-site) are being used more regularly, and may include Sandberg's bluegrass, big bluegrass (*Poa ampla*), bluebunch wheatgrass, Snake River bluebunch wheatgrass (*Elymus wawawaiensis*, native to Idaho but not to CRMO), thickspike and riparian wheatgrasses (*Elymus lanceolatus*), Western wheatgrass (*Elymus smithii*), needleandthread grass (*Stipa comata*), Indian ricegrass, sand dropseed (*Sporobolus cryptandrus*), Wyoming or basin big sagebrush, fourwing saltbush (*Atriplex canescens*), and other species less frequently used. Weedy herbs often common on disturbed sites include tumbled mustard (*Sisymbrium altissimum*) and prickly lettuce (*Lactuca serriola*). Less-disturbed areas are often dominated by even-aged stands of Wyoming big sagebrush and/or threetip sagebrush (*Artemisia tripartita*), with often open, sometimes almost barren, interstitial areas dominated by Sandberg's bluegrass and squirreltail. The second zone is characterized by relatively less-disturbed sagebrush communities often situated on moister, cooler range sites, and often containing relatively

less cheatgrass presence and increased presence of bluebunch wheatgrass, other native bunchgrasses, and greater amounts and diversity of herbs. These areas are most prevalent in the northern 1/3 portion of CRMO. In both groups, the dominant shrubs are Wyoming big sagebrush in less disturbed areas and rabbitbrush in more disturbed areas. Stands of basin big sagebrush can be found in deeper soils and cracks of lava blisters. In many areas of these zones, especially in alkaline-tending or heavier soils, threetip sagebrush is dominant or co-dominant with Wyoming sagebrush.

The third floristic zone is the small Huff Creek geothermal hot springs area. Situated on the boundary of CRMO and private land, it contains thermally-influenced riparian vegetation communities that are not found in the rest of CRMO. It does not contain particularly rare vascular plants, and until around 2004 when an enclosure was erected, was grazed by cattle under BLM management.

The fourth zone is the montane shrub-grass foothills of the areas north of Highway 20/26/93, formerly called the “North Unit,” and expanded to include additional BLM-administered foothills along and north of the highway. The steep foothills are not always of basaltic soils, and are dominated by mountain big sagebrush on ameliorated sites and by low sagebrush (*Artemisia arbuscula*) on harsher or thinner-soil sites. Certain low sage exemplar areas have been nominated as a National Natural Landmark (Idaho Natural Heritage Program, 1989). Bitterbrush (*Purshia tridentata*) and to a lesser degree Utah snowberry (*Symphoricarpos oreophilus*) can be locally common. Dominant grasses occurring with mountain big sagebrush and bitterbrush communities include Idaho fescue and bluebunch wheatgrass, with Sandberg’s bluegrass, Nelson’s needlegrass (*Stipa nelsonii*), oniongrass (*Melica bulbosa*), slender wheatgrass (*Elymus trachycaulus*), junegrass (*Koeleria macrantha*), and upland sedges (*Carex* spp.) often well represented. The dominant grasses occurring with low sage are usually Idaho fescue or Sandberg’s bluegrass. Common herbs of the foothills include buckwheat (*Eriogonum* spp.), lupine (*Lupinus* spp.), arrowleaf balsamroot (*Balsamorhiza sagittata*), phacelia (*Phacelia* spp.), valerian (*Valeriana* spp.), smallleaf angelica (*Angelica pinnata*), and hawksbeard (*Crepis* spp.). Obscure phacelia (*Phacelia inconspicua*), the most globally-rare vascular plant known to occur in CRMO, has been documented within CRMO only in a few areas of the North Unit (Popovich, 2001), Pratt Butte (Murphy, 2002b), and Snowdrift Crater (P. Wolken 1174b, CRMO catalog number 5067), but a fair amount of suitable habitat remains unsurveyed, and it may well occur elsewhere. The numerous ridgelines, occasional rock outcrops, and harsh sites can be rather devoid of vegetation, and often exhibit stunted low sagebrush, Sandberg’s bluegrass, and low-to-the-ground herbs adapted to difficult growing conditions such as stemless mock goldenweed (*Haploppapus acaulis*). On cinder cones and cooler, wetter north- or east-facing foothill slopes, small conifer stands are present, and are dominated by Douglas-fir (*Pseudotsuga menziesii* var. *glauca*). Some localized aspen (*Populus tremuloides*) stands are also present on sideslopes, at some of the occasional seeps, and in draws, often with many herbs and grasses in their understories, particularly blue wildrye (*Elymus glaucus*) and pinegrass (*Calamagrostis rubescens*). Occasionally, limber pine (*Pinus flexilis*) and Rocky Mountain juniper (*Juniperus scopulorum*) are encountered.

The fifth zone is flora transitional to the adjacent Big Lost River Valley and Idaho National Engineering and Environmental Laboratory (INEEL, formerly INEL) flora. These areas adjacent to CRMO exhibit more components of saline- and alkaline-adapted plant communities. Within increasing proximity to these areas abutting the extreme northeast and east-northeast peripheries of the Park Unit, subtle indicator species better adapted to sandy, salty and/or alkaline soils scarcely begin to appear, such as shadscale, saltbush, winterfat, spiny hopsage [*Grayia* (= *Atriplex*) *spinos*a], and sand dropseed. Threetip sagebrush is often dominant.

The sixth floral zone contains trace amounts of plants associated with the hotter, dryer Snake River Plain of more eastern Idaho, such as Utah juniper (*Juniperus osteosperma*). The seventh zone contains presence of species associated with hot, dry, and often sandy soils of the more western Snake River Plain, similar to native flora observed in the Hagerman or Mountain Home areas. As with the INEEL transitional flora of Zone 5, Zones 6 and 7 are marked by subtle, small shifts in plant community composition and appearances of species more commonly occurring in hotter, dryer growing conditions, or in sandy habitats. Along the extreme southern boundary of CRMO, the hottest, driest situations can be found, and there are pockets of sandy soils and sandy blowouts supporting sand-affinity species like white tidytips (*Layia glandulosa*), sharpleaf beardtongue (*Penstemon acuminatus*), and yellow wildrye (*Elymus flavescens*).

The eighth floral zone is the vegetation on lava flows. Vegetation on flows can range from near absence to moderate presence and cover, depending upon the type of lava and the flow age. Older flows with relatively more soil deposition in cracks and flatter undulations or smoother lava generally contain more vegetation. Plants common on lava flows include limber pine, juniper, mountain big sagebrush, bitterbrush, fernbush (*Chamaebatiaria millefolium*), spirea (*Holodiscus dumosus* var. *dumosus*), dwarf goldenbush (*Haplopappus nanus*), narrowleaf wirelettuce (*Stephanomeria tenuifolia* var. *myrioclada*), sticky cinquefoil (*Potentilla glandulosa*), turpentine wavewing (*Cymopterus terebinthinus* var. *foeniculaceus*), scabland beardtongue (*Penstemon deustus*), fleabane or daisy (*Erigeron* spp.), Sandberg's bluegrass, and cheatgrass. The beautiful shrub Lewis's mock-orange or syringa (*Philadelphus lewisii*) is the State Flower of Idaho, and in CRMO is completely restricted to lava flows, where its fragrant, bright white flowers are strongly contrasted against the stark black hues of the lava rock. Curlleaf mountain-mahogany (*Cercocarpus ledifolius*) is fairly common north of CRMO but is known within the Park Unit only at two small sites on lava flows, a somewhat unusual occurrence. Ferns, some rare within CRMO, mosses, and sedges occur in deep, sheltered cracks and lava tube openings, where the air is cooler and water is available at the rooting zone. Cinder gardens are frequently dominated by Great Basin wild buckwheat (*Eriogonum microthecum* var. *laxiflorum*), dwarf cushion wild buckwheat (*Eriogonum ovalifolium* var. *depressum*), dusty maiden (*Chaenactis douglasii*), scorpionweed (*Phacelia hastata*), and bitterroot (*Lewisia rediviva*), and can explode with colorful flowers in favorable years, especially with dwarf monkeyflower (*Mimulus nanus*), buckwheat, and blazingstar (*Mentzelia* spp.)

Unfortunately, many old and ecologically significant trees on CRMO's lava flows and in the North Unit were cut in the 1960's in a well-intentioned but ecologically insensitive

attempt by the National Park Service to inhibit the spread of dwarf mistletoe (*Arceuthobium cyanocarpum*). By 1967, at least 6,600 limber pine trees were believed removed in a 2-square-mile area, with plans for the “continuation of the program” (Wunner, 1967). I have observed many old stumps of Douglas-fir trees in stands on cinder cones north of Highway 20/26/93, which I am told is more often believed to be a result of historic use and proximity to the Oregon Trail rather than of NPS vegetation management. In Wood Road Kipuka of the southern edge of CRMO, many old, bonsai-appearing junipers were cut for fuel wood and fence posts in the first half of the 20th century, and old-timers have recalled to me the need for taking such measures in the early part of the 20th century. I once saw a beautiful bonsai-looking polished juniper section taken from there in the 1970’s being used as a jewelry display at an art fair in Shoshone, Idaho. The section was loaned to the USGS office where I worked in Corvallis, where studies by dendrologists showed that it was about 450 years old, but the reason for the particularly acute and interesting morphology was not resolved. The owner said that many people had harvested such trees in the area over time.

A ninth floristic zone is the riparian areas scattered across CRMO (not depicted on Attachment 5). There are several intermittent or weakly perennial drainages and seeps in the foothills. The most significant bodies of water are relatively small, and are comprised of Lava Lake southwest of the Headquarters along Highway 20/26/93, which is man-made, playas such as Steamboat Lake, which are numerous and localized in Laidlaw Park and outlying areas, and a geothermal seep at Huff Creek. Many riparian areas tend to be alkaline-tending. Riparian vegetation in CRMO comprises species typical of local riparian communities. Somewhat surprisingly, no playas examined to date have yielded exceptionally rare species, perhaps due in part to the high levels of historic and on-going livestock use as watering stations. A few of the locally-rare riparian species occurring in the Lava Lake or Huff Creek geothermal spring areas within CRMO are lesser Indian paintbrush (*Castilleja exilis*), Bacigalupi’s downingia (*Downingia bacigalupii*), and fleshy porterella (*Porterella carnosula*), with beaked spikerush (*Eleocharis rostellata*) being observed but unconfirmed. Draws and microsites with soil water retention may exhibit chokecherry (*Prunus virginiana* var. *melanocarpa*) and aspen, and sometimes cottonwoods (*Populus* spp.) and willows (*Salix* sp.). Occasional water sources, sometimes called “sinkholes,” are found on stark lava flows in areas where water is discharged, but seldom contain noteworthy vegetation, with soils being largely undeveloped or absent. Some saturated depressions in lava on the Carey Flow western edges near agricultural water sources contain weedy riparian vegetation.

Kipukas and Scientific Value

Most kipukas in CRMO have presumably never been grazed by domestic livestock, and are therefore valuable as range reference areas and vegetation refugia. Some kipukas, however, may have been historically grazed by livestock. Little Prairie and nearby areas were apparently once used by domestic sheep. In the early 1990’s I visited an old abandoned sheep wagon inside North Laidlaw Butte Kipuka situated on heavy snow runners, and also have observed from a helicopter what looks like an old sheep trail, possibly widened by heavy equipment, to that kipuka. I have heard rumors from knowledgeable local ranchers that Carey Kipuka may have been historically used in hard

times for sheep grazing, although I cannot determine reasonable access unless possibly over snow. The hiking trail from the east does not seem feasible for livestock. I did notice a faint possible trail from the west while flying overhead. Hovering overhead in a helicopter in the mid-1990's, I followed rock cairns denoting a distinct trail into Bear Park Kipuka. Nonetheless, several valuable studies of kipuka vegetation have been conducted in CRMO. The more substantive studies are Passey and Hugie (1962), Hugie et al (1964), Hugie (1970), Anderson and Lovejoy (1979), Hironaka et al (1983), Hosten (1995), and unpublished kipuka field inventories conducted by CRMO around 2006. Results of vegetation studies in kipukas should be used with caution when comparing as reference areas to the rest of the Snake River Plain. Kipukas may contain different soils, soil chemistry and depths, and soil temperatures, with even slight differences producing different assemblages of vegetation over thousands of years, and therefore, depending upon study goals, may or may not be appropriately comparable to other areas. It would be particularly challenging in using kipukas to isolate and examine the variable of livestock grazing influences from among the many other confounding site factors that contribute to differences between ungrazed kipukas and grazed areas elsewhere on the Snake River Plain. Very regrettably, many kipukas, even those situated in the deep interior of the lava flows, contain high levels of cheatgrass and sometimes other weeds. This may represent invasions from wind and/or animals, and is exacerbated by wildfire.

Laidlaw Park and Scientific Value

The 240,000-acre Laidlaw Park area split by Zone 1 in the south and Zone 2 in the north deserves special mention. Laidlaw Park, which was not accessible to domestic livestock grazing until around 1908 when rough roads were forged over the previously-isolating stark lava flows, was one of the last areas in southern Idaho to be manipulated by man or grazed by livestock. As a result, some of its areas are of high biological and scientific value, and can serve as exemplar range reference areas. Portions of it exhibit some of the least disturbed vegetation of the Snake River Plain, a highly significant statement, with good presence of big and threetip sagebrush, bluebunch wheatgrass, taller *Poa* species, other native bunchgrasses, a diversity of native herbs, and little to nearly absent cheatgrass. Bluebunch wheatgrass, junegrass, needlegrass, and threadleaf sedge (*Carex filifolia*) are locally abundant. Some of the stands of bitterbrush and sagebrush are among the best remaining examples in CRMO. Grey horsebrush (*Tetradymia canescens*) is occasional in north Laidlaw Park and northeastward, but largely absent elsewhere. Unfortunately, wildfires have increased in the area, and two large recent wildfires, one in 1992 ("Potter Butte fire") and another in the 2000's, burned much of the landscape and sagebrush in the central portion, resulting in significant soil erosion and fire rehabilitation seedings of native and non-native plant materials in BLM-administered areas. The most remaining unburned vegetation in Laidlaw Park is found north of a west-east line running from Ant Butte to the south end of Little Laidlaw Park. This may correlate with slightly cooler temperatures and greater precipitation. Often being more dominated by Idaho fescue, and containing range sites that are somewhat cooler and moister with heavier soils, much of the vegetation north of this line may not be highly representative of what existed prior to grazing in more southern areas of Laidlaw Park, and possibly much of the dryer Snake River Plain. The "thumb," constituting south-east Laidlaw Park, is hotter and dryer, with sandier soils. This area has good representation of the bunchgrasses

needleandthread and Indian ricegrass. As with other areas of Laidlaw Park, large wildfires in the 1990's have burned much of the former sagebrush communities, and have fostered increases in cheatgrass. Some individuals in stands of basin big sagebrush as tall as 6-8 feet/1.8-2.4 meters along the thumb's eastern junction with lava flows had about 100 rings at their burned bases noted in post-burn inspections (Popovich, wildfire rehabilitation pers. observations in mid-1990's).

Wildflowers

Many species of herbs and wildflowers are present in CRMO, with incredible flower displays in wet years and good growing conditions. In springtime (mid April through early June depending upon elevation and year) with good conditions, the "green up" that can occur in CRMO is breathtaking. In 1993, wildflower displays in spring were particularly spectacular. They were among the most abundant and diverse in the last 30-50 years, according to many local old-timer wildflower enthusiasts I interviewed that spring who remembered similar years back to the 1930's. They were certainly the most conspicuous I observed 1992-2002 and 2006. Among the first flowers ushering in the spring are Anderson's buttercup (*Ranunculus andersonii*), woodlandstar (*Lithophragma* spp.), yellowbells (*Fritillaria pudica*), bluebells (*Mertensia* spp.), violet (*Viola* spp.), biscuitroot (*Lomatium* spp.), and turkey peas (*Orogenia linearifolia*). Flowering peaks in several phases from snowmelt in spring through September, with most flowering done by late June, but some species can be found in flower as early as February and others (especially non-native weeds) as late as through November. Plentiful spring precipitation, summer storms, and moderate spring and summer temperatures are paramount to promoting the most productive and beautiful growing seasons. A leaflet with photographs of some of the many beautiful wildflowers to be found in CRMO is available at Headquarters (Craters of the Moon Natural History Association, undated).

Among my favorite plants in CRMO are: Cusick's primrose (*Primula cusickiana*), largeflower gymnosteris (*Gymnosteris nudicaulis*), smallflower gymnosteris (*Gymnosteris parvula*), Beckwith's violet (*Viola beckwithii*), yellowbells, dwarf monkeyflower, Suksdorf's monkeyflower (*Mimulus suksdorfii*), Picabo milkvetch (*Astragalus oniciformis*), woollypod milkvetch (*Astragalus purshii*), hare's foot locoweed (*Oxytropis lagopus*), turkey peas, syringa, golden sedge (*Carex aurea*), bluebunch wheatgrass, Western serviceberry (*Amelanchier alnifolia*), curlleaf mountain-mahogany, and bitterbrush.

Historic Botany Work In and Near CRMO

The following discussion represents the first time that historical botanical work in CRMO has been thoroughly synthesized and presented. It is based upon information gained from the NPSpecies efforts and my personal knowledge and experience while working for the Shoshone BLM and shared work with CRMO. All literature reviewed as part of this exercise is listed in Attachment 13 (there are about 6 additional references not appearing in the attachment). Personal interviews or communications have also occurred with several of the authors of the reports cited below, as well as those familiar with CRMO

history, and resulting information has been included.

Early Botanical Explorers

As part of western exploration by Europeans in the 18th century and subsequent settlement in the 19th century, present-day Idaho and the Snake River Plain were of strategic and economic importance to Spain, England, France and the fledgling United States. Early explorers who may have passed through the Snake River Plain in the CRMO area in the early and mid 1800's to and from important Fort Hall (near present-day Idaho Falls) include Peter Skene Odgen, John C. Frémont, and mountain men and fur traders associated with the North West Company, Hudson's Bay Company, American Fur Company, and the Rocky Mountain Fur Company. The Lewis & Clark Expedition passed through northern Idaho well north of CRMO and did not enter the Snake River Plain. Early botanical explorers to the Intermountain Region who may have passed through CRMO, and who were probably the first Europeans to collect plants for scientific purposes on the Snake River Plain, include John McCleod, Thomas Nuttall, Joseph Burke, and Karl Geyer. Early botanical explorers to the Intermountain Region and its general vegetation ecology are discussed in detail in *Intermountain Flora* (Cronquist et al, 1972, vol. 1)

More recent notable historic and contemporary botanists who collected in southern Idaho and are known to have, or may have, collected within or near CRMO include, but are not limited to: Atwood, Baker, Christ, Christ & Christ, Coulter, Cronquist, Davis, Douglass Henderson, Hitchcock, Hitchcock & Martin, Hitchcock & Muhlick, Holte, McBride, McBride & Payson, Packard, Payson & Payson, and Reveal. Others who may have collected in the area include: Dixon, Ertter, L.F. Henderson, Holmgren, Aven Nelson, Pennell, and Sandberg. The reader may recognize many of these names as familiar to the world of Western U.S. pioneering botany.

Lewis et al (1964) reported a collection from Macbride & Payson of *Gayophytum racemosum* (Macbride & Payson 3032) as collected from "Lava Lake, Idaho," which is on the boundary of CRMO. They also reported a collection from Cronquist of *Gayophytum ramosissimum* (Cronquist 2414) as collected in "Craters of the Moon, Butte County." In both cases they do not cite herbaria. One specimen collected by R. J. Davis in 1933 resides at the Park Unit (CRMO catalog number 4163). An expedition under the name "Chas D. Sneller Expedition," the details of which are curious but are not known to me, apparently was in CRMO and made collections in June and July, 1936, and possibly other times. Between 100 and 150 specimens at CRMO collected around that time period with collectors unidentified may be from that expedition or related efforts, but this has not been confirmed. Virginus H. Chase, relative to Agnes Chase, reviser of *Manual of the Grasses of the United States*, 2nd ed. (Hitchcock, 1950), collected at least 57 specimens residing at CRMO, presumably as part of a bigger collection under the expedition, including two grass specimens deposited at the Park Unit that Agnes Chase determined, probably at the National Herbarium (Herbarium US). In *Intermountain Flora* (1977, vol. 6), Cronquist et al state that *Allium parvum* is found "at the Craters of the Moon," but they do not cite a specimen, and the presence of this taxon is

unconfirmed. A few taxa are cited as being present in CRMO in *Flora of the Pacific Northwest* (Hitchcock and Cronquist, 1973), but they do not cite specimens, and cited taxa are well documented with other vouchers residing in CRMO. There were likely many others who may have passed through and collected incidentally in such an alluring area, such as Coville or Leiberg. Of note, Per Axel Rydberg annotated several collections from CRMO.

Work Performed within CRMO

Considerable botany-related work has been conducted in CRMO, and many informal and formal studies and lists have been reviewed by myself. These are presented in full (sometimes with abstracts included) in my *User's Guide*, page 73 (Popovich 2006a, Attachment 2). While some of this work is highly botanical in nature, most of this work has not been for purely botanical purposes, and has focused instead on wildlife, avifauna, rangeland, soil, noxious weeds, general baseline vegetation inventory, or wildfire or denuded rangeland vegetation rehabilitation. The majority of resulting plant lists are generally unreliable, and usually cannot be verified by voucher collections.

Descriptions and studies of botanical resources at CRMO have made progress in fits and starts, some years gaining momentum, some years passing in silence. The earliest plant list reviewed under the NPSpecies project was written by Marie McElreath in 1928, and appears as a *Flora* section in a formal publication entitled *Craters of the Moon National Monument, Idaho* (McElreath, 1928a, in Stearns, 1928). It contains a short but fairly instructive discussion on general vegetation of CRMO, and lists 65 scientific names of plants “found in the area” divided into trees, shrubs and herbaceous plants, and grasses. Interestingly, the non-native hugely problematic weedy grass *Bromus tectorum* (cheatgrass, called “brome grass” in the report) appears on the list. The publication seems to have been successful, because it was reprinted at least six times (McElreath, 1928b, in Stearns, 1959). The next formal sizable plant list appeared in 1941 (Eggler, 1941). Other vegetation and animal studies through time, often conducted as Masters theses in the 1960's through the early 2000's at Idaho colleges, began to include species lists (e.g., Anderson and Lovejoy, 1979; Lovejoy, 1980; Day, 1985; Hanser 2001), with long-term vegetation monitoring eventually being reported in various forms (e.g., Glennon et al, 1998; Majors, 2000). The Soil Conservation Service (now Natural Resources Conservation Service) and others used vegetation and soil characteristics from some sites in and nearby CRMO to help form formal rangeland site descriptions (e.g., Soil Conservation Service, 1958-1968; Hironaka and Fosberg, 1979; Passey et al, 1982; Hironaka et al, 1983). In 1985, Day and Wright derived the first in-depth vegetation typing for CRMO (Day, 1984; Day and Wright, 1985).

The first significant plant list for CRMO was prepared by Robert C. Wunner in 1967, entitled *A flora of Craters of the Moon National Monument* (Wunner, 1967). It listed 291 taxa, and represented a comprehensive flora of all vascular plants known to occur in CRMO at that time. Wunner collected plant specimens in Craters of the Moon National Monument while he was a Seasonal Naturalist from March to September, 1967, while concurrently completing a Master's thesis at Humboldt State College (now Humboldt

State University) that resulted in *A Flora of Lava Beds National Monument* in California (Wunner, 1970). He actually conducted his CRMO collection determinations while a student at the University of Kansas (Herbarium KANU) (Wunner, pers. comm. with S. Popovich, winter 2004). His CRMO *Flora* was an exceptional work given the constraints of the time, and it is still the only document that contains working keys of the flora for the Park Unit. His introduction and comments on the distribution and abundance of species are particularly helpful. A total of about 316 specimen sheets collected by Wunner in 1967 are in the CRMO database.

Karl Albert Urban, a deceased former National Park Service and Forest Service employee and nationally recognized for his contribution to awareness and management of botanical resources and wildflowers, worked at CRMO in 1966, 1967, and 1968, and possibly other times. He worked alongside Wunner, who learned many valuable things from Urban, and who recalls their comradery with fondness (Wunner, pers. comm. with S. Popovich, winter 2004). In Wunner's *Flora*, he states that "Urban's help in compiling distributional records, collecting specimens, and his knowledge of the flora was vital to the success of the study" (Wunner, 1967). Around the time Wunner departed CRMO, Urban revised the CRMO checklist slightly in 1968, which contained about 302 records (Urban, 1968a). His introduction is rather eloquent and pleasurable to read, and his attention to plant ecology is obvious. He also avidly pursued other projects relating to CRMO's vegetation resources, and produced several reports (Urban, 1967a, 1967b, 1971; Urban et al, 1971), including his Master's thesis, entitled *An ecological appraisal of the dwarf mistletoe problem at Craters of the Moon National Monument, Idaho* (Urban, 1968b). A total of about 78 specimen sheets collected by Urban in 1966, 1967, and 1968 are in the CRMO database. Work by Urban and Wunner was perhaps the first purely botanical work to be conducted in earnest in CRMO.

Several significant vegetation studies occurred during the 1980's, even though there is a lack of associated specimens in the CRMO herbarium. Bertrand F. Harrison conducted what may be the first formal field surveys of rare plants in summer 1981 in BLM-administered areas in and near CRMO (Harrison, 1981), from which three specimens are in the NPSpecies database. Field work was expanded in 1984 by Packard, Smithman, Mangan, and Carter (Packard and Smithman, 1984). During both studies, the surveyed areas were then not part of CRMO. In 1983, Roger Rosentreter compiled a list of uncommon plants on land then administered by the BLM-Shoshone Field Office (Rosentreter, 1983). The Idaho Natural Heritage Program assessed several areas occurring within the CRMO boundaries at that time as well as in nearby BLM-administered lands, and made recommendations of sites for consideration as *National Natural Landmarks* or *Research Natural Areas* in the North Unit, Brass Cap Kipuka west of CRMO Headquarters, and Sand Kipuka and Big Juniper Kipuka on the Wapi Flow (Caicco and Wellner, 1983a, 1983b; Idaho Natural Heritage Program, 1983, 1989). These areas have had subsequent visits in 1991, 1996, 1997, 1999, and perhaps other times (Mancuso, 1991; Rust 1996a, 1996b, 2004; Murphy, 2003a).

In 1988, Jennifer Blakesley and R. Gerald Wright generated a review of scientific research at Craters of the Moon National Monument, which presented some of the

vegetation studies accomplished by then (Blakesley and Wright, 1988). In 1991, Jennifer Whipple created a revised species list for CRMO (Whipple, 1992). In 1992, she collected specimens to further expand the list. Her noteworthy work is discussed in more detail in the *Plant Collection History* section below.

Field work by myself occurred in CRMO each year 1992 through 2002, as part of my normal work duties as Botanist for the BLM in areas administered by that agency 1991 through about 1997, as research duties for the USGS 1997 through about 1999, or for NPSpecies efforts. Some workloads as BLM Botanist involved collaborative duties with adjacent CRMO when resources staff were shared, such as assessing potential impacts to rare plants from the 1990's CRMO North Unit boundary adjustment and inventory of adjacent Blizzard Mountain, or assisting in reading vegetation plots at Carey Kipuka.

From 1992 to 1999, while BLM Botanist and USGS Plant Ecologist, I initiated and implemented numerous detailed and substantive studies on native and non-native vegetation wildfire rehabilitation (EFR) treatment efficacies and plant community responses following wildfires (Popovich, 1992-1999), as well as subsequent impacts to rare plants (Popovich, in prep 1). Roughly 100 permanent and temporary study plots were established on the BLM Shoshone District and read several years following wildfire, some of which occur in BLM-administered areas within CRMO. The consequent massive amount of synthesized data were cursorily analyzed in Corvallis by Dr. David Pyke, Research Plant Ecologist, and myself, but unfortunately, results were not formally published prior to my leaving the USGS to return to Shoshone as a private consultant.

While BLM Botanist, I conducted several studies of a rare endemic herb, Picabo milkvetch (*Astragalus oniciformis*) (Popovich and Pyke 1992-1999), and reported impacts from BLM wildfire rehabilitation efforts (Popovich and Pyke, 1997). A report details locations and methods of study plots for this taxon, some of which occur in BLM-administered areas within CRMO (Popovich, 1994a). I conducted a substantial survey effort during June 1994 to better delineate the range of this legume. The survey resulted in finding new disjunct populations east of the Great Rift lava fields and confident circumscription of the species' range (Popovich, 1994b). Several sites occur in areas administered by the BLM within CRMO. In 1995, I co-authored a status review of Picabo milkvetch, and uncommon or rare pollinators observed on the plants, including a possible new taxon, were also noted (Moseley and Popovich, 1995). Intrigued by the isolated nature of the sites east of the Great Rift lava fields, Jason Alexander (graduate student at Oregon State University), Dr. Aaron Liston (Herbarium OSC) and myself investigated whether or not the sites exhibited genetic differences from previously-known sites situated west of the substantial lava flows; interestingly, we found that they did not (Alexander et al, 2004). Some study sites included areas administered by the BLM within the larger CRMO boundary.

On June 16, 1989, Atwood made the first collection in the area of the rare herb obscure phacelia (*Phacelia inconspicua*) from BLM-administered land just within CRMO and on adjacent private property (Atwood 13620: RM acc. no. 548212, RM! S. Popovich 05

May 2007). This plant is considered to be the most globally rare plant occurring in CRMO. Shortly thereafter, Robert Moseley prepared a status review in 1989 (Moseley, 1989). I monitored the site several times in the 1990's. In 1993, Caryl Elzinga conducted rare plant surveys to augment Whipple's 1992 species list, resulting in the documentation of about 40 new species. She also encountered a few new small sites of obscure phacelia within the North Unit. The exact locations were never GPS'd by her (Elzinga, pers. comm. with S. Popovich, 1995), and she may have returned to collect in 1994 (Elzinga s.n., CRMO catalog number 2495). Over the next two years or so, NPS staff Natalene Cummings, Vicki Snitzler-Neek, and myself together tried several times in vain to relocate the Elzinga populations during the proper phenology using precise directions provided to myself by Elzinga. As a contractor, I again conducted re-surveys of her sites of obscure phacelia in 2001 without success (Popovich, 2001). Perhaps the exceptional growing conditions of late spring 1993 produced more plants in that survey year. Chris Murphy conducted additional surveys in and near CRMO and prepared another status review in 2003 (Murphy, 2002b, 2003b). Other reviews of this rare plant also exist (e.g., Holland, 1996).

In addition to the rare Picabo milkvetch and obscure phacelia, several other rare plants have been assessed or inventoried that occur in or near CRMO. Among these are the Idaho endemic Aaseae's onion (*Allium aaseae*) (McNeal, 1993), the globally-rare arching pussy-toes (*Antennaria arcuata*) (Lorain, 1990), least phacelia (*Phacelia minutissima*) (Moseley, 1995a), and Welsh's buckwheat (*Eriogonum capistratum* var. *welshii*) (Murphy, 2002a). Although not indicated in his report, Moseley cursorily searched some of the North Unit and near Pratt Butte for least phacelia as a minor part of his survey efforts in the Pioneer Mountains northwest of CRMO (Moseley, pers. comm. with S. Popovich, summer, 1995). Also not indicated in his report, minor survey efforts were conducted by Murphy for Welsh's buckwheat in the peripheries of the expanded CRMO North Unit, resulting in the finding of *Eriogonum crosbyae sensu lato* "capistratum" phase (Murphy, pers. comm. with S. Popovich, fall 2004). Material corresponding to the phase recognized as *Eriogonum capistratum* var. *welshii*, considered a rare Idaho endemic, is found nearby to the north of this Park Unit, but is not anticipated to occur within it; however, it is doubtful that the "welshii" phase will be retained as a separate entity under *Eriogonum crosbyae sensu lato* (Jim Reveal, Herbarium MARY, pers. comm. with S. Popovich, December, 2007).

I have a passion for, and am fascinated by, kipukas and their vegetation ecology. I have visited many kipukas numerous times within and surrounding CRMO from 1992 to 2002, both for work (e.g., Popovich, in prep 2) and for recreation. I have visited Brass Cap Kipuka twice, including once in the early 1990's while leading a Native Plant Society field trip co-hosted by Michael Mancuso. I have been to "Bear Paw" Kipuka four times, including once with Sheldon Bluestein, who has authored two books describing hiking opportunities of the high desert within CRMO and elsewhere (Bluestein, 1981, 1988), and once for NPSpecies efforts. I have visited Carey Kipuka at least six times, including once in the mid-1990's with Senator John Peavey, Mary Gaylord (former Shoshone BLM District Manager), Linn Kincannon (Idaho Conservation League), Mike Medberry (Idaho Conservationist), and John Shelly (Sawtooth National Forest), to discuss the

appropriateness of comparing vegetation in Carey Kipuka to ungrazed rangelands elsewhere on the BLM District; once to make observations regarding the occurrence probabilities of questionable species from Carey Kipuka cited in former CRMO references (Popovich, 1994c) and the possibility of historic sheep grazing in Carey Kipuka and North Laidlaw Butte Kipuka; and once for NPSpecies survey efforts. In 1995, I conducted aerial reconnaissance of difficult-to-reach kipukas to look for rare plants, landing inside the kipukas and inventorying the areas (Popovich, in prep 3). Dennis Fielding, former Entomologist for the Shoshone BLM Field Office while I was employed there, also had an interest in kipuka ecology and explored many kipukas in and nearby the southern reaches of CRMO. I have never encountered rare plants within kipukas. Overall kipuka vegetation based on my and Fielding's observations is sometimes very healthy, with excellent representation and high density of vigorous grasses, herbs, shrubs, and structural and species diversity, but also sometimes it is very "decadent," and not uncommonly it is very weedy, especially with cheatgrass, and is not otherwise incredibly remarkable. Recently, CRMO has conducted substantial vegetation inventories in kipukas, and has confirmed unexpectedly frequent occurrences of weeds.

In 1995, Paul Hosten, a PhD student at Utah State University, presented a rigorous review of traditional and contemporary philosophies of plant community ecological dynamics and successional pathways as applied to sagebrush-steppe ecosystems (Hosten, 1995). His study sites involved some areas within and near CRMO, including kipukas and the Laidlaw Park area, and I worked closely with him in strategizing study locations and logistics. Also in 1995, Robert Moseley assessed plant communities of Idaho's geothermal hot springs, including the Huff Creek geothermal springhead in CRMO (Moseley, 1995b). This resulted in a reliable observation of the uncommon plant beaked spikerush (*Eleocharis rostellata*), but no collection was made (Moseley, pers. comm. with S. Popovich, 1994). It has been searched for since then by the NPSpecies efforts but not encountered, although it is a fairly easily-recognized taxon that may be found with additional surveys.

Although I co-collected a few specimens of interest in 1999 and assessed field conditions and logistics in 2000, field work in CRMO for NPSpecies formally began in 2001, when I made several pilot field visits to test NPSpecies inventory protocols and begin collections. Principle field survey and collecting efforts under NPSpecies occurred by my team and myself in 2002 (Phase I) and again in 2006 (Phase II). There may well have been other recent vegetation studies or monitoring within CRMO about which I am unaware. In 2006, I produced a comprehensive vascular plant interim checklist for CRMO resulting from efforts in Phase I of the NPSpecies project (Popovich, 2006b; Attachment 3). Results increased the total number of taxa reported in CRMO from about 348 cited by Whipple in 1992 to 661 known to be present in 2006, plus 155 probably present, unconfirmed, encroaching, or falsely reported.

Work Performed adjacent to CRMO

In 1996, an academic group produced *Plant Communities, Ethnoecology, and Flora of the Idaho National Engineering Laboratory* (Anderson et al, 1996). This informative and

thorough treatise discussed many natural resources topics regarding CRMO's adjacent roughly 565,800-acre/229,000-hectare Department of Energy-administered land, called Idaho National Engineering and Environmental Laboratory (INEEL, formerly INEL), including a fairly comprehensive checklist of all plants known to occur. Although not part of CRMO, a fair amount of the Laboratory's land base is similar to CRMO and is about 6 air-miles/10 air-km from the northeastern boundary, and many of the plants occurring there also occur at CRMO. More recently, INEEL's Environmental Surveillance, Education and Research Program (ESER) has completed vegetation mapping, vascular plant checklists, and a noxious weed list, all of which are available on the World Wide Web. INEEL researchers started long-term vegetation monitoring in 1950 and 1957, which is of high scientific value and is among the longest-running vegetation monitoring program in southeast Idaho. Duane Atwood conducted the first comprehensive floristic survey of the area in the 1960's (Atwood, 1970). Roy Harniss and Neil West produced the first vegetation map of INEEL in 1973 (Harniss and West, 1973). Richard Jeppson sampled permanent vegetation plots in 1975, and established a working herbarium in 1976. Ray McBride and others produced a map of vegetation types and a description of soils in 1978 that has since been used by many other investigators (McBride et al, 1978). Anita Cholewa and Douglass Henderson (Herbarium ID) reviewed the status of rare vascular plants in INEEL in 1984 (Cholewa and Henderson, 1984).

Other survey work by the Idaho Natural Heritage Program has occurred near CRMO, mostly adjacent to the northwestern portions of the foothills (Rust et al, 2003, two reports with different co-authors). These surveys may have including portions of the recently-expanded North Unit and unknowingly crossed into and collected within areas administered by CRMO (Murphy, pers. comms. with S. Popovich, 2005). Moseley and others have surveyed areas east of CRMO administered by the BLM (e.g., Moseley, 1985).

Plant Collection History

There are 3,176 voucher records from within (or a few reference collections from near) CRMO in the NPSpecies database as of January, 2008. These cumulatively represent collections over time from about 30 collectors. Of this total, the total number of new plant voucher sheets assigned new catalog and accession numbers resulting from this project is about 2,288. The bulk of collecting occurred in the 1930's, 1960's, 1990's, and with the NPSpecies project 2001-2006. Various pioneering botanist collections and study collections from internal NPS efforts and Master's theses probably have been made about which we are unaware, and student collections, if extant, probably reside at respective universities.

The oldest plant collection known from CRMO is *Allium aaseae*, collected by R. J. Davis on May 14, 1933, and residing at the Rocky Mountain Herbarium (Herbarium RM) in Laramie, Wyoming (R. J. Davis 97: RM acc. no. 135484, RM! S. Popovich 08 July 2003). The material is in poor condition, not uncommon with *Allium* collections of that age. Originally identified as *Allium anceps*, it was annotated in 1947 by *Allium* authority

Marion Ownbey to “*Allium aaseae*, not typical.” The identification is still unconfirmed despite a recent evaluation by Dr. Don Mansfield (Herbarium CIC), and it is best regarded as *Allium confer aaseae*. The oldest plant collection residing in the CRMO working herbarium is *Achillea millefolium* ssp. *lanulosa* var. *lanulosa*, dated July 5th, 1935, collected by an anonymous collector with no collection number (CRMO catalog number 141). Some historic collections do not cite collection dates, but the collector names indicate that they are probably not from an earlier time period.

The first significant numbers of specimens known to be collected from CRMO were collected in the mid to late 1930’s, when about 300 collections were made that have been deposited in CRMO. They were collected from Virginus H. Chase, Dole, and the Chas D. Sneller Expedition, but mostly by collectors that are anonymous (perhaps NPS staff or as part of the above groups). Collections are then conspicuously absent for about 25 years, from 1938 to 1962, and I ponder whether that represents a lack of collecting effort or if unknown collections may exist elsewhere. About 60 specimens reside at CRMO that were collected between 1962 and 1965 by Buchanan, Contor, Hambly, Horning, and Menning. Urban, Wunner, and a few others collected about 383 specimens from 1966 to 1968 (only one was from 1968). There are no collections known from 1969 to 1979. Collecting resumed again in the 1980’s with about 100 collections by Adams, Barrington, Griffith, and others through 1988. Barrington later co-authored a fire management plan for CRMO (Barrington et al, 1989). In the early 1990’s, Whipple, Elzinga, and myself began making collections for NPS and BLM work assignments, some of which have been previously discussed.

By 1991, CRMO had a substantial historic collection of plants in an informal working herbarium. In that year, Jennifer Whipple, assisting CRMO while a Botanist for Yellowstone National Park (a position she still holds), expended significant effort in annotating specimens, organizing, and curating the by then ill-maintained herbarium, which contained about 705 rather poorly-curated specimens at that time (Whipple, 1992). Two hundred and eighty-two specimens (40% of all collections) needed annotation labels for either erroneous identifications or updated synonymy. She also derived a comprehensive species list (National Park Service, undated) that synthesized and updated the previous lists by Wunner (1967) and Urban (1968a), and solved some of the numerous checklist discrepancies (see discussion in Whipple, 1992). Although it did not resolve all issues with CRMO plant collections, Ms. Whipple’s greatly needed and much-appreciated work significantly organized and increased the level of understating of flora at CRMO, and properly curated the working herbarium. Her checklist presented about 348 taxa. A total of about 83 specimen sheets collected by Whipple in 1992 (including two from 1999) are in the CRMO database. The collaborative efforts of Wunner and Urban in 1967, augmented by Whipple’s efforts in 1992, firmly anchored a placeholder in recognizing and documenting CRMO’s botanical resources.

The collecting efforts executed under NPSpecies by the team, Wolken, and NPS interns in 2001, 2002, and 2006, added about 1,900 collections, representing the most exhaustive collecting efforts to date. A total of about 730 specimen sheets collected by myself from 1992 through 2006 are in the CRMO database. Atwood collections total about 952,

Blackburn collections total about 208, Mancuso collections total about 106, and Wolken collections total about 120. A synthesis of principle collectors and noteworthy collection contributions is depicted in Table 1 below.

Table 1. Principle collectors and their collections from CRMO entered into the NPSpecies database. An asterisk (*) indicates collections made under the NPSpecies project.

Year	Collector	Approximate No. of Collections at CRMO
1933	R. J. Davis (oldest collection reviewed)	1
1936-1938	Anonymous, Chase, Dole, Sneller Exp.	300
1963-1965	Buchanan, Horning, Menning	58
1966-1968	Urban (general inventory work)	87
1967	Wunner (inventory work, flora, thesis)	316
1980-1981	Adams, Griffith	59
1981	Harrison (rare plant surveys on BLM land)	3
1987-1988	Barrington	41
1989	Atwood (1 st coll. of <i>Phacelia inconspicua</i>)	1
1992; 1999 (2)	Whipple	83
1992-1998	Popovich (job duties/rare plant inventories)	203
1993	Elzinga (North Unit rare plant surveys)	62
1995	Jorgensen	29
1999	Alexander w/Liston & Popovich (genetics)	6
2001	Popovich (pilot visits)	24*
2002	Popovich, Atwood, Blackburn (Phase I)	1,259*
2006	Popovich, Atwood, Blackburn, Mancuso	472*
2003-2006	Wolken	120* (some)
2006	Rowland	15* (some)

Methods of the NPSpecies Initiative Project

This is a summary report outlining project accomplishments. Admittedly, the methods and results section of this report are quite detailed, and certain portions are repeated in different sections of this report. The paucity of clear information and lack of details I encountered while reviewing the numerous literature works and past reports written by others often made their reports' data interpretation difficult or impossible, which sometimes had substantial ramifications on the confidence in their results that were incorporated into this project. To avoid a similar situation, I therefore wanted to be as accurate and clear as possible in this summary report.

Goals and Documentation of 90% of Flora Present in CRMO

The goals of the project were to 1) document 90% of vascular plants present in CRMO, 2) create a fully functional, current working herbarium for CRMO, with verified vouchers representing as many taxa as possible, 3) create a current checklist of vascular plants in

CRMO, and 4) accomplish the NPSpecies Initiative by achieving Goal 1 above and by populating the corresponding NPSpecies electronic database.

Project Strategy

Work was divided into five strategies: 1) assemble and review all relevant literature and internal data forms concerning plant information for the Park Unit and conduct limited herbaria searches and interviews with knowledgeable staff and local past collectors, 2) incorporate all pre-existing Popovich and other unaccessioned collections made in the past in the Park Unit, 3) conduct field surveys in CRMO sufficient to reach 90% documentation of known/suspected plants and assign confidence in results, 4) build a properly-curated working herbarium in the Park Unit, and 5) populate the NPSpecies vascular plant electronic database for CRMO, including all three sources of evidence – vouchers, observations, and references – and create organized, thorough plant checklists that list all plants **present**, **probably present** (called “suspected” in the checklists, which is a more accurate term), **encroaching**, **unconfirmed**, **historic**, and **falsely reported** (assignments were followed as defined by the NPSpecies database rules).

Timeframes, Phases I and II, Collection Years

The original timeframe for the CRMO project was 1999 through 2002. However, due to unforeseen postponements, such as Congress freezing funds temporarily, the project was extended to January 30, 2008. Also, certain project components had actually already begun as part of the HAFO NPSpecies workloads prior to 1999 (e.g., literature reviews and interviews seeking information about both Park Units). The project was divided into two phases, with two field seasons to be conducted. Even with the amount of existing collections and taxa already vouched at CRMO, it was recognized that more than one field season would be needed to capture variation in growing conditions and due to CRMO’s large area and access challenges. Principle collection years were 2002 and 2006. Small “pilot visits” to test collecting strategy were performed by myself in 2001.

Phase I, occurring from 1999 to 2002, consisted of 1) assembling and reviewing all relevant literature and internal data forms concerning plant information for the Park Unit and conducting limited herbaria searches and interviews with knowledgeable staff and local past collectors, 2) incorporating all pre-existing Popovich and other unaccessioned collections made in the past in the Park Unit, 3) conducting major field surveys focusing in areas most likely to yield the most undocumented taxa, 4) building a properly-curated working herbarium, and 5) populating a first-generation NPSpecies vascular plant electronic database.

Phase II, occurring from 2003 to January 2008, consisted of using results from Phase I in 1) deriving a working species list, 2) deriving delineation of floristic zones and general areas in CRMO most likely to yield undocumented taxa, 6) generating maps with specific areas denoted that may contain remaining undocumented taxa to survey for in Phase II, 3) deriving a master species list of taxa potentially occurring in CRMO to survey for in Phase II and outyears, 4) using this information in conducting final field surveys in

focused areas most likely to yield the most remaining undocumented taxa, 5) populating the final version of the NPSpecies database with revisions from results in Phase II, and 6) preparing a summary report (this report) outlining results, documenting whether documentation of 90% of CRMO flora was achieved, and recommending future work.

Partners and Cooperators

In addition to the core team of Popovich, Atwood, and Curto, and the expanded team of Mancuso and Blackburn, many other colleagues and technicians assisted in this effort. I employed about 8 technicians across the years for data entry, synonymy research, plant mounting/labeling, affixing final annotation labels, and herbarium folder construction and organization. Atwood also used several technicians for specimen and label preparation, and CRMO employed interns to assist in field collecting and related work on their unit.

Popovich workloads associated with this project were conducted under University of Idaho (Moscow), Department of Fish & Wildlife Resources, NPSpecies Project Contract P.O. P0011391 and RM-CESU Cooperative Agreement H1200040001. Curto and Blackburn worked for Popovich for both Phases. In Phase I, Atwood worked for Popovich. Independent contracts by the University/NPS were let directly to Atwood and Mancuso for Phase II, although I remained team leader.

The NPSpecies Project Government Technical Representative (GTR) was Ms. Paige Wolken, Vegetation Ecologist, Craters of the Moon National Park and Preserve, Arco, Idaho. The NPS/University of Idaho Representative was Lisa Garrett, Upper Columbia Basin Network Coordinator, University of Idaho, Moscow. I worked closely with these individuals throughout the life of the project. Overall project design and anticipated accomplishments was a collaborative effort between Ms. Wolken, Ms. Garrett, and myself.

Specimen Identification and Verification Process

Presence of a taxon within the Park Unit can only be confirmed via the existence of a *reliable* voucher specimen known to be *competently* identified and *known* to be collected from within the Park Unit. We employed a rigorous process to ensure confident specimen identifications and data recordation integrity. Nevertheless, identifications are subject to error, and are generally accepted to never be 100% correct. One must use best judgment when collections are sub-optimal, immature, or lack required parts for identification. Also, identifications are subject to change with future inspection or changing trends in taxonomy.

All previously-existing specimens and those collected under this effort were first reviewed and determined or confirmed by competent individuals, called the “determiners.” As a second quality assurance step, all specimens involved in this effort (but only the specimen labels for non-problematic 2006 collections) were reviewed again by specialists, herbaria staff, or myself, called the “verifiers.” So, each specimen was both “determined” and “verified.” In numerous instances, Atwood or an authority served

as both the determiner and verifier of the same specimen sheet if taxon identification was relatively straightforward, or if the authority was the first person to attempt identification and also served as the authority to then verify it (redundancy). Particularly challenging specimens were reviewed by multiple examiners. Determination and verification dates and herbaria used were always indicated on the plant or annotation label (except for numerous 2006 collections Duane or colleagues determined, in which the determination date and herbarium are not indicated but are well implied on the collection label). Annotation labels or penciled annotations were always made when an annotation was needed and affixed above or aside the original plant collection label. Original labels and historic annotation labels were never modified or removed so that tracking of annotations can be followed in perpetuity. Full Latin names and their authorities were used.

Specimens were identified to the infraspecific level (i.e., subspecies, variety, or form) when practical, meaningful, and recognized in the region. There is considerable debate as to the concept validity and utility of using infraspecific assignments for many taxa in CRMO. As is observed elsewhere in southern Idaho, many plants can exhibit forms intermediate between subspecies or varieties of the same species.

Duane Atwood determined the great majority of specimens at Herbarium BRY via inspection and used standard comparison procedures against known specimens. Similarly, Michael Curto determined/annotated all grasses (Poaceae) at Herbaria UTC or OBI. Because the treatment and presentation of bluegrasses (*Poa* spp.) can be exceedingly complex, Robert J. Soreng, Poaceae authority at Herbarium US (Smithsonian Institution), and I met in Washington D.C. in winter 2005 to overview our intended presentation. He reviewed Curto's treatment of the bluegrasses as appearing in my CRMO 2006 interim checklist (Popovich, 2006b).

Importantly, James (Jim) L. Reveal (Herbaria BH, NY; currently Herbarium MARY, College Park, MD, USA), *Eriogonum* authority, reviewed and annotated all CRMO *Eriogonum* specimens and greatly revised their synonymy, except for 15 specimens inadvertently skipped that were collected in 2004 or 2006. Reveal's preferred synonymy is current as of winter 2007 and conforms to or supersedes his treatment presented in *Flora of North America* (Flora of North America Editorial Committee, 2005, vol. 5). Specimens not verified by him were verified by Atwood or Wolken and are not problematic or new taxa. Reveal has agreed to review and annotate the remaining 15 collections in spring 2008.

Additionally, we involved numerous other taxonomists as cooperators to identify collections for taxa in which they are authorities. Together with Atwood, Curto, and Reveal, these individuals are among the most reputable and well-qualified individuals to determine collections from CRMO. The people I worked with directly, and to my knowledge all others, offered their services gratis.

They and their foci were, in approximate order of contribution to the project:

Stanley L. Welsh and Sherel Goodrich (Herbarium BRY, Provo, UT, USA):

Problem specimens, Fabaceae
Paul M. Beardsley (Herbarium IDS, Pocatello, ID, USA):
 All Mimulus
Thomas A. Ranker (Herbarium COLO, Boulder, CO, USA):
 All ferns
A. A. (Tony) Reznicek (Herbarium MICH, Ann Arbor, MI, USA):
 Problem Cyperaceae
Aaron Liston (Herbarium OSC, Corvallis, OR, USA):
 Astragalus
Patricia L. Packard (Emeritus) and Don Mansfield (Herbarium CIC, Caldwell, ID, USA):
 Problem specimens
Gregory K. Brown (Herbarium RM, Laramie, WY, USA):
 Pyrrocoma
B. E. (Ernie) Nelson (Herbarium RM, Laramie, WY, USA):
 Problem specimens
Lee Johnson (Herbarium BRY, Provo, UT, USA):
 Navarretia
Roger Rosentreter (Herbarium SRP, Boise, ID, USA):
 Artemisia longiloba

All determinations and/or annotations under this project occurred from 2003 through winter, 2007, by one or more of the above at one or more of the following herbaria: BRY (the vast majority), CIC, COLO, CS, IDS, MICH, OCS, SRP, and the CRMO working herbarium (annotations of a few specimens). Dr. Reveal visited BRY to review *Eriogonum*, but may have assessed some material at Herbaria BS, NY, and MARY. Additionally, I reviewed a few sheets of CRMO Poaceae material with Paul Peterson at Herbarium US.

I annotated the identifications of about 446 collections. I used Herbaria RM and CS. In a few instances, Paige Wolken determined or verified specimens at CRMO's working herbarium.

It should be noted that for this report, "CRMO" is an NPS-designated acronym for Craters of the Moon National Monument and Preserve, and "CRMO working herbarium" should not be confused or interchanged with any International Botanical Congress acronyms for other herbarium.

Preferred Scientific Plant Names and Synonymy

Detangling synonymy is a tedious, convoluted and difficult subject matter in the plant world, and is usually best left to qualified taxonomists. There are abundant synonyms that can be applied to a taxon. Meanwhile, the manager needs to know what a taxonomic entity is called, and at least some of its synonyms that are sure to be encountered. Selection of plant names and recognition of infraspecific assignments can markedly increase or decrease the "total number of taxa" found at a park, a number often emphasized by land managers and ecologists.

For this project, a single unique scientific plant name for each taxon was selected. This was called the “preferred name.” All other names were identified as synonyms of the preferred name. There are fair and understandable differences in preferred names used by regional floras, the NRSC PLANTS database, and other sources. Taxonomy is always in flux as new information becomes available. New information reflecting current trends in taxonomy has especially increased in the last decade as in-depth genetic work, molecular biology, and the genomic application to taxonomy has introduced many name changes. The concomitant releases during this NPSpecies project of volumes published serially of *Intermountain Flora* and *Flora of North America*, along with releases of the 2nd and 3rd revisions of *A Utah Flora*, often complicated selections of preferred names and revised synonymies. There often is no single “best” name. Synonyms corresponding to the same plant entity are often used interchangeably in southern Idaho (e.g., Table 2). Personal preferences or preferred taxonomic philosophies sometimes differ between Atwood and myself, and often merely reflect differences in naming presentations between *A Utah Flora* and *Intermountain Flora*. A single person needed to make choices. As team leader and being more closely tied to conventional naming practices particular to Idaho’s central and eastern Snake River Plain, I personally selected the preferred names for non-grasses, sometimes in consulting Atwood and others. For grasses, preferred names and synonymy entirely relied upon the recommendations of Michael Curto (Herbarium OBI), whose concepts are current and in line with those preferred by myself.

The unique, single “preferred” scientific name employed for each plant taxon (e.g., species, subspecies, variety, form) was derived on a case-by-case basis. I selected the preferred name from all available names based upon its currently accepted appropriateness by regional taxonomic authorities given the regional floristic locale of the Park Unit (Snake River Plains Floristic Section of the Intermountain Floristic Region as per *Intermountain Flora*, Volume I, 1972). **In most instances, my preferred names follow those preferred by the appropriate regional floras, most notably *Intermountain Flora - Vascular Plants of the Intermountain West, USA* (Cronquist et al, 1972-2005, vols. 1, 2B, 3A, 3B, 4, 5, 6), but sometimes names were preferred from *A Utah Flora* (Welsh et al, 2003, 3rd ed, revised) or *Flora of North America* (Flora of North America Editorial Committee, 1993-2006, vols. 1-5 and 19-27).** Many other works were consulted, but their preferred names were rarely if ever adopted when they differed from those in the above. Consulted references included *Flora of Idaho* (Davis, 1952), *Flora of the Pacific Northwest* (Hitchcock and Cronquist, 1973), *Vascular Plants of the Pacific Northwest* (Hitchcock et al, 1955-1969), *The Cruciferae of Continental North America* (Rollins, 1993), various appropriate recent botanical monographs, Western U.S. floras and other botanical works such as *Weeds of the West* (Whitson et al, 1996 -2006, 5th – 9th eds), and *Plant Communities, Ethnobotany, and Flora of the Idaho National Engineering Laboratory* (Anderson et al, 1996). Preferred taxonomic standings in the NRCS PLANTS database (Natural Resources Conservation Service, 2008) were reviewed and considered for each taxon. **The suite of total plant names in the NPSpecies database is therefore eclectic and does not follow one particular reference.**

Table 2. Examples of synonyms corresponding to the same plant entity used interchangeably in Park Units HAFO and CRMO.

<u>Taxon name</u>	=	<u>Taxon name</u>
Atriplex spinosa		Grayia spinosa
Lappula redowskii		Lappula occidentalis
Rorippa nasturtium-aquaticum		Nasturtium officinale
Salsola kali		Salsola pestifer

Synonymy of scientific plant names can be very complex and confusing particularly with grasses, and Curto and I have tried to keep it as simple as possible. Sometimes material collected which fits under one ITIS (a standardized taxonomic naming acceptance system used by the NPSpecies database) accepted name can go to more than one locally preferred synonym, and vice-versa. For example, plant collection sheet 1 with ITIS name "Species A" goes to local preferred synonym "Species Y," but another duplicate collection sheet, sheet 2 of ITIS "Species A," goes to local preferred synonym "Species Z." Therefore, some of the material we have thus far collected in the past under a certain historic name can be placed under one particular preferred synonym, but other material we have thus far collected with the same historic name needed to be placed under a different preferred synonym.

For this report, when a synonym is listed with "in part" following it, that means that some of the material we have is accommodated under that synonym, while other material can be accommodated under another synonym.

Example: *Elymus lanceolatus* = *Agropyron dasystachyum* var. *dasystachyum* (CRMO material, in part) and also *Elymus lanceolatus* = *Agropyron dasystachyum* var. *riparium* (CRMO material, in part). In this case, the old names *Agropyron dasystachyum* var. *dasystachyum* and *Agropyron dasystachyum* var. *riparium*, which were formerly viewed as two separate varieties of *Agropyron dasystachyum*, are now both accommodated under the new preferred name, *Elymus lanceolatus*, and we made no infraspecific distinctions under this preferred name (i.e., material representing both entities has been "subsumed" under one entity). Also, these varieties have in the past been treated as separate species, *Agropyron dasystachyum* and *Agropyron riparium*.

A nested diagrammatic depiction of the above synonymy could be:

Elymus lanceolatus (single preferred name in the NPSpecies database)
 = *Agropyron dasystachyum* var. *dasystachyum* (CRMO material, in part)
 = *Agropyron dasystachyum*
 = *Agropyron dasystachyum* var. *riparium* (CRMO material, in part)
 = *Agropyron riparium*

Sometimes materials corresponding to several different plant names, as viewed by some, can all be accommodated under a single, more broadly defined taxonomic entity/plant

name, as viewed by others. When a synonym is listed with "sensu stricto" following it, it means that the material assigned to that name only fits the strict, or "narrow sense," taxonomic concept of that plant name. When a synonym is listed with "sensu amplo" following it, it means that the material assigned to that name fits a more "broad sense" taxonomic concept of that plant. That is, all material that could be assigned to other, more narrow plant names is accommodated under the single broad-sense name.

Example: *Agropyron cristatum*, sensu stricto: This means only plant collections conforming to the narrow definition of the original plant material used to describe the species can be accommodated. *Agropyron cristatum*, sensu amplo: This means, if adopting a broader taxonomic view, that other closely related plant materials can be accommodated under this name as well, if one chooses to place them taxonomically under a larger set of materials encompassed by a broader allowance under *Agropyron cristatum*. In this case, one could say *Agropyron cristatum*, sensu amplo = all material corresponding in the strict senses to *Agropyron cristatum*, *A. desertorum*, *A. pectiniforme*, *A. fragile*, and *A. sibericum*. Some view these as separate taxonomic entities at the species level, while others view these entities as all simply parts in a continuum of morphological and genetic forms under a single, broader species, *Agropyron cristatum*, "sensu amplo."

The above examples are somewhat oversimplified and can be difficult to conceptualize. You are not alone if you are confused!

In summary, taxonomic placements differ based upon these interpretations. This is important because it affects the selection of preferred names, and data attributes of interest, such as the total number of species present (e.g., one species present, *Agropyron cristatum*, "sensu amplo," versus five species present, "sensu stricto": *Agropyron cristatum*, *A. desertorum*, *A. pectiniforme*, *A. fragile*, and *A. sibericum*), and even sometimes the nativity concept of the taxon.

Given the above complexities, Curto generated exceptional annotation labels for all grass collections. His labels not only give the preferred taxon name (denoted in bold on his annotation label) for that particular specimen sheet, but also list local often-used or otherwise important synonyms and their current standings (e.g., *nomen illegitimum*, *sensu stricto*, *sensu lato*, *pro parte*, etc.). **Incredibly, in addition to identifying our "preferred name" for each specimen sheet, Curto also tried to list the synonym name(s) that the specimen would pass under in the three most-used Floras for grasses in southcentral Idaho: *Manual of the Grasses of the United States* (Hitchcock, 1950), *Vascular Plants of the Pacific Northwest* (Hitchcock and Cronquist, 1969), and *Intermountain Flora* (Cronquist et al, 1977, vol. 6).** This feat saves arduous cross-walking efforts, and will surely be appreciated by future examiners of the collections.

I personally reviewed each physical specimen sheet and its final annotation label of all sheets collected prior to 2006. I reviewed determinations on photocopied labels for most specimens collected in 2006 (and several Whipple collections returned by her to CRMO in 2006) without seeing most of the actual specimens. However, the physical specimens

for several score of problematic collections from 2006 and some Whipple submissions were reviewed and annotated by myself.

I also personally ensured that each specimen representing a taxon was identified by the single preferred taxon name for all collections other than grasses. Curto performed this task for grasses. This sounds simple, but proved to be a formidable task. When older synonyms or un-preferred names were used, we first had to make sure that the preferred synonym desired would still properly reflect identification of that particular specimen: as previously discussed, sometimes a specimen of an older name can key to several different newer names depending upon philosophy employed, requiring re-keying of the specimen and consistency in application. We then annotated each specimen so that the annotation name exactly matched the preferred full taxon name. In this way, consistency was maintained: all specimens corresponding to the same taxon have the exact same taxon name, and can therefore be found in the same genus folder in the herbarium. This will save future users of the CRMO herbarium hours of frustrating cross-walking between synonyms, and moreover was needed to prevent the same taxonomic entity from being entered as present under different synonyms in the NPSpecies database, which would generate over-counting and confusion.

It is important to note that corrections to erroneous identifications and preferred name synonymy annotations I made to CRMO specimens were not made for any duplicate specimens residing anywhere other than at CRMO. In particular, this means that the numerous duplicate specimens deposited at BRY are still housed there under their original un-annotated names appearing in the original collector's record books, which could be a source of confusion in the future.

Literature Reviews

In the 1970's, Idaho began an increasingly strong and committed track record of assessment and documentation of rare plants, beginning with a compilation by Robert Steele in 1975 (Steele, 1975) that was further refined by Douglass Henderson, F. D. Johnson, Patricia L. Packard, and Steele in 1977 (Henderson et al, 1977), Steele and Steven Brunsfeld (Steele and Brunsfeld, 1981), and the landmark "red book" tracking of the early 1980's (Idaho Natural Areas Council, 1983, reprinted from the 1981 original). Herbaria searches were conducted for rare plants (e.g., Moseley, 1990), and lists were again refined in 1990 and 1992 (Moseley and Groves, 1990, 1992). This history has been reviewed in an article by Moseley (citation unavailable). The Idaho Native Plant Society in conjunction with the Idaho Natural Heritage Program hosted very successful annual rare plant conferences I attended in the 1990's, and much useful information about rare plants in and near CRMO was exchanged. In addition to information stemming from the above, there exist many informal and formal government, contracted, and student reports that contain information about vegetation in CRMO. Subsequently, there are many references and sources containing botanical information.

References that could contain CRMO information were searched for at the following locations by myself and resident staff: CRMO Headquarters, intermittently 1999 through

2005; HAFO Headquarters, intermittently 1994 through 2002; BLM Shoshone Office, thoroughly from 1992 through 1996 and briefly in 2001; BLM State Office, Boise, 1996; IDCDC Office, Boise, intermittently 1995 through 2005; Herbaria CIC, ID, IDS, KANU, HSC, RM, CS, GREE, and COLO between 1999 and 2007; and a very cursory search at Herbarium US in 2005. Carol Blackburn also researched some reference material at CRMO around 2002.

All Element Occurrence records for rare plants and plant communities tracked by the Idaho Natural Heritage Program's Idaho Conservation Data Center that occur in or near CRMO as of December 2004 were examined (Idaho Natural Heritage Program, 2004; Attachments 60 and 61). In addition, I reviewed the database of most Idaho Natural Heritage Program rare plant and plant community publications and of all plants tracked by the Idaho Natural Heritage Program for information of taxa related to CRMO (Idaho Natural Heritage Program, 2005). Their web sites list most Idaho Natural Heritage Program publications pertaining to rare plants and noteworthy plant communities, grouped by the following topic headings, with their own website folders within the IDCDC plants folder: 1) Idaho's special status plants (tracking stages of all vascular and non-vascular plants); publications regarding: 2) special status vascular and nonvascular plants; 3) plant community ecology; 4) natural areas and conservation sites; 5) miscellaneous publications; 6) endemic vascular and non-vascular plants of Idaho: preliminary list compiled by Michael Mancuso, ICDC botany program leader 1999; 7) plants once considered rare in Idaho but no longer of conservation concern: year of decision and rationale; 8) wetland indicator status; 9) wetlands; and 10) plants believed to be extirpated from Idaho. All reports pertinent to NPSpecies objectives from all lists were reviewed by myself and entered into NPSpecies as appropriate. I specifically asked all people listed in the interview section below if they were aware of published or unpublished vegetation studies, lists, data, etc., in or near CRMO.

I reviewed all entries tied to CRMO in the NPS NatureBib reference database as of late 2005. I also had some relevant information in my personal files. All above references gathered as part of the NPSpecies efforts were reviewed by me.

From a total of about 180 references dated through 2004 for CRMO identified as possibly containing information relevant to this project, about 110 (61%) were further identified as potentially useful (Attachment 13 plus about 6 references not appearing in the attachment). I retained all references containing any species lists, plant names, or plant community names, except those references from CRMO or BLM that were the unit's various internal natural resources data forms that were determined to be unreliable. I compared all plant names in the references, cross-walking synonyms as needed, against the list of taxa known to be present in CRMO. A name and the link to its reference was retained if it met the criteria described in the *When was a plant reference included in the database?* section of this report.

Several references contained names that may represent new taxa at CRMO, but the studies occurred in areas that were either very near and unknown if reaching within CRMO, or both within and beyond CRMO such that there is no way to know if the

species cited in the references actually occurred within CRMO. I retained such references and attempted to contact their authors to seek clarification. Often, the authors were able to confirm if a particular taxon cited in the reference was actually observed within CRMO. Nonetheless, in those instances, the taxon name for that reference was still considered “unconfirmed.” For every reference reviewed, I indicated whether it contained any taxon names that were carried forward for inclusion into the NPSpecies database, and if it could be determined whether or not the reference’s study area was within CRMO (Attachment 13). A taxon was never confirmed as present from a reference if the reference(s) constituted the only record for the taxon (i.e., no vouchers exist or could be reviewed). In such cases, cited taxa were listed as “unconfirmed.”

Interviews and Consultations

The following key individuals have been interviewed or consulted between 1994 and 2007 as part of this project. In addition, roughly 25 others, mostly local government staff, were also consulted during this process. They all are unaware of additional unreviewed plant lists, studies, reports, or specimens from CRMO that have not been addressed in our project. I also asked if they had personally observed any taxa about which we were unaware. These individuals represent the area’s public, government, academia, conservation, and herbaria staff most likely to know about additional lists or studies. Their affiliations, current at the time of communication, may be outdated.

Academia:

Jay Anderson, Idaho State University, deceased
Steve Bunting, University of Idaho, Moscow
Steve Brunsfeld, University of Idaho, deceased
Min Hironaka, Researcher, retired
Joy Mastroguiseppe, Pendleton, Oregon
Steve Monsen, former USFS Researcher, retired, private consultant
Dave Pyke, Researcher, USGS FRESA, Corvallis, Oregon
Sandra Robins and Curtis Bjork, Lambert Erickson Weed Diagnostic Laboratory,
University of Idaho, Moscow
Bruce Ryan, Bryologist, Arizona State University, deceased
Nancy Shaw, USFS Researcher, Boise
Al Winward, USFS Researcher

BLM Shoshone Field Office staff, 1992-1999:

Scott Anderson, former Senior Rangeland Conservationist, retired
Floyd DeWitt, former Air/Water/Soil Specialist, retired
Julie Hilty, formerly with IDCDC, currently BLM Botanist, Shoshone
Paul McClain, former Wildlife Biologist, retired
Susanne Henriksen, former Archeologist
Rick Vandervoet, Recreation Specialist
All other relevant staff and line officers

Conservationists with knowledge of the local area:

Sheldon Bluestein, Idaho
Katie Fite, Idaho
Linn Kincannon, Idaho Conservation League, Ketchum
Mike Medberry, Idaho
George Wuerthner, Idaho

Herbaria:

N. Duane Atwood, Herbarium BRY, NPSpecies team member
Mary E. Barkworth, Herbarium UTC
Robin Bencie, Herbarium HSC, Humbolt (search for Wunner collections)
Pam Brunsfeld, University of Idaho, Herbarium ID
Linda Cook, University of Idaho, formerly with Herbarium ID
Michael Curto, Herbaria UTC, OBI, NPSpecies team member
Barbara Ertter, former southern Idaho inventory work, currently Jepson
Herbarium, Berkeley, California
Douglass Henderson, University of Idaho, Herbarium ID, deceased
Karl Holte, Idaho State University, Herbarium IDS
Don Mansfield, Biology Department, Albertson College of Idaho, Caldwell,
Herbarium CIC
Caleb Morse and the Curator Emeritus from the late 1960's, University of Kansas,
Herbarium KANU (searches for Wunner collections)
Patricia L. Packard, Emeritus, Albertson College of Idaho, Caldwell, Herbarium
CIC
James Reveal, Herbaria BH, MARY, NY

Idaho Conservation Data Center (IDCDC) and TNC:

Steve Ciacco, formerly TNC Idaho, currently USFWS, Reno, NV
Shelley Cooke, formerly IDCDC Data Coordinator
Maybell Jankovsky-Jones, formerly IDCDC Botanist
Lynn Kinter, IDCDC Botany Program Leader
Michael Mancuso, former IDCDC Botany Program Leader, currently independent
consultant, Boise, NPSpecies expanded team member
Stephanie Mitchell, IDCDC Ecology Information Manager
Bob Moseley, former IDCDC Botany Program Leader, currently Director of
Conservation, TNC Illinois Chapter
Chris Murphy, IDCDC Restoration Ecology and Wetlands Conservation Program
Leader
Steve Rust, IDCDC Ecosystem Assessment and Mapping Program Leader
George Stevens, IDCDC Rare Species Information Manager

NPS CRMO and HAFO staff, 1992-2008:

John Apel, Resources Program Manager
Beth Colket, former HAFO Biological Technician, currently IDCDC Botanist
Dave Clark, former CRMO Chief of Interpretation, retired
Natalene Cummings, formerly with CRMO

Neil Farmer, former HAFO Physical Scientist, currently Hydrology Field Technician, Bureau of Reclamation, Idaho Falls Office, Idaho
Phil Gensler, HAFO Paleontologist
Hugh Harper, former HAFO technician/volunteer
Vicki Snitzler-Neek, former CRMO Chief of Res. Mgmt, now in Wrangell-St. Elias National Park, Alaska
Bob Willhite, former HAFO Park Ranger, late 1990s - ca. 2001, deceased
Paige Wolken, CRMO Vegetation Ecologist

Other individuals:

Carol Blackburn, private consultant and NPSpecies expanded team member, Shoshone, Idaho
Nancy Cole, former Idaho Power Company Plant Ecologist, Boise
Ann DeBolt, former BLM Botanist, Boise
Joe Duft, Boise, deceased
Caryl Elzinga, former south Idaho BLM Botanist, private consultant, Tendoy, Idaho
Valerie Geertson, formerly with Idaho Power Company, currently BLM Botanist, Boise
Sherel Goodrich, USFS Ashley National Forest
Clark Heglar, Idaho historian, Paisley, Oregon
Emerenciana "Mering" Hurd, USFS, Boise
Darwin Jeppson, former Soil Scientist, BLM Idaho Falls, retired
Robin Jones, former USGS-BRD contractor, Boise
John Mitchell, USFS Research Range Scientist, Rocky Mountain Research Station, Fort Collins, Colorado (formerly conducted studies at INEEL)
John Peavey, Idaho State Senator, Carey
Mike Pellant, Idaho BLM State Office Range Scientist, Boise
Lou Pence and Paul Reese, former SNRA District Rangers, Ketchum
Carol Prentice, former Boise private consultant and HAFO NPSpecies contractor, currently Washington, D.C.
Roger Rosentreter, Idaho BLM State Office Botanist, Boise
John Shelly, Sawtooth National Forest, Fairplay
Lynda Smithman, private consultant, Boise
Karl Urban's widow
Robert Wunner, formerly Seasonal Naturalist at CRMO, now in the west coast

Herbaria Searches

Brief herbaria searches were conducted by myself between 1994 and 2001 at the following herbaria: ID, CIC, IDS, and SRP. These were cursory in nature. The most reliable sources of data for knowing if there were specific collections from CRMO residing in herbaria was to ask the respective collection managers. If they thought possible collections from CRMO were easily locatable, we searched for them. Full herbaria searches were well beyond the scope of this effort.

In addition, during the Phase I specimen and literature review process, I found that 128 Wunner (and 1 Urban) specimens cited in Wunner's *A Flora of Craters of the Moon National Monument* (1967) were missing, some of which would constitute new records for CRMO (Attachment 42). Herbarium KANU is cited in *A Flora of Craters of the Moon National Monument* as where plants were deposited. Wunner stated to Popovich that the missing specimens once existed, and were definitely deposited by himself at KANU as unmounted, labeled collections to be accessioned, from which some could have been subsequently removed by himself and deposited at Humboldt State University (Wunner, pers. comms. with S. Popovich, winter 2004 and 07 March 2005). Wunner stated that Lava Beds National Monument itself, where he performed his field data collections for his Masters thesis at Humboldt State University prior to collecting at CRMO, should not contain any CRMO specimens. The KANU Curator Emeritus from the late 1960's has no recollections of accessioning any Wunner or Urban specimens (Curator Emeritus, pers. comm. with Caleb Morse, Collections Manager at Herbarium KANU, who relayed information to Steve Popovich via pers. comm., winter 2004). Karl Urban, a co-collector of Wunner's while in CRMO, is deceased. However, Urban's widow had no information on the missing specimens' disposition (Widow, pers. comm. with Jean Wood, USFS Botanist, Umatilla NF, December 2005, who relayed information to Steve Popovich via pers. comm., 06 December 2004).

The collections managers of KANU and HSC, Caleb Morse (KANU) as well as the Curator Emeritus from the late 1960's when Wunner would have been a student at Lawrence, and Robin Bencie (USC), conducted exhaustive searches in 2005 for the missing specimens as well as any other specimens from CRMO. Fairly exhaustive herbarium searches were also conducted in 2005 for them and any other specimens from CRMO at the following herbaria, which are the most likely herbaria at which they would have been accessioned:

Craters of the Moon National Monument working herbarium (Arco, ID) – by myself
BLM Shoshone working herbarium – checked by myself in 1997.
ID (Moscow, ID) – checked by Pam Brunsfeld
IDS (Pocatello, ID) – checked by Karl Holte and Jim Glennon
RM (Laramie, WY) – checked by Grace Kostel, botany graduate student

A substantial herbarium search effort for general cataloging of Idaho flora by county was expended in the late 1990's by the Idaho Conservation Data Center and others, who examined various herbaria in Idaho (and elsewhere?). Incorporating their results at the time by having researchers record whenever a specimen was encountered that was from CRMO was considered in the NPSpecies effort, but budget constraints precluded that from happening. The searchers documented taxa tallied by county, but not by CRMO. Carol Prentice, a Boise, Idaho, private consultant botanist involved in that effort, told me that she saw several specimens with plant labels identifying locations from within CRMO, but that they were all common species (Prentice, pers. comm. with S. Popovich, 1999).

Field Work

Office work to prepare for field work was conducted in 2000 and 2001 based upon results of the literature and herbarium reviews and CRMO working herbarium evaluation. Lists were generated to take to the field of known or suspected taxa and their presence status (present, unconfirmed, false report, etc.). I had already well surveyed large portions of CRMO from 1992 to 2000. This included repeat visits to certain promising microsites over several years, or in early or late times of the growing season specifically to collect early and late blooming plants, or collecting in years of exceptional growing conditions. I carefully considered areas that could be discounted from focus due to previous efforts by myself and others (e.g., Elzinga, 1996).

To be efficient and meaningful, surveys should be performed by *qualified* botanists and capture the full range of flora present: that is, that they be conducted across the spectrum of growing seasons, plant phenologies, habitat types, total acreage present with adequate geospatial sampling distribution, and over several years capturing differing growing conditions. This also requires focused visits to sufficiently sample specialized microsites and habitats. We incorporated these factors into our overall survey strategy.

In 2001, I made several pilot field visits to test NPSpecies inventory protocols and begin minor collecting. Principle field survey and collecting efforts under NPSpecies occurred by my team and myself in 2002 (Phase I) and again in 2006 (Phase II). Surveying in two growing seasons is better than one but not as good as three or more. Given limited budget and past surveying history by myself and others, two seasons were deemed reasonable. No field work was conducted and no specimens were collected as part of this effort in 2007, although the NPS may have collected specimens to be incorporated later or for other purposes about which I am unaware.

Our strategy was to focus collecting to maximize the finding and recordation of new and unconfirmed taxa. Although always recommended and of scientific value, we were less concerned about collecting to capture distribution of taxa already known to be present or making multiple collections of the same taxon because that would depart from focus and efficiency in maximizing documentation of new or unconfirmed taxa. We carried the generated species list and our zone maps and divided search areas by survey priority and assigned team. Sometimes principle collectors collected by themselves, but often they were joined by other team members and/or NPS interns to maximize efficiency. We focused on collecting any taxa that we thought could be new or that were unconfirmed. We held pre-field meetings with Ms. Wolken to streamline our approach and maintain strategy consistency among collecting teams. Atwood, Wolken, and myself spent the first day of major surveys in 2006 in the field collecting together to compare approaches. Throughout the project, we mixed pairing of collectors to maintain consistency among groups, exchange knowledge, and gain experience from each other.

In 2002, we focused on collecting 1) across spring, summer and late summer peak phenologies, 2) across large areas and all parts of CRMO to achieve adequate geospatial distribution, including boundary areas, 3) at easily accessed areas where many taxa could

be found with relative ease, and most importantly 4) in under-surveyed habitats and specific areas most likely to yield undocumented taxa, such as specialized microsites, ridgelines, lava tube openings and deep, cool recessions of lava cracks, rock outcrops, areas of late snow retention, forested north slopes of cinder cones, aspen stands, Douglas-fir stands, seeps and other water sources such as playas and Lava Lake, certain kipukas, sandy sites, alkaline sites, disturbed sites and agricultural field edges, etc.

In general, we felt that certain floristic zones were less surveyed and had more promise, and we spent significantly more energy on those. They included the montane foothills (Zone 4), Huff Creek geothermal riparian area (Zone 3), hot, dry, southernmost areas (Zone 7), extreme southern and southeastern peripheries, including completely circumscribing the Wapi Flow, and areas transitional to alkaline/salt affinity flora (Zone 5). The foothills zone was particularly focused upon. We only cursorily surveyed areas or performed very specific spot-checks in areas that I or others had already surveyed from 1992 to 2000. Extremely inaccessible interior kipukas were not visited because the time to reach them by walking was inefficient for what we thought we may find there, although some kipukas were visited that are fairly interior and remote, such as “Bear Paw” Kipuka. Due to budget constraints and other factors, no field work was conducted by our team in 2003, 2004, or 2005, although Wolken and the NPS did make a few collections.

For final field season 2006, we refined search areas and target taxa based on synthesized results from 2002, numerous reviewed references, and my personal knowledge of taxa reasonably suspected to occur in CRMO. Prior to the field season, I created thorough lists of about 500 taxa suspected to occur upon which to focus our efforts (Attachments 54-57). They included unconfirmed taxa, rare plants, weeds, plants known to occur nearby (within ca. 20 air-miles/32 air-km) in areas that have similar habitat to CRMO based on personal knowledge or various checklists, as well as additional taxa from many other sources. They listed search priority, data source, anticipated habitats, geographic areas in which to search (sometimes specific locations), and likelihood of occurrence for each taxon. A significant effort was expended in the generation of these lists, and they attempt to **represent all taxa reasonably possible to occur without citing entire regional floras**. After reviewing all areas visited by myself and others 1989 through 2002 (Phase I), I created an overview map (Attachment 58) and detailed maps (Attachment 59) identifying 130 specific survey polygons most likely to yield additional undocumented taxa to survey in Phase II and outyears. Using these as guides, we focused more intensively on remaining under-surveyed areas and specialized habitats, under-surveyed timing relative to peak phenologies of target plants, and particular geographic locations to fill spatial holes. I particularly visited northern foothill boundaries of the newly-expanded areas north of Highway 20/26/93, while Atwood focused on Zones 4 and 5, and briefly in 7. Blackburn focused on riparian, weedy, crop, and ornamental species of boundary, riparian and agricultural edge areas along the Carey Interface. Mancuso focused on northern areas. Popovich and Wolken surveyed playas together in Laidlaw Park and nearby areas.

We used vehicles and ATV's to reach target search areas. We always conducted surveys by employing intuitively controlled, meandering pedestrian transects. When a search area seemed particularly promising, we slowed and explored the area thoroughly, collecting all taxa of interest. Helicopters and pack animals were not used. No photographs were taken in the field.

We could have pursued many more collections than effected. But rather than "hay bale," we instead focused on collecting only those specimens that we thought could be new taxa or rare for CRMO, or that otherwise would contribute to the overall mission. We were prudent in collecting, emphasizing quality over quantity. We frequently collected one or more duplicates, many of which ended up at Herbarium BRY. I, Blackburn, and Mancuso gave all our collected material to Wolken or Atwood at the end of each season.

Specimens were pressed in the field, usually the same day or alternating days. Daily logs and collector and collection numbers were entered in the field in standard botanical field record books. To maximize efficiency, survey days were typically long, sometimes to 14 or more hours. At most collecting sites, UTM coordinates were recorded with GPS units unless satellite reception precluded it, in which case legal locations were noted. I always recorded both legal locations and UTM's. Survey routes were hand drawn in the field on BLM 1:100,000-scale surface management maps as well as USGS 7.5-minute topographic maps. GPS tracking of travel routes was not used. Some collections were collected within CRMO even though the GPS point may have been recorded just outside the immediate boundary. In such cases, the plant label should indicate the ownership of the location where the plant was collected (i.e., CRMO) or that the population extended from other ownerships into CRMO, from where the plant was collected, even though the GPS point may not be within CRMO.

Observations

Field observations by others of plant taxa within CRMO were recorded as part of this project as they became evident. Interviews were conducted with the observer(s) when possible to ask about those and other taxa of interest possibly observed, and to confirm the confidence and location of the observations. Several taxa were reliably observed but uncollected by myself within CRMO prior to NPSpecies, some of which have been entered into the database. With the commencement of the NPSpecies project, our team always collected plant material of target taxa rather than rely solely on our observations. Observations were made by our team, however, of noxious weeds and other weedy species of management concern that were not collected, and they were recorded in our field books and reported to CRMO staff. Noxious weed observations were also entered into the database.

Expansion and Curation of the CRMO Working Herbarium

All specimens housed at the CRMO herbarium at project inception were shipped to me for evaluation and proper curation. I reviewed them in Fort Collins, Colorado. My technicians repaired damaged specimens.

For Phase I, new specimens collected were mounted by my or Atwood's technicians. Specimens collected for Phase II were mounted by Atwood's technicians. My technicians worked at Colorado State University's Zoology Building and Herbarium CS in Fort Collins, Colorado; Atwood's technicians worked at Herbarium BRY in Provo, Utah. Blackburn generated her plant labels for phase I. I generated some of my plant labels, while Atwood's technicians generated the great majority of Popovich labels and all Atwood and Mancuso labels. (Note: The Popovich labels generated by Atwood's technicians contain many errors of fact, omission and spelling, which do not reflect upon my record book notes; see brief discussion in Attachment 49. Furthermore, erroneous identifications sometimes appearing on Popovich labels generated by his technicians do not reflect the identifications I entered in my record book, and am unsure of their sources). I always used acid-free bond label paper. Labels produced by Atwood were apparently not always made with acid-free paper for Phase I, but acid-free paper was supposedly used in Phase II. Mounting paper was of standard herbarium size and grade.

Each new mounted collection (accession) was assigned an accession number and catalog number. These numbers were provided by CRMO. They were written in firm pencil (so they can be changed if needed) in a stamped box appearing on every specimen sheet indicating the Park Unit and herbarium. The stamp was created by myself specifically for CRMO's herbarium and resides with them. Black acid-free India ink was used for the stamp. Final number assignment, stamping, labeling, folder generation and curation preparation was performed by my technicians for Phase I. For Phase II, final preparation of specimens was performed by Atwood's technicians. It is important to note that each **specimen sheet** was assigned and stamped a unique catalog number, even if it was part of multiple sheets of the same specimen or organism (part 1 of 2, part 2 of 2, etc.) or a duplicate sheet. This system proved very efficient and useful given problematic sheets such as mixed collections appearing on a single sheet, multiple sheets of different taxa but with the same collector's number, etc. It proved to be the only way to uniquely identify and track each specimen **sheet**, thereby being able to make sure all **sheets** can be accounted for, entered into the database, and able to be queried. It was also adopted in part for consistency, as this method is how catalog numbers had apparently been assigned to the historic collections at CRMO, perhaps for the same reasons. It departs somewhat from cataloging protocols more recently employed by CRMO, which identify all parts of a single organism (e.g., part 1 of 2, duplicate sheets, etc.) with sub-identifiers within the same catalog number for that organism, such as catalog number "1031a," "1031b," "1031c," etc., for each sheet of the same plant. Some catalog numbers may be changed in the future to adopt this philosophy. In the last weeks of this project, it was attempted to change such catalog numbers from Phase II collections, but the NPSpecies database version used at that time, although current, would not accommodate alpha characters in catalog number assignments. A more recently-released version now allows this.

Collector's numbers were not always straight-forward, especially with historic anonymous collectors. Rules for determining collector's naming and number assignment conventions are discussed in the *User's Guide*.

In a few instances deemed meaningful, images (i.e., color photographs printed on acid-free paper) of plants rare in CRMO have been mounted and curated as voucher specimens when collections were not made, a practice that is valid under NPSpecies guidelines. Such instances include specimens of *Primula cusickiana* and *Cercocarpus ledifolius*, and represent the only vouchers of the latter taxon.

Additionally, *Missing Plant Specimen* sheets were made for specimens known to be missing. Each sheet contained the taxon, CRMO accession and catalog numbers (if assigned), and the reason that the specimen is missing (e.g., on loan at cited herbarium, temporarily misplaced by contractors or NPS staff, lost and will not be recovered, or other explanation). The sheet also identified if the missing specimen has or has not been entered into the NPSpecies database, and by whom and when the sheet was last updated. Some sheets also have a full-size photocopy attached of the specimen itself if it resided at another herbarium and was examined as part of this project. The sheets were included as part of the working herbarium to be placed within the appropriate taxon folders.

Genus folders of standard herbarium quality Rancho Santa Ana or Missouri Botanical Garden types were used to store taxa. Each taxon received its own genus folder. Multiple genus folders or folders with 1/4- or 1/2-inch spines were used for one taxon to accommodate bulky specimens or when numerous specimens existed for that taxon. Within a genus folder, lighter-weight herbarium species folders were used to group 2-5 or so sheets at a time. Genus folders were numbered sequentially at the end of Phase I in the lower left-hand corner in pencil so they could be replaced properly after examination. Pencil was used so the numbering can be changed, although additional folders can be assigned half-numbers (e.g., new folder 31.5 could be stored between folders 31 and 32). Species folders were numbered “1 of 2, 2 of 2”, etc., within a taxon’s folder(s). They were used simply to offer more organization and a greater degree of protection between multiple sheets. The family name, taxon full scientific name, and very commonly used alternate names (synonyms) or alternate spellings are written across the folder bottoms.

Colored folders were used to set apart species of significance. The color scheme used is as follows:

Blue = plants that are considered rare (globally, regionally, or in Idaho), as determined by:

1) plants currently listed as species of special concern by Idaho-BLM, 2) any plant currently tracked by the Idaho Conservation Data Center, and 3) all plants appearing on the list generated by the Idaho Native Plant Society’s 2007 Annual Rare Plant Conference. Additionally, any plant that was formerly recognized as rare by the Idaho Native Plant Society 1983-2007 (“red book” tracking onward) is identified as “formerly rare” and also received a blue folder.

Orange = plants believed to be non-native to the Park Unit. These may or may not be native to Idaho or to North America. Plants with unknown nativity were not included.

Red = plants that are currently listed as Noxious Weeds or Weeds of Concern by the State of Idaho as of the last revised Noxious Weed List, March 30, 2007.

Manila = remaining native plants not accommodated above (includes plants of unknown local nativity).

Genus folders are arranged alphabetically by family and scientific taxon name within family. The herbarium is organized phylogenetically, with ferns and fern allies first, followed by gymnosperms and angiosperms.

The fully curated “ready to go” historic collections and herbarium specimens from Phase I were delivered by myself to CRMO in fall 2003, where Paige Wolken, Lisa Garrett and myself personally loaded them into awaiting herbarium closets at the Headquarters’ Resources Management Building. The herbarium has recently been moved to another secure location at Headquarters.

Except for problem specimen collections I examined, all specimens from Phase II were sent fully curated directly from Atwood to Paige Wolken in 2007. I do not know how they were integrated into the herbarium, but hopefully the same procedures were used to maintain consistency regarding colored folders, numbering new folders, etc. I personally reviewed and recommended all final annotations to the taxon names to make sure preferred names used in Phase I and the NPSpecies database were employed on all Phase II specimens. If I could not personally make the annotation to the sheet, they were confirmed performed by Wolken at CRMO.

Whenever specimens were transported between locations or herbaria, strict protocols were followed to prevent contamination, usually following the protocols requested by the visited herbarium.

Duplicate specimens from Phase I and II were deposited elsewhere, and were under the purview of the NPS and Atwood. For Phase I, all known or suspected duplicates and their repositories are indicated in the Steward/Repository section of each voucher in the NPSpecies database. For Phase II, identification of duplicates was initiated by CRMO and Atwood but was not completed, and was not entered into the NPSpecies database.

Helpful papers addressing herbarium organization and proper use protocols were written by myself (Attachments 46-48).

Populating the NPSpecies Database

Creating and populating the NPSpecies database was the main thrust of reporting. **The NPSpecies database serves as the formal comprehensive National Initiative database of record of all evidence occurrence data generated and synthesized from this project.** The concept of the database is to enter each taxon exhibiting one of the presence statuses for the Park Unit (present in park, probably present, unconfirmed, encroaching, or historic) into the database and minimally provide evidence of its Park

Unit status by at least one evidence source – voucher, observation, or reference. The evidence counts and other data form the record or “profile” for each taxon, called the *Park-Name Profile*. We used the database to accomplish many more utilities and record keeping. It contains every voucher sheet known to exist from CRMO, as well as reference collections, and provides certain extra observations and references for noteworthy taxa even when they have a voucher. One may use the database to query for any voucher, and for that purpose does not need to access an ANCS+ database. It contains many plant name synonyms often used by the region or Park Unit. It also identifies special statuses such as State-listed noxious weeds, rare plants tracked by the Idaho Natural Heritage Program, or plants endemic to Idaho.

The database contains many data fields and features. There were numerous rules used to define parameters of data inclusion or rejection and data entry formats. The database’s structure, functions, queries, and output capacities are not intuitively obvious. A detailed review of how the database was created and populated, all the rules used, extra data entry and capability customizations for CRMO, and step-by-step instructions on how the database can be utilized, are presented in my 2006 *User’s Guide*. Although created specifically for CRMO and HAFO, it should also be useful to anyone using the NPSpecies database in other Park Units. Although some of the specific examples and statistics are now outdated, the general concepts are unchanged.

After conducting the literature reviews, interviews, herbaria searches, and assessment and curation all collections from 2002 and previous years as part of Phase I efforts, resulting data were entered into the newly-created database in 2003. Data resulting from the final 2006 field season and Phase II efforts were similarly entered in fall 2007, and data were reviewed for quality assurance by myself using NPSpecies tools in January 2008 prior to final submission. The “final” proofed database was submitted to Wolken on January 15, 2008. The Park Service performs final quality control/quality assurance exercises and then merges the processed database back-end file into the overall Park Unit NPSpecies back-end file of all organisms (animals, plants, etc.) to be linked to NPSpecies application software for use on either personal computers or web-based applications. The database is ultimately intended by the NPS to be available to the public by either avenue.

All three forms of evidence of a taxon’s presence – vouchers, references, and observations – were assessed, organized, and entered. Each taxon was assigned a presence value of **present**, **probably present**, **encroaching**, **unconfirmed**, **historic**, or **falsely reported**, and all their “checklist” and “management” fields were populated. The *details* sections of these fields were also consistently populated following certain rules described in the *User’s Guide*. All evidence counts (vouchers, references, and observations) were populated. Certain less-critical data fields were not populated as part of this project, and are identified in the *User’s Guide*. They are intended to be populated by CRMO in outyears.

Certain standard outputs about taxa can be generated by queries. Among them are the checklist fields: park status (present, unconfirmed, etc.), nativity, abundance, and cultivation, and the management fields: weedy plant (yes, no), identification of species of

management priority, and identification of species of exploitation concern. Additionally, very useful customized filters or queries created specifically for CRMO can be applied to generate certain special outputs. Some of the most useful examples are: listing all plants occurring in a certain habitat or in a certain area, stating an estimate of probability of presence if a taxon is unconfirmed or falsely reported, listing all rare plants *currently* tracked by the Idaho Conservation Data Center and Idaho Native Plant Society as of the most recent Rare Plant Conference February 14, 2007, listing all rare plants *formerly* tracked by the Idaho Conservation Data Center and Idaho Native Plant Society as of February 14, 2007, and listing all plants identified by the State of Idaho as Noxious as of the most recent official Idaho Noxious Weed List, dated March 30, 2007.

Certain standard outputs about voucher collections can also be queried, such as querying by CRMO accession or catalog numbers, listing all vouchers collected of a certain taxon, or by a certain collector or date, or listing all specimens that were not collected from within the Park Unit. Additionally, useful customized filters or queries that were created specifically for CRMO can be applied to generate certain special outputs. Some of the most useful examples are: recordation of who originally determined each specimen, and when and what herbarium was used, as well as who, where and when each specimen was verified, listing all specimens that have a record of existing but that are missing, and listing all duplicates residing at other herbaria (except for collections made in Phase II). Such filter tools are powerful and are provided in the *User's Guide*.

The customized filters or queries created specifically for CRMO exceeded the contract scope, and were created gratis to address meaningful and often-requested queries that NPSpecies could otherwise not accommodate. These are called "Special Features" in this report and are discussed in the *Special Features* section. Key words can be used to filter by these attributes and are explained in the *User's Guide* as well as in this report. My recommendations to incorporate these query capabilities into future versions of NPSpecies have been well received by the national NPSpecies database manager, and the database team is fully considering them.

Taxa Included in the Database

All taxa with one of the following presence status were included in the database: **present**, **probably present**, **encroaching**, **unconfirmed**, **historic**, and **falsely reported**. In my resulting hard-copy interim 2006 checklist, "probably present" is called "suspected," which is a more accurate term.

Specifically, taxa included in the NPSpecies database and checklist toward the count of total taxa present, probably present, unconfirmed, or encroaching in the Park Unit are as follows:

- Taxa identified to infraspecific levels (subspecies, variety, or form)
- Taxa identified only to the species level, **if** no infraspecific assignments exist
- Taxa identified only to the genus level, **if** that record represents the only record of the genus for the Park Unit. In most cases, such specimens could not be reliably

determined to the species level because they were immature or lacked sufficient reproductive parts. Such taxa always have a presence assignment of "NA" in NPSpecies, even though they are present.

Taxa not included in the count of total taxa present, probably present, unconfirmed, or encroaching are as follows:

- Taxa identified only to genus level, if other collections of that genus were identified to species, and the collection identified only to genus level was not thought to be different from the identified species.
- Taxa identified only to class, order, or family (e.g., Magnoliopsida, Onagraceae)
- Taxa whose presence is determined to be a false report
- Taxon names that are synonyms of other preferred names. Such taxa always have a presence assignment of "NA."
- Taxa identified only to the species level, if most collections were identified to infraspecific levels, and the collection identified only to species level was not thought to be different from any of the identified infraspecific assignments. There are two scenarios in which this routinely occurs:

Avoidance of Common Names and Acronyms

When a common name was the sole source of information record for a taxon, it was **not** considered, unless the common name was unequivocal in nature and could be accurately cross-walked to a valid scientific name (e.g., that common name clearly refers to one and only one valid scientific name). Similarly, acronyms or "plant codes" of scientific plant names appearing in literature and data forms (e.g., "Pose" for *Poa secunda*) were **not** considered because they are consistently unreliable in crosswalking to the intended current scientific names.

Mis-Spellings Appearing in Literature Sources and Plant Labels

The database we created recognizes one proper spelling of a plant taxon. All sources of evidence were entered with the preferred spelling. If a plant name appeared mis-spelled in a bibliographic reference that appears in the database, the misspelling was not carried forward in the database list of names. Instead, the correct spelling of the appropriate scientific name was entered, and the reference's incorrectly spelled name was linked to the correct spelling of the appropriate scientific name. However, the misspellings were entered into the Park-Name Profile's *Record Information Comments* section for the taxon, and were retained exactly as they appear in the references. They are denoted by a phrase indicating "mis-spelled as". In this way, a person can search for the mis-spelled word exactly as it appears in the reference by entering the character string in a search of the database's *Record Information Comments* data field.

Similarly, if a plant name or collector appears mis-spelled on the original voucher plant collection label, the misspelling was not carried forward in the database; rather, the proper preferred spelling was entered into the database. The physical plant label was

never altered, however, except for annotations. Some Park Units enter the exact misspelling, but that would not allow queries of all records of a particular taxon.

Example: *Potentilla rivalis* is mis-spelled in a reference. It is clarified in the NPSpecies database's Park-Name Profile *Record Information Comments* field for *Potentilla rivalis* with the passage:

“Reported in: *A Flora of Craters of the Moon National Monument* (Wunner 1967, NatureBib bibkey nos. 48749, 166790), mis-spelled as *Potentilla rivularis*.”

Synonyms Included in the Database

Rectifying older names and cross-walking them to newer preferred names was a critical task. Final resolution was performed in all cases by myself, in consultation with many others, and constituted a major effort. I added synonyms to the database that met the below criteria. **This captured enough names to allow the reader to cross-walk names encountered in publications and regional floras that are most often applied to the flora of this Park Unit.** To attempt to list all synonyms of a plant taxon is unnecessary and well beyond the scope of NPSpecies goals.

Criteria employed to include a synonym:

1. ANY plant name appearing in any reviewed reference. All scientific plant names in all pertinent references reviewed for this project have been entered into the database, regardless of how new/old the name may be or how reliable/unreliable the reference. All references reviewed for the NPSpecies project and CRMO database (except the team's 2006 field record books) appears in the *References reviewed* section of the *User's Guide*,
2. Any plant name historically often used and understood by the Park Unit, but which is now considered antiquated (e.g., *Sitanion hystrix* is now *Elymus elymoides*),
3. Selected additional names preferred by appropriate regional *Floras*, principally selected names from *Intermountain Flora*, *A Utah Flora*, and *Flora of the Pacific Northwest*, or
4. Selected names from appropriate recent monographs or other consulted floral works.

Common names, illegible names, and acronyms (e.g., Pose for *Poa secunda*) were totally **ignored**, as they are consistently unreliable as to intended taxon. An exception was if a common name was universally accepted as unequivocally representing one and only one scientific name.

The preferred name, identified in the NPSpecies database classification view as the “local classification accepted scientific name,” is the single unique preferred name to which all other synonym names are linked.

Plant Vouchers, Observations, and References Included in the Database

When was a plant voucher included in the database? A voucher was included in the database whenever it was known or suspected (missing specimens) to exist, and it was collected from within or near the Park Unit. Some vouchers from other areas are sometimes in the database because they serve as reference collections in the Unit's working herbarium to represent taxa that are suspected to occur in the Park Unit. All vouchers currently residing at the Park Unit's working herbarium and those resulting from limited herbaria searches have been entered. There are undoubtedly more unexamined vouchers at unresearched herbaria that were historically collected in CRMO. **However, it is unlikely that unexamined vouchers would represent previously-undocumented taxa for these Park Units.**

When was a plant observation included in the database? Many reported observations were reviewed as part of this NPSpecies effort. An observation was linked to a taxon and was included in the database whenever it was deemed to be "unequivocal" (i.e., its field identification was reliable and could not be confused with another closely-related taxon) and:

- 1) it served as supporting evidence for a taxon not otherwise documented by a verified voucher (or when the sole voucher is missing), or
- 2) the abundance was not well reflected by the few vouchers and the taxon was of particular local interest or rarity.

When was a plant reference included in the database? Many references were reviewed as part of this NPSpecies effort (Attachment 13 plus about 6 references not appearing in that attachment). A reference was linked to a taxon and was included in the database whenever:

- 1) it cited a scientific name or unequivocal common name that represented a taxon not otherwise documented by a verified voucher (or when the sole voucher is missing),
- 2) the taxon name in a reference had a park presence status of anything other than "Present in Park" (i.e., whenever Park status was "Probably Present," "Unconfirmed," "Encroaching," or "False Report"), or
- 3) the plant is tracked by the Natural Heritage Program's Idaho Conservation Data Center or Idaho Native Plant Society Rare Plant Status as stated in the Rare Plant Conference Proceedings, or the BLM as a Special Status rare plant.

Checklist Fields: Park Status, Abundance, Nativity, Cultivation

Park Status (Presence Status) in CRMO

The following lists the park status definitions set by NPSpecies (in quotes) as of 4/4/05,

and additional customized criteria employed for CRMO. The customized definitions involve subjectivity (e.g., what is "unequivocal" or "qualified"?), but an attempt was made to arrive at tighter definitions that could be applied consistently and with minimal subjectivity.

Present in Park - "Species occurrence in Park is documented and assumed to be extant." Additional customized criteria: "Present in park" was defined by two absolute conditions: 1) a verified voucher specimen clearly shown to be collected from within the Park Unit (or from immediately adjacent land with a voucher label clearly stating that the population continued into the Park Unit) that was physically reviewed by Steve Popovich's NPSpecies project team or cooperating herbarium curators, and 2) the taxon also had to be considered currently extant. By following these criteria, "present in park" is 100% reliable -- the species really is present at this time. Reliable "recent" field observations that are "clearly unequivocal" (i.e., the observer is of demonstrated competence and the species could not have been mis-identified) were not considered. Species cited by "reliable" references or observations, but for which no specimen could be confirmed, were not included in the "Present in Park" status.

Probably Present - "Park is within species' range and contains appropriate habitat. Documented occurrences of the species in the adjoining region of the park give reason to suspect that it probably occurs within the park. The degree of probability may vary within this category, including species that range from common to rare." Additional customized criteria: "Probably present" was only sparingly used, and was reserved for taxa that had a valid verified specimen collected from very nearby the Park Unit or along the Park Unit's boundary in similar habitat to the Park Unit, and which could be "reasonably presumed" to therefore occur within the Park Unit.

Encroaching - "The species is not documented to occur in the Park, but is documented as being adjacent to the Park and has potential to occur in the Park." Additional customized criteria: This value-laden word was reserved for known nearby occurrences of non-native plants (no native plants were assigned "encroaching") that are "reasonably expected" to encroach into the Park Unit in the foreseeable future. These species were usually, but not necessarily, within a few air miles of the unit, and are often noxious weeds.

Unconfirmed - "Included for the Park based on weak (unconfirmed) record or no evidence, giving minimal indication of the species' occurrence in the Park." Additional customized criteria: "Unconfirmed" was defined by any source, "reliable" or "unreliable," stating that the taxon was present, or "could be" present, but for which no reliable, verified specimen could be confirmed by the contracted NPSpecies efforts. This included 1) specimen citations that could not be confirmed by direct specimen review, or that were not clearly collected from within the Park Unit, 2) literature references of equivocal species (e.g., those species that could be confused with other species, or those that have taxonomic ambiguity preventing solid identification without physical specimen review), 3) recorded observations by "qualified" or "unqualified" observers, 4) Park Unit or other internal or informal dubious records/files, and 5) partially illegible/incorrectly-spelled cited names that needed to be speculated upon as to true intended taxon. Completely

illegible names were totally ignored.

Historic - "Species' historical occurrence in the Park is documented, but recent investigations indicate that the species is now probably absent." This assignment has been used for only one taxon in this Park Unit. It was never used for weedy species that have been treated and could possibly be eradicated from the Park Unit, because no plants are known to have been *completely* extirpated from the entire Park Unit, even with some "eradicated" weeds.

False Report - "Species previously reported to occur in the Park, but current evidence indicates that the report was based on a misidentification, a taxonomic concept no longer accepted, or some other similar problem of interpretation." Additional customized criteria: "False report" was reserved only for those previous records of occurrence which had "unequivocal proof" of being incorrect: usually a verified and corrected misidentification of a voucher specimen or a taxonomic concept no longer accepted, but also "reliable" references that reported corrections (e.g., a reliable reference clarifies that a name published in a previous reference – typically by the same author – was in error due to a misidentification or taxonomic issue). A clarification of the false report appears in the Park-Name Profile's *Record Information Comments* field.

Abundance

The following lists the park status definitions set by NPSpecies (in quotes) as of 4/4/05, and additional customized criteria employed for the CRMO Park Unit. Abundance refers to **within the Park Unit only**. Many species may be uncommon or even common beyond the Park Unit, but may be rare within the Unit, or vice-versa. Local Park Unit rarity does not imply regional or range-wide rarity.

Abundant - "Large number of individuals; wide ecological amplitude or occurring in habitats covering a large portion of the Park." Additional customized criteria: This assignment was reserved for those plants occurring in high densities over very large areas of the Park Unit, and was only sparingly used. If one had to think about whether or not a plant was clearly abundant, it was not abundant.

Common - "Large numbers of individuals predictably occurring in commonly encountered habitats but not those covering a large portion of the Park." This assignment fits many species and was routinely used.

Uncommon - "Few to moderate numbers of individuals; occurring either sporadically in commonly encountered habitats or in uncommon habitats." This definition fits most species and was most frequently used.

Rare - "Few individuals, usually restricted to small areas or are habitat." This definition fits many species, and was routinely used. If a species occurs in the hundreds of plants at each of 15 or 20 sites across the entire Park Unit, it was still given the assignment of "Rare" because it occupies and occurs in such relatively few numbers and sites.

Unknown - "Abundance unknown." Additional customized criteria: This assignment was used whenever a plant's abundance was not clearly known. It was also sometimes used when a plant was only identified to genus level or higher if that plant's species identification was needed to ascertain abundance.

Nativity

Like Abundance, "Nativity" refers to nativity **within the Park Unit itself**. Some plants may be native to North America or Idaho, but presumably not to the Park Unit itself. Assignment of local Park Unit nativity for many plants known to be native to other areas of Idaho is often problematic and rather nonsensical, and should be used with caution. Also, if a plant occurs naturally in the Park Unit, but seed from the same species has been collected from off-site and then seeded in the Park Unit, materials are present which are both native **and** non-native to the Park Unit. In these instances, nativity was assigned as "native." An example is bluebunch wheatgrass (*Elymus spicatus*, formerly *Agropyron spicatum*), which occurs naturally in CRMO, but which has also been seeded in large areas in BLM-administered areas within CRMO using seed collected from a different part of Idaho or a different state, which is different genetically from the Park Unit's local *in situ* native plant material. The *details* section often discusses this.

The following lists the Park nativity status definitions set by NPSpecies (in quotes) as of 4/4/05.

Native - "The organism is native, or would be native, to the Park (either endemic or indigenous)."

Non-native - "The species is not native, or would be native, to the Park (neither endemic nor indigenous). Cultivated organisms as defined under the *Cultivation* field are also considered non-native."

Unknown - "Nativity is unknown relative to the Park." This was used whenever local nativity was unknown, including when a species is known to be native to other areas of Idaho, but there is reason to believe it may not be native to the Unit, usually because it would be out of the species' known or anticipated range or habitat.

Cultivation

The following lists the Park status definitions set by NPSpecies (in quotes) as of 4/4/05, and additional customized criteria employed for the CRMO Park Unit.

Cultivated - "A non-native species that is currently cultivated in the Park." Additional customized criteria: Emergency Wildfire Rehabilitation (EFR) or range improvement seedings routinely carried out in Bureau of Land Management-administered areas were considered "cultivated." "Persistent" could also be used for such seedings because they are usually only seeded once, and are not harvested.

Persistent - "A non-native species that persists in the Park (either reproducing or non-reproducing) from a previous cultivation in the Park."

Not cultivated - "A non-native species that is not currently cultivated in the Park."

Unknown - "A non-native species for which cultivation in the Park is currently unknown."

Management Fields: Weedy, Management Priority, Exploitation Concern

Weedy

If a taxon is not weedy, the *Weedy Plant?* checkbox data field is not checked. If it is weedy, or if "weediness" is unknown and may have potential, the checkbox is activated. The *details* field is populated as appropriate.

The following lists the park status definition for "weedy" set by NPSpecies (in quotes) as of 4/4/05, and additional customized criteria employed for the Park Unit.

Weedy - "Plant species are considered 'weedy' or 'invasive' if they (a) occur almost exclusively in disturbed habitats, (b) relatively recently occupied natural habitats in competition with native species, or (c) occur across a broad range of ecological conditions." Additional customized criteria: native plants were NOT considered weedy simply if they occurred across a broad range of ecological conditions. For this project, "weediness" **was not** simply lifted from the generic recognitions appearing in the NRCS PLANTS database or *Weeds of the West* (Whitson et al, 5th – 9th eds., 1996-2006), although these works were consulted for each taxon. Rather, "weedy" was determined by myself and local authorities within a more appropriate applied local context, and was defined based upon "the plant's capacity to be 'weedy,' realized or potential, in the particular Park Unit of interest (i.e., CRMO), given the local environmental and ecological conditions." For most, but not all species, my determinations of "weedy" match the same generic determination in the NRCS PLANTS database. A plant was determined to be of a more substantial or meaningful "weedy" nature if it was "weedy to a degree of realized or potential management concern in the particular Park Unit, or weedy in the local geographic area to a magnitude which adversely impacts or potentially could adversely impact the Park Unit's affected ecosystems" (my definition). If a weed is invasive or listed by the State of Idaho as a Noxious Weed as of March 30, 2007, it was automatically considered weedy. A taxon was considered weedy regardless of nativity.

Management Priority

If a taxon is not management priority, the *Management Priority?* checkbox is not checked. If it is a management priority, the checkbox is activated. The *details* field is populated as appropriate.

For this project, “management priority” species were initially defined by myself as those taxa that are 1) noxious in Idaho or of a highly invasive and competitive weedy nature, 2) considered “rare” as defined and tracked by Idaho’s Natural Heritage Program (Idaho Conservation Data Center), the Idaho Native Plant Society’s Rare Plant Conference, or the BLM (for plants within CRMO), 3) considered as significantly contributing to the unique character of the Park Unit, 4) exhibiting significant decline or lack of protection in other areas across the species’ entire or local regional range, and often a keystone species, rendering the Park Unit’s populations of noteworthy genetic resource, refugium, or retention value (e.g., *Artemisia tridentata* var. *wyomingensis*, *Purshia tridentata*), 5) subject to identifiable threats to long-term viability in the Park Unit (applicable to native plants only), usually resulting from ecological or anthropogenic causes (e.g., over-collecting; weed invasion out-competing a native species, 6) a controlled substance (e.g., marijuana, *Cannabis sativa*), 7) addressed in the Park’s Resource Management Plan, or 8) species otherwise desirable by the Park Unit to maintain or increase (e.g., aspen, *Populus tremuloides*). For CRMO, species meeting these criteria were then reduced to a smaller final list based upon what the Park Unit desired or had independently identified by the Chief of Natural Resources. The final CRMO list is about half the number of my originally-derived species. CRMO may have amended their list since I reviewed it in 2002, and any differences may not have been incorporated into the NPSpecies database.

Exploitation Concern

If a taxon is not an exploitation concern, the *Exploitation Concern?* checkbox is not checked. If it is an exploitation concern, the checkbox is activated. The *details* field is populated as appropriate.

For this project, “exploitation concern” species were defined by myself as those taxa that are 1) subject to identifiable threats resulting from commercial value or private collection harvesting, or 2) any plant identified by the Park’s law enforcers, or contained within the Critical Incident Report System database, or that is grown or harvested and is a controlled substance (e.g., marijuana, *Cannabis sativa*).

Special Features for Park-Name Profiles

Special Feature: Probability of Occurrence for Plants Not Present in Park

An estimated probability of occurrence is listed in the *Record Information Comments* section of the Park-Name Profile for any species in the database not occurring in the Park Unit or known to be encroaching (i.e., for those taxa with a park presence status of Probably Present, Unconfirmed, or False Report). Probabilities were assigned as “remote,” “low,” “medium,” or “high” based on presence of nearby plants and suitable habitat within the Park Unit. The closest known locations were also stated if deemed meaningful to understanding the taxon’s proximity.

Example from the database for *Poa gracillima*, which is unconfirmed in CRMO:
“Probability of presence in this Park Unit of *Poa gracillima* sensu stricto is low;

restricted to greater elevations. Closest site known to Steve Popovich is in the Sawtooth Mountains, Idaho.”

Special Feature: Species Habitat and/or Distribution within the Park Unit

Every taxon is populated with a certain habitat and/or distribution **descriptor text string**. This attribute was populated in the *Record Information Comments* section of the Park-Name Profile. Descriptors are based on logical divisions of local plant communities or habitats. This is not part of the standard data fields for NPSpecies, and was created specifically for CRMO. Upon request of the Park Unit, I also identified all taxa I felt were generally restricted to non-foothills areas within CRMO that are administered by the BLM and incorporated a descriptor to that effect (see code field number 4 below). There are no taxa known to occur only in foothill areas administered by the BLM (i.e., they also occur in foothill areas administered by the NPS).

The CRMO *Record Information Comments* habitat/distribution specific descriptor text strings are as follows. The strings are never altered. These are therefore strings that can be used to search and filter. The value to the left of the string is a code that one could use in the future if desiring to code long text strings into shorter data. These always start with "Habitat in this Park Unit = ".

When multiple habitats occur, all applicable text strings were listed, keeping hierarchical order.

Example for CRMO: “Generally occurring (or expected to occur) throughout the Park Unit, usually except at greatest elevations of the foothills; often in sandy sites.”

Code Text string appearing in the Park-Name Profile's *Record Information Comments* field

- =1 Habitat in this Park Unit = Generally occurring (or expected to occur) throughout the Park Unit, usually except at greatest elevations of the foothills.
- =2 Habitat in this Park Unit = Generally restricted to lava flows.
- =3 Habitat in this Park Unit = Generally restricted to foothills in and near the North Unit; may include Huff Creek meadows and Laidlaw Park areas.
- =4 Habitat in this Park Unit = Generally restricted to non-foothills BLM-administered land within this Park Unit.
- =5 Habitat in this Park Unit = Distribution within this Park Unit is unknown.
- =6 Habitat in this Park Unit = Often in disturbed areas or weedy sites.
- =7 Habitat in this Park Unit = Often in sandy sites.

- =8 Habitat in this Park Unit = Often associated with riparian zones or mesic sites.
- =9 Habitat in this Park Unit = Often in mesic-tending swales.
- =10 Habitat in this Park Unit = Often in heavy or fine-textured soils.
- =11 Habitat in this Park Unit = Often in fine-textured, usually alkaline soils of playas or vernal pools.
- =12 Habitat in this Park Unit = Often in alkaline meadows.
- =13 Habitat in this Park Unit = Often in aspen or Douglas-fir stands.
- =14 Habitat in this Park Unit = Abundance and distribution not applicable - false report.
- =15 Habitat in this Park Unit = Abundance and distribution not applicable - not known to occur within this Park Unit.
- =16 Habitat in this Park Unit = Believed restricted to Headquarters area, where planted or adventive.

Special Feature: Plants Tracked as Rare by IDCDC and INPS

The text string "Rare plant ("[2007 status]") as per the Idaho Conservation Data Center and Results of the 23rd Annual Idaho Rare Plant Conference, Boise, February 13-14, 2007" appears in the *Management Priority details* fields if the plant is considered "rare" and is currently tracked by Idaho's Natural Heritage Program (Idaho Conservation Data Center) and the Idaho Native Plant Society as reflected in the most current Rare Plant Conference proceedings (Attachment 62). Such plants are often also considered "species of special concern" by the BLM.

Special Feature: Plants Formerly Tracked as Rare by IDCDC and INPS

The text string "Formerly rare" or "Formerly considered rare" followed by information of **when** and **why** the plant's rarity status was dropped, and whether or not the taxon currently warrants special management, appear in the *Management Priority details* field if the plant was formerly considered "rare" and is no longer tracked by Idaho's Natural Heritage Program (Idaho Conservation Data Center) or the Idaho Native Plant Society, as reflected in the most current and previous Rare Plant Conference proceedings or other source cited in the *details* field. Such plants may or may not be considered "species of special concern" by the BLM. All plants reviewed for rarity status as part of Idaho's "Redbook" efforts of the 1980's and onward through the 23rd Annual Idaho Rare Plant Conference in 2007 were considered.

Example of the details comment field for *Gymnosteris parvula*: “Formerly rare (in Idaho). The Idaho Native Plant Society Annual Meeting dropped rarity status in 1996, stating that the taxon was ‘found to be common.’ It is rare in CRMO, but does not warrant special mgmt.”

Special Feature: Plants Endemic to Idaho

All plants endemic to Idaho have the text string “Idaho endemic” in their *Nativity details* as well as *Record Information Comments* fields.

Special Feature: Taxa that Have Been Seeded or Planted in CRMO

To determine if the species is or was **seeded or planted**, it is identified as such in the *cultivation details* field. The words "seeded" or “planted” were specifically used to be useful search/query words. Nearly always, the cultivars frequently used are also listed (e.g., 'Secar' snake river wheatgrass). If a non-native plant was or is currently seeded, it was classified as “**cultivated**” because the seeding area is currently basically managed as, and is similar to, an unharvested crop, often a monoculture. However, if native species were or are seeded, they were classified as “**not cultivated**” because NPSpecies defines “cultivated” as relating to non-native plants only. Seedings that contain both native and non-native plants are basically managed as unharvested crop seedings by local management agencies.

Special Feature: Degree of “Weedyness”

Relative levels of "weedyness" were developed by myself and assigned to each taxon. This is much more useful to a manager than simply knowing if a plant is "weedy" or not. The *Weedy Plant? details* field was populated with **specific descriptor text strings** for "weedyness" for every taxon in the database, and these strings were never altered. These appear below and are therefore strings that can be used to search and filter. The value to the left of the string is a code that one could use in the future if desiring to code long text strings into shorter data.

"Weedyness" descriptors for CRMO:

Code Text string appearing in the Park-Name Profile's *Management Info, Weedy Details* field

- =0 Not weedy; of no management concern.
- =1 Somewhat weedy, but not invasive in this Park Unit; often decreasing with time after disturbance or with improved ecological condition; of little or no management concern.
This descriptor includes most native “weeds” that are part of a “normal” functioning ecosystem and pose no threat to native plant communities.

- =2 Weedy, but apparently stabilized in this Park Unit; of little or no management concern.
- =3 Potentially INVASIVE in this Park Unit; of low to moderate management concern; monitoring or treatment may be advisable.
- =4 Known to be INVASIVE in this Park Unit; of moderate to high management concern; treatment advisable.
- =5 Potentially highly INVASIVE and AGGRESSIVE in this Park Unit; of high management concern; treatment advisable.
- =6 Known to be highly INVASIVE and AGGRESSIVE in this Park Unit or nearby similar areas; of high management concern; treatment advisable.
- =7 It is unknown if this plant is or could be weedy or invasive in this Park Unit; monitoring may be advisable.

Special Feature: Identification of Idaho State Listed Noxious Weeds

In addition to descriptors for levels of “weedyness,” all species listed as **Noxious** by the State of Idaho as of the most current official State Noxious Weed List, dated March 30, 2007, contain the text string “Listed as State of Idaho Noxious Weed as of 3/30/2007” in both the *management priority?* and *weedy plant? details* fields.

Special Feature: Population of Details Fields when Data Fields are “NA”

If a plant could only be identified to genus, its Park Status is still “NA,” even if the taxon is present in CRMO. NPSpecies does not recognize it as an organism, so its checklist and management data fields are not allowed to be populated. The information has still been captured by entering it into the *details* sections of each data field.

Important rules and their accommodations are:

1. A park status not equal to "present in park" cannot have abundance and cultivation checklist fields populated, but can have nativity populated. When a plant is not "present in park," I populated the *details* fields and added a conditional clause indicating lack of confirmed presence, such as "If found to be present...." or "Were this species found to occur in this Park Unit, abundance would be....."
2. A native plant cannot have a cultivation status (even though off-site native plants are regularly seeded or "cultivated" by the BLM in this Park Unit).
3. Any plant not identified to species (e.g., genus or family only) cannot have any checklist field populated. This was frustrating, because we could often identify a plant to genus but not species. It is of course "present" in the park, and often nativity and

abundance were clearly known, even though we didn't know exactly which species it was.

So, for all plant names other than synonyms, **every checklist and management field is populated, in the *details* sections if needed. This way, one can know the checklist and management attributes of ALL plants in the database, whether or not they are native to CRMO or identified to species level.** Of course, sometimes they are populated with “unknown” when the attributes could not be assigned without knowing the species.

Special Features for Vouchers

In addition to providing special features to the Park-Name Profiles, special features were also added to the vouchers database. These are discussed in the *User's Guide*.

Special Feature: Identification of Specimen Determiner and Verifier Data

Among the most important of the special features for vouchers is the recordation of who determined and who verified each specimen. The dates of determination and verification, as well as herbaria used, are also listed. This information appears at the beginning of the comments in each voucher's *Record Information Comments* section.

Data Sensitivity Level

The *Sensitivity Level* data field was populated. A specimen, reference, or observation has sensitivity set to "Public" unless one of the following conditions exist: 1) the taxon is listed as a Threatened or Endangered plant species, or is a Proposed or a Candidate plant species, under the Endangered Species Act (none in this Park Unit), 2) the taxon is a controlled substance or is of law enforcement concern, or 3) the taxon is currently tracked by the Natural Heritage Program's Idaho Conservation Data Center or by the U.S. Bureau of Land Management. In these instances, sensitivity was set to "NPS-Only."

Sensitivity is set to "NPS-Only" for 30 voucher records. Sensitivity is set to "Public" for all observations and references in the evidence counts. No records have sensitivity set to "Park-Only."

Are Vouchers or Observations from within CRMO?

The *From Park?* data field was populated with Yes, No, or Unknown whenever 1) a specimen is not residing in the CRMO working herbarium, 2) a specimen or observation is known to be from outside the Park Unit by more than ca.100 feet, or 3) the specimen is missing.

Database User's Guide

As previously discussed, a detailed review of how the database was created and populated, all the rules used, extra data and capability customizations for CRMO, and step-by-step instructions on how the database can be utilized, are presented in my 2006 *User's Guide* (Attachment 2). Although some of the specific examples, lists, and statistics are now outdated, the concepts are unchanged. The general concepts should prove useful to any database user for any Park Unit. It is hoped that a revised *Guide* will be generated as part of my final report anticipated May, 2008.

The *User's Guide* created specifically for CRMO and HAFO exceeded the contract scope. It was generated at an additional fee to provide meaningful instructions to the complex database and its functionalities. It also lists several often-requested queries that NPSpecies can perform.

Quality Control

I was team leader throughout the life of the project, and was responsible for execution of all phases of the project, overall quality control, project strategies and field logistics, and project accomplishments. In Phase II, Atwood and Mancuso worked directly under the National Park Service in concert with team objectives and delivered their products directly to CRMO, with hard copies to me. **The over-arching rule of all work performed under this project was that results are, without exception, based upon a preponderance of evidence and the best scientific and commercial data available, including assurance of confident specimen verifications.**

Results

Overview

About 14 years of intermittent efforts involving over 30 individuals and expending roughly 4,000 total person-hours (!) of vascular plant work for both CRMO and HAFO have been effected under the national initiative from 1994 through January, 2008. Of this, 2/3 or more of all expended energy focused on CRMO. This amount of manpower and applied expertise by extremely well-qualified individuals is unusual for a project inventory of this scope and focus, and reflects well on the commitment of the Park Unit to accomplish the intended goals and acquire more knowledge about their botanical resources. As such, it is deserving of recognition.

All targeted office work, two field seasons, and CRMO's working herbarium expansion and curation were successfully completed. The NPSpecies vascular plant electronic database for the unit was populated, including all three sources of evidence – vouchers, observations, and references – that list all plants **present, probably present** (called “suspected” in the checklist, which is a more accurate term), **encroaching, unconfirmed, historic, and falsely reported** for the Park Unit current as of January 15, 2008. A spreadsheet 2006 interim checklist exists (Attachment 4), and a more thorough 2006

interim plant checklist (Attachment 3) has been posted on the web. A revised 2008 checklist will accompany my final report in May, 2008. Additionally, a *User's Guide* (Attachment 2) was developed and distributed to CRMO staff and project coordinators to allow global users to more effectively utilize the powerful NPSpecies database available on line. A synthesis of historical botanical work and plant collections in CRMO has been presented and is current through January 15, 2008. Much of the results from this project regarding vegetation descriptions, historical botany work, and herbarium expansion formed the basis for much of the discussions in the *general vegetation* and *floristic zones* of CRMO and *historical botany work* sections of this report, and has already been presented.

Although it seems conceptually simple, it is difficult to generate exact numbers and tallies of statistics for collections data due to convoluted reasons when using the NPSpecies database and the context in which the numbers are generated (e.g., two collections sheets of the same taxon, "Part 1 of 2" and "Part 2 of 2" count as one collection but two unique sheets, each entered into the database; whether or not a collection of a taxon identified only to genus level counts toward the total number of taxa present, mixed collections with the same collector's number but representing different taxa are problematic to tally, etc.). Therefore, numbers are approximate, and the reader should not be overly concerned if small inconsistencies are observed in tally numbers, or if numbers quoted in this report do not exactly agree with numbers presented in the attachments. One can consult the NPSpecies database to resolve differences.

Supplementary materials regarding results (e.g., field record books) will be included in my final report due May, 2008.

General Floristics

The total number of taxa (including subspecies, varieties, and forms) known to be present in this Park Unit is 752; they occur in 77 families. The greatest numbers of plants occur in the Asteraceae (composite or sunflower) family with 125 taxa, followed by the Poaceae (grass) family with 82 taxa, the Brassicaceae (mustard) family with 49 taxa, the Fabaceae (legume or pea) family with 48 taxa, and the Scrophulariaceae (figwort or penstemon) family with 45 taxa. These families collectively represent 349 taxa, or almost 50% of the total taxa known to be present in CRMO. Roughly 633 taxa are believed to be native to CRMO, about 19 taxa may be native to CRMO, and about 100 taxa are not native to CRMO. Many taxa not native to CRMO are also not native to North America. **In addition, there are 96 taxa that are unconfirmed (many of which are unlikely to occur), five probably present, five encroaching, one historic, 34 falsely reported, and two with status unknown** (the intended taxa are unclear, and are possibly invalid taxon names). These totals include all final results from the 2006 field season. The unconfirmed taxa include members of two additional families, Santalaceae (sandal wood) family and Cannabaceae (hemp) family. The number of unconfirmed taxa is greatest in the Asteraceae family with 21, followed by the Poaceae family with 20. The taxon believed historic is non-native henbit (*Lamium amplexicaule*), presumed intentionally extirpated when the Headquarters landscaping in which it occurred was

removed or converted to native plant materials sometime after 1992.

The total number of taxa documented as “present,” “probably present,” “unconfirmed,” “encroaching,” or “historic” as entered in the NPSpecies database now totals 895. I consider this to be very good documentation. The number of taxa documented in CRMO over time and associated references are listed in Table 3 below.

Table 3. Number of taxa documented in CRMO over time and associated references.

Year	Number of Taxa Documented in CRMO	Reference
1928	65	McElreath 1928a
1967	291	Wunner 1967
1968	302 (includes 11 unconfirmed)	Urban 1968a
1992	348 (includes unconfirmed)	Whipple 1992
2006	661 present + 132 encroaching, prob. pres., or unconfirmed + 23 falsely reported	Popovich 2006b
2008	752 present + 106 encroaching, prob. pres., or unconfirmed + 1 historic + 34 false rep. + 2 unk.	Popovich 2008 (this report)

General floristic zones have been delineated (Attachment 5). The floristic zones were developed by myself based upon my years of experience botanizing in the area, literature review, and personal observations and data provided by local BLM and NPS staff and academes. I well remember the countless hours of discussions held over the years in the field and in the office between Floyd DeWitt and me, and to a lesser degree between Doglass Henderson, Darwin Jeppson, Jay Anderson, Steve Monsen, Steve Bunting, Al Winward, Roger Rosentreter, Mike Pellant and me, in determining vegetation community types, discernable boundaries, vegetation-climate-soil patterns, application and appropriateness of vegetation succession theories, and disturbance regime impacts to observed plant communities. These people, especially Floyd DeWitt, were extremely knowledgeable and helpful in understanding and describing local observed vegetation. DeWitt and I believe Jeppson were former Chiefs-of-Party or similar positions for several local County Soil Surveys. The zones are for general guidance only, are subject to refinement, and are not meant to be formal.

NPSpecies Database and Evidence Counts Tallies

In the NPSpecies database (Attachment 1), there are **1,366 total taxon records** for CRMO, including synonyms and false reports. **Regionally-preferred synonyms as well as all synonyms appearing in all references reviewed are included.** There are **3,176 plant voucher (specimen) database records.** In addition to voucher data, there are **54 linked plant observations.** Also, there are **65 linked plant bibliographic references.** The uncompressed database is about 25 megabytes in size.

The entire NPSpecies database was exported to a series of Microsoft Office Excel 2003 capturing the data and segregating them into a set of meaningful spreadsheets (Attachments 6-12 and 15-25). Overviews of species present and not present (i.e., probably present, unconfirmed, encroaching, historic, false report, and status unknown) are in Attachments 21-25. Albeit unwieldy, in this fashion one may view the entire database in spreadsheet format by using Microsoft Excel, if the NPSpecies application is not available. The NPSpecies spreadsheet (Attachment 6) is the “master” data spreadsheet, is entirely current, and perfectly reflects the NPSpecies database as of its delivery to the NPS on January 15, 2008. It was exported after all final edits had been made. Some of the other spreadsheets, however, were exported a few days prior to making a few minor NPSpecies database revisions. Mandatory ANCS+ data fields for voucher records gathered as part of Phase II efforts were entered (Attachment 10) and exported into a text file (Attachment 11). They have also been retained in the attached submitted NPSpecies database.

Although such spreadsheets are believed current, there may be a few discrepancies that resulted from not carrying forward the minor edits made in the final NPSpecies database after export of those spreadsheets. If any discrepancies are encountered between spreadsheets, the master file NPSpecies spreadsheet (Attachment 6) is most accurate, and always takes precedence, except in the case of the *Park Status* data field. As previously discussed, taxa identified only to genus level or higher (family, etc.) have their Park Status and some checklist and management fields populated with “NA” because they are not recognized by NPSpecies as organisms. Park Status was hand-edited for these taxa and is accurately portrayed in Attachments 21 and 22. The only such two taxa impacted that have their only form of documentation in CRMO by genus level are *Fraxinus* sp., which has a Park Status of “Present in Park,” and *Dalea* sp., which has a Park Status of “Unconfirmed.”

Field Work

Two seasons of collecting were accomplished, 2002 and 2006. A total of about 56 field days were expended by the team, counting 4 collecting days in 2001 by myself. This figure does not include field time from Wolken and other NPS staff. From 2002 through 2006, Wolken and Rowland field record books indicate an additional 44 days in which collections were made specifically for NPSpecies and/or as part of routine job duties. If including their efforts, the total number of field days was 100. Using an average field day length of 9 hours, this equals 900 hours. Within a calendar year, field visit dates for the team ranged from May 5 to October 4. Wolken made a few unaccessioned collections (e.g., Wolken 1129, 1130) as early as April 1st, 2003. I have surveyed and/or collected in previous years as early as early March in the hottest, driest areas of CRMO and as late as late November for sagebrush seed inspection forays. Many of the NPSpecies surveys I performed were accompanied by others. The more involved, lengthier of these were: Popovich and Davis (NPS Intern) trip to the North Unit highest-elevation boundaries on May 25, 2001; Popovich and Blackburn circumscription and exploration of the Wapi Flow on May 5 and 6, 2002; Popovich and Wolken trip to Round Knoll and “Grassy Knoll” Kipukas on August 20, 2002; Popovich and Frick (NPS Intern)

trip to “Bear Paw” Kipuka on August 21, 2002; and Popovich and Wolken trip to Steamboat Lake and other southern playas and Laidlaw Park on June 20, 2006.

General survey routes are depicted on 1:100,000-scale topographic BLM surface management status maps in Attachments 51-53. The maps show survey routes for Popovich and Blackburn for Phases I and II, and Atwood for Phase I. Atwood and Mancuso survey routes for Phase II have been submitted separately to CRMO. Particular stops totalled in the hundreds, and are not depicted. When reviewing the maps, it is important to be mindful of the overall accomplishments from all previous surveys that are not depicted. Accessible areas representing holes or gaps appearing in these maps very often have been surveyed by previous efforts. All significant survey efforts by myself and my technicians conducted 1992 through 2006, all survey efforts by the NPSpecies team for Phase I and Phase II, and some past survey efforts by others will be included on revised survey maps submitted with my final report. They will show significantly greater area surveyed. A set of USGS 7.5-minute topographic maps showing all routes by myself for Phases I and II that often depict individual stops will also be included. Overall survey accomplishments in CRMO from all previous surveys and the NPSpecies efforts are quite substantial, and have resulted in a fairly comprehensive survey and documentation of CRMO flora.

A total of about 1,910 collections were made from the NPSpecies field efforts, and are discussed further in the *CRMO Herbarium Status* section below. Upon initiation of this project, the CRMO working herbarium contained about 705 specimen sheets representing about 348 taxa in about 47 families. As a result of Phase I, about 1,811 specimen records were added (including about 137 records for specimens known to be missing), and the total number of taxa known to be present almost doubled to about 657. Phase II added about 660 more specimen records and increased the total number of taxa known to occur in CRMO to about 752, a 14% increase over Phase I. It also confirmed about 35 taxa that were unconfirmed from Phase I.

During Phase II, we visited many of the target survey polygon areas identified as highest priority (Attachment 59), as well as numerous other areas encountered in route to the polygons. By conducting the 2006 Phase II field season, we expected to increase the number of new taxa by 50-100, and to confirm perhaps 25 taxa previously believed to occur but that were unconfirmed. Our expectations were well estimated. Field work conducted in 2006, in combination with reviewing 83 previously-unexamined specimens from Ms. Jennifer Whipple (Botanist, Yellowstone National Park) collected in CRMO in 1992 (including two from 1999), resulted in the documentation via collections of 83 new taxa. Additionally, we confirmed via collections the presence of 35 previously unconfirmed taxa (Table 4 and Attachment 38), for a total of 118 additional taxa confirmed in 2006. This brings the total number of taxa (species, subspecies, and varieties) known to occur in this Park Unit via reliable collections to 752, and the number of still-remaining unconfirmed taxa to 96, of which 23 have reliable field observations by myself and competent others, and could, in my opinion, be considered present.

Table 4. Taxa confirmed present in CRMO in 2006 from Phase II survey efforts that were unconfirmed following 2002 Phase I surveys. Number of taxa = 35.

Family	Scientific Name	Park Abundance	Park Nativity
Asteraceae	<i>Acroptilon repens</i>	Rare	Non-Native
Asteraceae	<i>Antennaria stenophylla</i>	Uncommon	Native
Brassicaceae	<i>Arabis puberula</i>	Rare	Native
Viscaceae	<i>Arceuthobium douglasii</i>	Uncommon	Native
Asteraceae	<i>Artemisia cana</i>	Rare	Native
Asteraceae	<i>Artemisia longiloba</i>	Rare	Native
Asteraceae	<i>Aster campestris</i>	Rare	Native
Chenopodiaceae	<i>Atriplex canescens</i> var. <i>canescens</i>	Rare	Native
Liliaceae	<i>Camassia quamash</i>	Rare	Native
Cyperaceae	<i>Carex nebrascensis</i>	Rare	Native
Scrophulariaceae	<i>Castilleja exilis</i>	Rare	Native
Chenopodiaceae	<i>Chenopodium murale</i>	Rare	Non-Native
Asteraceae	<i>Cichorium intybus</i>	Rare	Non-Native
Ranunculaceae	<i>Clematis ligusticifolia</i>	Rare	Native
Boraginaceae	<i>Cryptantha ambigua</i>	Rare	Native
Poaceae	<i>Danthonia unispicata</i>	Uncommon	Native
Poaceae	<i>Elymus elongatus</i> ssp. <i>ponticus</i>	Rare	Non-Native
Onagraceae	<i>Epilobium alpinum</i> var. <i>alpinum</i>	Rare	Native
Onagraceae	<i>Epilobium angustifolium</i>	Rare	Native
Saxifragaceae	<i>Heuchera grossulariifolia</i> var. <i>grossulariifolia</i>	Rare	Native
Poaceae	<i>Hordeum vulgare</i>	Rare	Non-Native
Brassicaceae	<i>Isatis tinctoria</i>	Rare	Non-Native
Scrophulariaceae	<i>Linaria genistifolia</i> ssp. <i>dalmatica</i>	Rare	Non-Native
Asteraceae	<i>Matricaria maritima</i> ssp. <i>inodora</i>	Rare	Non-Native
Polemoniaceae	<i>Navarretia minima</i>	Rare	Native
Asteraceae	<i>Onopordum acanthium</i>	Rare	Non-Native
Scrophulariaceae	<i>Orthocarpus luteus</i>	Rare	Native
Scrophulariaceae	<i>Penstemon procerus</i> var. <i>procerus</i>	Rare	Native
Primulaceae	<i>Primula cusickiana</i> var. <i>cusickiana</i>	Rare	Native
Rosaceae	<i>Rubus idaeus</i> var. <i>strigosus</i>	Rare	Native
Salicaceae	<i>Salix geyeriana</i>	Rare	Native
Fabaceae	<i>Trifolium gymnocarpon</i>	Rare	Native
Dryopteridaceae	<i>Woodsia oregana</i> ssp. <i>oregana</i>	Rare	Native
Asteraceae	<i>Wyethia amplexicaulis</i>	Rare	Native
Asteraceae	<i>Xanthium strumarium</i> var. <i>canadense</i>	Rare	Native

Field conditions were generally favorable. Survey date timings relative to targeted plant phenologies best for collecting were generally achieved. Droughty conditions and excessive heat during the growing season can markedly reduce the number of taxa

expressing themselves above ground and resulting effectiveness of surveys. I don't think these conditions were expressed severely enough to seriously impact our survey results. The 2002 growing season was somewhat hot and dry, with some taxa in summer not well represented, but I do not think it was significant for our purposes. Growing season 2006 approached average growing conditions. As previously mentioned in the *field work methods* section, I had already well surveyed large portions of CRMO from 1992 to 2000 that included repeat visits to certain promising microsites over several years, or in early or late times of the growing season specifically to collect early and late blooming plants. These past surveys specifically included years of exceptional growing conditions when plant expression was strong, which helps to offset possible loss of detection of plants from the dryer conditions during NPSpecies efforts.

I attempted unsuccessfully to locate and re-collect at the unconfirmed *Allium confer aaseae* site.

In fall 2006 (revised in 2008) a progress report was written by myself that documented results of the 2006 Phase II field survey efforts, discussed new taxa encountered, assessed if 90% of CRMO flora had been documented, and offered direction for future work (Popovich, 2008a; Attachment 49). Soon thereafter, Atwood generated a similar report. Many of the records he believed to be new at the time were later found to be erroneous identifications or synonyms of pre-existing taxa, and were annotated by myself in the final verification process. The resulting records that are false reports were clarified in a follow-up report by myself, which also has Atwood's original report attached (Popovich, 2008b; Attachment 50). Hopefully, use of the clarifications report will stop any future confusion over material presented in his progress report.

Literature Reviews

From a total of about 180 references dated through 2004 for CRMO identified as possibly containing information relevant to this project, about 110 (61%) were further identified as potentially useful and were reviewed for CRMO (Attachment 13 plus about 6 references not appearing in the attachment), including **all** known references containing any species lists, plant names, or plant community names (except for the unit's various internal natural resources data forms that were determined to be unreliable). By far, all of the most promising references were reviewed, and it is doubtful that those not reviewed would yield additional new information. Any references created since 2004 have not been reviewed.

It should be noted that errors were sometimes made by the NPS when entering reference data into NatureBib. Also, NatureBib sometimes generates formatting errors when exporting references. I submitted fully accurate and complete literature citations to the NPS. I do not take responsibility for the accuracy or presentation format of NatureBib. For various reasons, there may be more than one Bibkey ID number for the same reference. Sometimes these are simply unintentional double entries, but other times they represent subtle but significant differences between differing references that may have been entered with the same reference name (e.g., original versus revised reports). Often

one reference may contain species lists not present in the other. If different versions of the same reference exist (resulting in different Bibkey ID numbers), all versions were reviewed. NatureBib sometimes cites full author names, and other times only cites letters (e.g., sometimes "John D. Smith," other times "J.D.S."), without regard to how the author name actually appears in the reference. To address this, because I didn't always examine the original references, I consistently provided full first names when they were known to me, even though such conversion can be seen as somewhat unconventional (e.g., "S.J.P." became "Popovich, Steve J."). When there are differences between literature citations in NatureBib and those in my report, mine are almost always the more correct. Full citations and important differences in different versions of the same reference are stated in the *References Reviewed for HAFO and CRMO* section of my *User's Guide* and Attachment 13. I also created and present in the *Guide* and Attachment 13 helpful abstracts for references that I discovered that were not yet entered into NatureBib or assigned NatureBib ID numbers.

CRMO Herbarium Status, Herbaria Searches, and Missing Specimens

There are **3,176 voucher records** from within (or a few reference collections from near) CRMO in the NPSpecies database as of January, 2008. The total number of herbarium specimen sheets existing prior to the NPSpecies efforts in for CRMO was about 705, including those that are located in all other repositories known. The total number of additional collection sheets made under the Phase I NPSpecies effort is about 1,595, not counting the numerous duplicates residing at BRY or that Atwood may have sent to NY and elsewhere. The total number of additional collection sheets made under the Phase II NPSpecies effort is about 693, not counting the numerous duplicates residing at BRY. The total number of new plant voucher sheets assigned new catalog and accession numbers resulting from both phases of this project is about 2,288, and about another 158 missing collections or those housed elsewhere were added into the database without assigning accession or catalog numbers. **These 2,445 voucher records entered from this project represent about 77% of the total voucher records in the NPSpecies database.**

Of the 3,176 vouchers entered into the database, there are currently **3,015 plant specimen sheets (vouchers) in the CRMO working herbarium**, not counting a few unaccessioned study specimens collected by Paige Wolken. There are an additional 21 collections known to be housed elsewhere, another two with repositories unknown, one specimen is known to have been discarded, and 137 specimens are known to be missing. The total number of specimens found at searched herbaria were about 18, occurring at Herbaria RM, OSC, and CS. These numbers do not reflect the several hundred duplicate specimens of original collections reviewed by Atwood or collected by team members that are known to be residing at Herbarium BRY, many of which from 2002 have been identified as duplicates, and can be queried as such in the database. There are 85 taxa represented by 10 or more vouchers, while 226 taxa are represented by only one voucher specimen (Attachment 43). The ecologically-important native bunchgrass bluebunch wheatgrass (*Elymus spicatus*) is most represented, with 25 collections. The large number is due in part to the fact that there are two forms recognized (awned and awnless), each

with their own representative collections. Cheatgrass (*Bromus tectorum*), by far the most problematic non-native plant in CRMO today, had only two collections in the herbarium prior to Phase I. Interestingly, two are from 1936. It now has eight, and its close cousin corn brome (*Bromus squarrosus*), which in CRMO is often mistaken by locals for cheatgrass, has 14 collections by Whipple and the NPSpecies efforts.

Accession numbers for herbarium specimens existing prior to the NPSpecies efforts for CRMO were: “unknown,” 01, 02, 06, 08, 110, 116, 126, 183, 188, 189; catalog numbers were various. Additional collections made under the NPSpecies Phase I effort are accession number 212 (and “not assigned” for those specimens that were not accessioned); catalog numbers are 2571 - 4165, inclusive. Additional collections made under the NPSpecies Phase II effort are accession numbers 223 and 224; catalog numbers are 4669 - 5361, inclusive.

All specimen sheets were reviewed from the existing CRMO working herbarium, other herbaria, others submitted by Jennifer Whipple she had collected in 1992 but stored elsewhere, and those collected by our team. An additional several thousand Popovich collections from southern Idaho were reviewed by myself to identify and incorporate all those collected from within CRMO. When reviewing the collections I made between 1992 and 2002 from BLM-administered areas within CRMO, I found about 215 Popovich collections that were not part of the NPSpecies effort, and entered about 203 of them into the voucher database. Unfortunately, some of my best collections of uncommon plants collected from BLM-administered areas within CRMO have apparently been mis-placed by others at Herbarium BRY. A few of the more important ones are mentioned in the NPSpecies voucher database as missing, but most were not entered.

A total of about 1,910 collections were made for CRMO for the NPSpecies efforts by all collectors and entered into the NPSpecies database. A total of about 730 specimen sheets were collected by myself from 1992 through 2006 and are entered in the database, including about 203 that were collected prior to 2002 and were not part of the NPSpecies project. The 730 Popovich sheets include 24 specimens collected in 2001 during pilot visits, and about 476 specimen sheets collected in Phase I in 2002 and Phase II in 2006, of which 48 specimens were collected as a “Popovich & Wolken” team (Popovich & Wolken 01 through 48), and 20 were collected as subordinate co-collector with Atwood (Atwood 31,400 – 31,419 & P. Wolken, A. Rowland, S. Popovich). They also include about 21 reference collections made from outside CRMO. Atwood collections total about 952 (one was collected in 1989), Blackburn collections total about 208, and Mancuso collections total about 106. The approximate numbers of specimens collected by principle collectors under the NPSpecies effort are listed in Table 5 below.

Table 5. Approximate number of specimens collected by principle collectors under the NPSpecies effort and all taxa collected by Popovich within or very near CRMO.

Year	Popovich	Atwood	Wolken	Blackburn	Mancuso
<2001	203				
2001	24				
2002	354	733		172	
2003-2005			35		
2006	122	218	85	26	106
Total	703	951	120	198	106

From 1992 through 2006, as reflected by specimens residing at CRMO, I variously collected in CRMO with team members N.D. Atwood, P. Wolken, and C. Blackburn, but also with: CRMO former Superintendent J. Morris; CRMO former staff N. Cummings; CRMO interns C. Davis, G. Frick, J. Short and A. Rowland; HAFO NPSpecies contractor to Popovich, S. Weiss; Conservationist M. Medberry; Academe J. Anderson; Dutch friend and Paleofaunal Archeologist L. van Es; and (mostly before 2002) Shoshone and Idaho Falls BLM former and current employees B. Brown, G. Gunther, K. Kubik, A. Pike, and D. Wallace. I collected a specimen with J. Livey but cannot recall his affiliation (BLM intern?). Some collections from areas near CRMO that I contributed as reference specimens for under-represented taxa were collected with USFS Sawtooth National Forest former and current employees J. Shelly and T. Haberle. I also asked a few BLM people to collect for me in the 1990's: G. Gusick, M. Aslett, S. Henriksen and E. Thiel. Other BLM employees that contributed one collection each are P. McClain (retired) and R. Rosentreter. Wolken accompanied Atwood several times.

None of the missing Wunner (or single Urban) specimens were found. I confirmed that the missing Wunner and Urban specimens are apparently not accessioned at the following U.S. herbaria: KANU, ID, IDS, USC, RM, BLM Shoshone working herbarium, or Craters of the Moon National Monument working herbarium. It is possible, but unlikely, that they may reside at CIC, which was not as thoroughly searched. It is also unlikely that they reside at INEEL's working herbarium, but it was not checked. In speaking with Wunner about the negative search results, he stated that, at the time of the collections, some of his collections were in a state of transition between several locations to, from, and at KANU, and could have been temporarily misplaced by himself and/or the then-current collections manager or his advisor, perhaps leading to eventual permanent loss (Wunner, pers. comms. with S. Popovich, 07 March 2005). **Wunner and I concluded that the specimens are believed lost and future search efforts are not warranted.**

It is noted that sheets of interesting Popovich collections of *Carex* cf. *hoodii* were sent by Emerenciana ("Mering") Hurd (USFS Rocky Mountain Research Station, Boise, ID) to *Carex* authority Joy Mastroguiseppe in Pendleton, Oregon, for determinations on May 10, 2002. At that time the specimens were undetermined, and they have not been returned by her to CRMO. Duplicates were later determined by *Carex* authority Tony Reznicek at Herbarium MICH in 2007 (CRMO catalog numbers 5356 and 5357). This is noted in the database.

It is doubtless that other collections from CRMO exist that were made by early botanists, government researchers, and graduate students that are unknown to myself or the Park Unit. I feel the more promising herbaria to search are probably ID (Moscow, ID), IDS (Pocatello, ID), CIC (Caldwell, ID), and SRP (Boise, ID), because that is where many student theses originated and those are local established herbaria used by many collectors. Other places where Cronquist and other early botanists could have deposited collections, such as in the Pacific Northwest and possibly UTC (Logan, UT), could be checked, as well as places where early expeditions may have deposited specimens, possibly RM (Laramie, WY), US (Washington, D.C.), and elsewhere. INEEL's working herbarium could house some specimens collected from adjacent CRMO.

Helpful guides to the proper use and organization of the CRMO working herbarium were generated (Attachments 47 and 48). A guide on how to interpret herbarium specimen and annotation labels, collector's numbers, and information occurring on a plant label was generated as well (Attachment 46).

Unconfirmed Taxa

There are 96 taxa that remain unconfirmed. Some, such as *Bromus japonicus*, are common in the region while others, such as *Microseris troximoides*, are sparingly present but consistently observed across the Snake River Plain. Such taxa very probably occur in CRMO, and will likely be documented with additional surveys. Given our diligence in field work and knowledge of the taxa, it is somewhat unexpected that they were not encountered during our field surveys even though they were specifically searched for, which indicates that they are definitely not common within CRMO. Many other unconfirmed taxa are unlikely to occur, however, because they would be out of the taxon's known and anticipated ranges or constitute improbable major range extensions, or they may be known to occur nearby, but in habitat that is clearly not present in CRMO. Many are probably misidentifications of other related taxa known to occur in CRMO. Without examining the original specimens (if they exist), it is impossible to know if these taxa are truly present in CRMO. Nevertheless, to be conservative, their records should be maintained.

Of particular interest is the single collection of *Allium confer aaseae*. The material is in poor condition, and the identification is still unconfirmed despite a recent evaluation by Dr. Don Mansfield (Herbarium CIC). If proven to be *Allium aaseae*, this would be a significant range extension, and would force our understanding of the species' range and perceived ecology to be re-evaluated.

Ten missing Wunner specimens would constitute new taxon records for CRMO if they were to be recovered and verified (Table 6 and Attachment 42).

Table 6. Missing Wunner specimens entered in the NPSpecies database that would constitute new taxon records for CRMO if they were to be recovered and verified. The specimens are cited in Wunner (1967). Number of specimens = 10.

Taxon name as cited in Wunner 1967	Wunner collection number	Synonyms and likely ID
<i>Agoseris retrorsa</i>	696	Probably mis-ID of a another <i>Agoseris</i> or <i>Crepis</i> sp.
<i>Allium tolmiei</i> (mis-spelled <i>tomei</i>)	634	Probably mis-ID of another <i>Allium</i> sp.
<i>Aster occidentalis</i>	962	May truly be new taxon for CRMO. Syns. = <i>A. spathulatus</i> ; <i>A. ascendens</i> var. <i>fremontii</i>
<i>Galium boreale</i>	1057	May truly be new taxon
<i>Galium triflorum</i> (mis-spelled <i>trifolium</i>)	1200	May truly be new taxon
<i>Haplopappus uniflora</i>	844	May truly be new taxon. Syn. = <i>Pyrrocoma</i>
<i>Mertensia campanulata</i>	641	Probably mis-ID of other <i>Mertensia</i> spp.
<i>Oenothera heterantha</i>	780	Probably mis-ID of <i>O. caespitosa</i> . Syn = <i>Camissonia subacaulis</i>
<i>Potentilla rivalis</i> (mis-spelled <i>rivularis</i>)	792	May truly be new taxon
<i>Solidago gigantea</i>	1201	Probably mis-ID of <i>S. canadensis</i> , but may truly be new taxon.

Additionally, 68 taxa are unconfirmed that appear in literature citations (Table 7 and Attachment 40 and 41).

Table 7. Taxa entered in the NPSpecies database that are unconfirmed within CRMO appearing in literature citations and the number of their historical references. Only taxa that are from references with collection locations clearly within CRMO are included. The number of references below does not include the Popovich 2006 and upcoming 2008 CRMO checklists or the IDCDC Element Occurrence database; however, these references are in the NPSpecies database. Number of taxa = 68.

Family	Scientific Name	No. of References w/Citation
Asteraceae	<i>Agoseris grandiflora</i>	1
Asteraceae	<i>Agoseris retrorsa</i>	4
Liliaceae	<i>Allium cernuum</i>	2
Liliaceae	<i>Allium parvum</i>	2
Liliaceae	<i>Allium simillimum</i>	3
Liliaceae	<i>Allium tolmiei</i> var. <i>tolmiei</i>	5
Caryophyllaceae	<i>Arenaria nuttallii</i>	1
Asteraceae	<i>Aster spathulatus</i>	5

Fabaceae	Astragalus atratus var. insepatus	1
Fabaceae	Astragalus scopulorum	1
Chenopodiaceae	Atriplex confertifolia	5
Asteraceae	Balsamorhiza hookeri	6
Poaceae	Bromus japonicus	2
Liliaceae	Calochortus nitidus	3
Onagraceae	Camissonia subacaulis	5
Asteraceae	Canadanthus modestus	1
Cyperaceae	Carex siccata	3
Scrophulariaceae	Castilleja applegatei var. pinetorum	6
Scrophulariaceae	Castilleja pilosa var. longispica	5
Caryophyllaceae	Cerastium glomeratum	3
Asteraceae	Cirsium eatonii	2
Asteraceae	Cirsium flodmanii	1
Asteraceae	Cirsium undulatum	6
Santalaceae	Comandra umbellata var. pallida	1
Boraginaceae	Cryptantha watsonii	6
Cyperaceae	Eleocharis rostellata	1
Poaceae	Elymus X saxicola	4
Asteraceae	Erigeron canus	2
Asteraceae	Erigeron compositus var. discoideus	2
Asteraceae	Erigeron nanus	5
Asteraceae	Erigeron pumilus ssp. intermedius var. euintermedius	1
Polygonaceae	Eriogonum compositum	2
Polygonaceae	Eriogonum flavum	1
Polygonaceae	Eriogonum heracleoides	19
Polygonaceae	Eriogonum mancum	1
Chenopodiaceae	Eurotia lanata	1
Poaceae	Festuca bromoides	2
Poaceae	Festuca scabrella, sensu stricto	5
Rubiaceae	Galium boreale	8
Rubiaceae	Galium trifidum	1
Rubiaceae	Galium triflorum	5
Asteraceae	Haplopappus resinosus	3
Rosaceae	Holodiscus discolor	2
Cupressaceae	Juniperus occidentalis	4
Boraginaceae	Lappula squarrosa	5
Apiaceae	Lomatium grayi	1
Poaceae	Melica fugax	1
Boraginaceae	Mertensia campanulata	5
Asteraceae	Microseris troximoides	7
Lamiaceae	Monardella odoratissima	1
Cactaceae	Opuntia polyacantha var. erinacea	Ca. 4
Cactaceae	Pediocactus simpsonii	1

Scrophulariaceae	Penstemon speciosus	3
Hydrophyllaceae	Phacelia incana	2
Hydrophyllaceae	Phacelia linearis	3
Poaceae	Poa cusickii	2
Poaceae	Poa gracillima	1
Polygonaceae	Polygonum sawatchense	3
Rosaceae	Potentilla gracilis var. fastigiata	3
Rosaceae	Potentilla rivalis	5
Asteraceae	Pyrrocoma uniflora var. uniflora	2
Grossulariaceae	Ribes viscosissimum	3
Asteraceae	Senecio multilobatus	2
Asteraceae	Senecio sphaerocephalus	5
Asteraceae	Solidago gigantea	5
Poaceae	Stipa lemmonii	1
Poaceae	Stipa richardsonii	1
Fabaceae	Trifolium pratense	5

Finally, there are 22 taxa that have been reliably observed in CRMO, but which lack voucher specimens (Table 8 and Attachment 39). In every case, this is because the observations were made prior to initiation of the project, so collections were not made. In some cases the taxa are rare, which is another reason collections were not made. Because no voucher specimens exist, these taxa are considered “unconfirmed” in CRMO. In every case, the observations are from competent individuals familiar with the local flora, and these taxa could, in my opinion, be considered present.

Table 8. Taxa entered in the NPSpecies database that have been reliably observed in CRMO but that lack voucher specimens collected from within CRMO as of January 15, 2008. Number of taxa = 22.

Family	Scientific Name	Nativity	Reliably Observed By
Asteraceae	Antennaria flagellaris	Native	Steve J. Popovich (BLM)
Fabaceae	Astragalus geyeri var. geyeri	Native	Steve J. Popovich (BLM)
Poaceae	Avena fatua	Non-Native	Steve J. Popovich (BLM)
Poaceae	Avena sativa	Non-Native	Steve J. Popovich (BLM)
Poaceae	Bromus japonicus	Non-Native	Steve J. Popovich (BLM)
Chenopodiaceae	Chenopodium botrys	Non-Native	Steve J. Popovich (BLM)
Cyperaceae	Eleocharis rostellata	Native	Robert K. Moseley (IDCDC)
Poaceae	Elymus junceus	Non-Native	Steve J. Popovich (BLM)
Poaceae	Elymus X hansenii	Native	Steve J. Popovich (BLM)
Poaceae	Elymus X saundersii	Native	Steve J. Popovich (BLM)
Poaceae	Elymus X saxicola	Native	Steve J. Popovich (BLM)
Chenopodiaceae	Eurotia lanata	Native	Steve J. Popovich (BLM)
Chenopodiaceae	Halogeton glomeratus	Non-Native	Steve J. Popovich (BLM)
Boraginaceae	Lappula squarrosa	Non-Native	Steve J. Popovich (BLM)
Lamiaceae	Nepeta cataria	Non-Native	Paige Wolken (NPS CRMO)
Boraginaceae	Pectocarya setosa	Native	Steve J. Popovich (BLM)
Rosaceae	Petrophyton caespitosum	Native	Steve J. Popovich (BLM)
Hydrophyllaceae	Phacelia incana	Native	Robert K. Moseley (IDCDC)

Steve J. Popovich

Asteraceae	Psilocarphus brevissimus var. brevissimus	Native	Steve J. Popovich (BLM)
Poaceae	Secale cereale	Non-Native	Steve J. Popovich (BLM)
Poaceae	X Elyhordeum macounii	Native	Steve J. Popovich (BLM)
Poaceae	X Elyleymus aristatus	Native	Steve J. Popovich (BLM)

Special Status Plants: Management Priority and Exploitation Concern, Rare, Endemic, Noxious, Seeded/Planted, BLM-Administered Land Affinity

Management Priority and Exploitation Concern

There are 33 taxa of management priority and one taxon (presence possible but unconfirmed) of exploitation concern.

Rare Plants

Of the rare plant taxa that are currently tracked by the Idaho Natural Heritage Program and Idaho Native Plant Society as appearing on the list generated by the Idaho Native Plant Society's 23rd Annual Rare Plant Conference, February 13-14, 2007, Boise, Idaho (Attachment 62), there are 11 entered into the NPSpecies database (Table 9 and Attachments 26-28). Three are present in CRMO.

Table 9. Taxa entered in the CRMO database that are currently tracked by the Idaho Natural Heritage Program and Idaho Native Plant Society, and their INPS and NatureServe rankings as of February 14, 2007. Number of taxa confirmed present in CRMO = 3; total number of taxa = 11.

Family	Scientific Name	INPS & NatureServe 2007 Rankings	Park Status
Liliaceae	Allium aaseae	Global Priority 3 (G3, S3)	Unconfirmed
Liliaceae	Allium anceps	State Priority 2 (G4, S2)	Unconfirmed
Asteraceae	Antennaria arcuata	Global Priority 2 (G2, S1)	False Report
Fabaceae	Astragalus atratus var. insepatus	State Monitor (G4G5T3, S3)	Unconfirmed
Fabaceae	Astragalus oniciformis	Global Priority 3 (G3, S3)	Present in Park
Boraginaceae	Cryptantha sericea	State Priority 1 (G4,SNA)	False Report
Campanulaceae	Downingia bacigalupii	State Sensitive (G4,S2)	Present in Park
Cactaceae	Pediocactus simpsonii	State Monitor (G4,S3)	Unconfirmed
Scrophulariaceae	Penstemon laxus	Review (G2G3, SNA)	False Report
Hydrophyllaceae	Phacelia inconspicua	Global Priority 1 (G1G2, S1)	Present in Park
Asteraceae	Pyrrocoma insecticruris	Global Priority 3 (G3, S3)	Probably Pres.

Additionally, there are 25 plant taxa in the CRMO database that were formerly recognized as rare or were considered for tracking as rare by the Idaho Natural Heritage Program and Idaho Native Plant Society 1983-2007 (i.e., the "red book" tracking of the early 1980's onward) (Table 10 and Attachment 29-31). Eighteen are present in CRMO. Although some may be rare within CRMO, they are no longer considered sufficiently rare in Idaho by the Idaho Natural Heritage Program to warrant formal tracking. Nonetheless, the National Park Service attempts to manage all native taxa regardless of rarity such that viability is secured in the long-term within a Park Unit. There are other

plants and noteworthy plant communities that are rare regionally or in CRMO that are not on these lists.

Table 10. Taxa entered in the NPSpecies database that were formerly recognized as rare or were considered for tracking as rare by the Idaho Natural Heritage Program and Idaho Native Plant Society as of February 14, 2007. Number of taxa confirmed present in CRMO = 18; total number of taxa = 25.

Family	Scientific Name	Dropped from Tracking	Park Status
Liliaceae	<i>Allium nevadense</i> var. <i>nevadense</i>	<1990	Present in Park
Asteraceae	<i>Ancistrocarphus filagineus</i>	2003	Probably Present
Asteraceae	<i>Antennaria flagellaris</i>	<1990	Unconfirmed
Asteraceae	<i>Artemisia longiloba</i>	<1990	Present in Park
Asteraceae	<i>Artemisia nova</i>	<1990	Unconfirmed
Fabaceae	<i>Astragalus convallarius</i> var. <i>convallarius</i>	<1990	Present in Park
Fabaceae	<i>Astragalus whitneyi</i> var. <i>confusus</i>	<1990	Present in Park
Brassicaceae	<i>Draba douglasii</i>	<1990	Present in Park
Polygonaceae	<i>Eriogonum douglasii</i> var. <i>douglasii</i>	1997	False Report
Polygonaceae	<i>Eriogonum thymoides</i>	<1990	Present in Park
Polemoniaceae	<i>Gymnosteris nudicaulis</i>	1993-4	Present in Park
Polemoniaceae	<i>Gymnosteris parvula</i>	1996	Present in Park
Asteraceae	<i>Haplopappus stenophyllus</i>	<1990	Present in Park
Polemoniaceae	<i>Leptodactylon watsonii</i>	<1990	Present in Park
Saxifragaceae	<i>Lithophragma tenellum</i> var. <i>thompsonii</i>	2001	Present in Park
Fabaceae	<i>Lupinus lepidus</i> var. <i>sellulus</i>	1993-4	False Report
Polygonaceae	<i>Oxytheca dendroidea</i>	1996	Present in Park
Boraginaceae	<i>Pectocarya setosa</i>	2001	Unconfirmed
Scrophulariaceae	<i>Penstemon perpulcher</i>	<1990	Present in Park
Hydrophyllaceae	<i>Phacelia incana</i>	<1990	Unconfirmed
Campanulaceae	<i>Porterella carnosula</i>	1996	Present in Park
Primulaceae	<i>Primula brodiaeae</i>	2005	Present in Park
Ranunculaceae	<i>Ranunculus andersonii</i>	<1990	Present in Park
Poaceae	<i>Stipa pinetorum</i>	1996	Present in Park
Poaceae	<i>Stipa webberi</i>	1990	Present in Park

There are also 28 noteworthy plant communities within or near CRMO tracked by IDCDC. Some riparian communities listed below occur at nearby Carey Lake Management Area administered by the State. The noteworthy plant communities within or near CRMO tracked by IDCDC as of December 31, 2006 are listed below:

Artemisia arbuscula arbuscula/*Agropyron spicatum*
Artemisia arbuscula arbuscula/*Festuca idahoensis*
Artemisia arbuscula arbuscula/*Poa secunda*

Artemisia longiloba/Festuca idahoensis
 Artemisia tridentata tridentata/Festuca idahoensis
 Artemisia tridentata tridentata/Stipa comata
 Artemisia tridentata vaseyana/Agropyron spicatum
 Artemisia tridentata vaseyana/Festuca idahoensis
 Artemisia tridentata vaseyana/Poa secunda
 Artemisia tridentata vaseyana-Symphoricarpos oreophilus/Agropyron spicatum
 Artemisia tridentata wyomingensis/Agropyron spicatum
 Artemisia tridentata wyomingensis/Stipa comata
 Artemisia tridentata wyomingensis/Stipa thurberiana
 Artemisia tripartita/Agropyron spicatum
 Artemisia tripartita/Festuca idahoensis
 Carex nebrascensis wet meadow (within and near CRMO at Huff Creek meadows)
 Eleocharis rostellata wet meadow (within and near CRMO at Huff Creek meadows)
 Elymus cinereus stands
 Eriogonum ovalifolium depressum cinder gardens
 Festuca idahoensis/Lupinus argenteus
 Juniperus osteosperma/Purshia tridentata/Poa secunda
 Pinus flexilis/Purshia tridentata
 Prunus virginiana stands
 Purshia tridentata/Agropyron spicatum-Elymus cinereus
 Salix boothii/mesic graminoids (on boundary and perhaps just inside CRMO at Huff Creek meadows)
 Scirpus americanus riparian (in and/or near CRMO at Huff Creek hot spring)
 Scirpus vallis riparian (in and/or near CRMO at Huff Creek hot spring)
 Thermal springs aquatic (in and/or near CRMO at Huff Creek hot spring).

Endemic Plants

There are eight plant taxa in the CRMO database that are endemic to Idaho (Table 11 and Attachments 32 and 33). Three are known to occur in CRMO. *Astragalus atratus* var. *inseptus*, *Astragalus oniciformis*, and *Pyrrocoma insecticruris* are endemic to only a few counties in Idaho, and occur in the local area.

Table 11. Taxa that are endemic to Idaho entered in the NPSpecies database and their INPS and NatureServe rankings as of February 14, 2007. Number of taxa = 8.

Family	Scientific Name	INPS & NatureServe 2007 Rankings	Park Status
Liliaceae	Allium aaseae	Global Priority 3 (G3, S3)	Unconfirmed
Fabaceae	Astragalus atratus var. inseptus	State Monitor (G4G5T3, S3)	Unconfirmed
Fabaceae	Astragalus oniciformis	Global Priority 3 (G3, S3)	Present in Park
Boraginaceae	Mertensia campanulata	Not tracked (G4, SNA)	Unconfirmed
Scrophulariaceae	Penstemon laxus	Review (G2G3, SNA)	False Report
Scrophulariaceae	Penstemon montanus (if considered var. idahoensis)	Not tracked (G4G5T2T3, SNA)	Present in Park

Scrophulariaceae	<i>Penstemon pumilus</i>	Not tracked (G4G5, SNA)	Present in Park
Asteraceae	<i>Pyrrocoma insecticruris</i>	Global Priority 3 (G3, S3)	Probably Pres.

A summary of tracked rare plants combined with their endemism, common names, and possible management concerns is provided below. The plant scientific name, common name, Park Unit presence status, current IDCDC tracking status, and park unit rarity for plants tracked in Idaho based on the results of the 23rd Annual Idaho Rare Plant Conference, Boise, February 13-14, 2007, are listed below:

- Allium aaseae*, Aaseae's onion, Unconfirmed, Global Priority 3, **Idaho Endemic**
[Endemic to Boise Front; voucher specimen R.J. Davis 97 at Herbarium RM is more likely a misidentification of another *Allium* species]
- Allium anceps*, twinleaf onion, Unconfirmed, State Priority 2
[No voucher; possible along eastern peripheries; reports may be misidentifications of another *Allium* species, literature references refer to *A. aaseae* specimen above]
- Antennaria arcuata*, arching pussytoes, **False Report**, Global Priority 2
[Plants occur immediately along CRMO boundary but apparently not within park]
- Astragalus atratus* var. *inseptus**, mourning mikvetch, Unconfirmed, State Monitor, **Idaho Endemic**
[No voucher; may be present in heavy soils along western peripheries; reports from within Brass Cap Kipuka are probably reliable]
- Astragalus oniciformis**, Picabo milkvetch, Present in Park, Global Priority 3, Uncommon, **Idaho Endemic**
- Cryptantha sericea*, silky cryptantha, **False Report**, State Priority 1
[Reports apply to misidentification of *Cryptantha speculifera* specimen]
- Downingia bacigalupii***, Bacigalupi's downingia, Present in Park, State Sensitive, Rare
- Pediocactus simpsonii*, Simpson's hedgehog cactus, Unconfirmed, State Monitor
[No voucher; reports may outside CRMO or misidentifications of *Coryphantha*]
- Penstemon laxis*, tufted beardtongue, Review, **False Report, Idaho Endemic**
[Reports apply to misidentifications of *Penstemon humilis* var. *humilis* and *Penstemon attenuatus* var. *militaris* specimens]
- Phacelia inconspicua****, obscure phacelia, Present in Park, Global Priority 1, Rare
[Most globally rare vascular plant known to occur in CRMO]
- Pyrrocoma* (= *Haplopappus*) *insecticruris*, bugleg goldenweed, Probably Present ("Suspected" in 2006 checklist), Global Priority 3, **Idaho Endemic**
[Suspected to occur along northwestern boundaries but not observed in surveys]

Noxious Weeds

There are 212 taxa that have been identified as exhibiting some level of "weedyess," Eleven of which have their "weedyess" unknown.

Of plants recognized as Noxious in Idaho (Attachment 63), there are 19 noxious weeds entered in the NPSpecies database, of which 13 occur in CRMO (Table 12 and Attachments 34 and 35). Four are encroaching, and two are falsely reported.

Table 12. Noxious Weeds of Idaho entered in the NPSpecies database and their official Idaho State weed management status as of March 30, 2007. Number of taxa = 19.

Family	Scientific Name	Idaho Listing	Park Status
Asteraceae	<i>Acroptilon repens</i>	Control	Present in Park
Asteraceae	<i>Ambrosia tomentosa</i>	Control	False Report
Brassicaceae	<i>Berteroa incana</i>	Contain	Encroaching
Cucurbitaceae	<i>Bryonia alba</i>	Contain	Present in Park
Brassicaceae	<i>Cardaria draba</i>	Contain	Encroaching
Asteraceae	<i>Carduus nutans</i>	Control	Present in Park
Asteraceae	<i>Centaurea diffusa</i>	Contain	Present in Park
Asteraceae	<i>Centaurea maculosa</i>	Contain	Present in Park
Asteraceae	<i>Centaurea solstitialis</i>	Contain	Encroaching
Asteraceae	<i>Chondrilla juncea</i>	Contain	Present in Park
Asteraceae	<i>Cirsium arvense</i>	Contain	Present in Park
Convolvulaceae	<i>Convolvulus arvensis</i>	Contain	Present in Park
Euphorbiaceae	<i>Euphorbia esula</i>	Contain	Present in Park
Solanaceae	<i>Hyoscyamus niger</i>	Control	Present in Park
Brassicaceae	<i>Isatis tinctoria</i>	Control	Present in Park
Scrophulariaceae	<i>Linaria genistifolia</i> ssp. <i>dalmatica</i>	Contain	Present in Park
Asteraceae	<i>Onopordum acanthium</i>	Contain	Present in Park
Lamiaceae	<i>Salvia aethiopis</i>	Control	Encroaching
Asteraceae	<i>Sonchus arvensis</i>	Control	False Report

A three-page overview of all tracked rare plants and noxious weeds is provided as a Microsoft Word document as Attachment 36.

Taxa Seeded or Planted in CRMO

There are 62 taxa entered in the NPSpecies database that are or may have been seeded or planted within CRMO (Table 13 and Attachment 45). Five are unconfirmed, two are falsely reported, and one is believed historic. About 28 are native to CRMO and occur naturally, and about 34 are or may be non-native to CRMO, some of which are not native to North America. Most seedings are performed by the BLM on BLM-administered land. In all cases, taxa seeded or planted in CRMO historically had nearly all source material used that came from off-site, which cannot and should not be considered local genotypes. Seeding or planting efforts by the NPS attempt to use plant materials native to the Snake River Plain, and desire to use material collected on site to preserve local genotypic material. Recognition and attempted use of local or regional native plant material substantially increased in the BLM in the 1990's, and continues to be stressed today.

Table 13. Taxa ordered by family entered in the NPSpecies database that are or may have been seeded or planted within CRMO. Native taxa that also occur naturally are denoted. Number of taxa = 62.

Family	Scientific Name	Park Status	Occurs Naturally In CRMO
Asteraceae	<i>Achillea millefolium</i> ssp. <i>lanulosa</i> var. <i>lanulosa</i>	Present in Park	X
Asteraceae	<i>Artemisia tridentata</i> var. <i>tridentata</i>	Present in Park	X
Asteraceae	<i>Artemisia tridentata</i> var. <i>vaseyana</i>	Present in Park	X
Asteraceae	<i>Artemisia tridentata</i> var. <i>wyomingensis</i>	Present in Park	X
Betulaceae	<i>Betula glandulosa</i>	False Report	
Campanulaceae	<i>Campanula rotundifolia</i>	Present in Park	
Chenopodiaceae	<i>Atriplex canescens</i> var. <i>canescens</i>	Present in Park	X
Chenopodiaceae	<i>Eurotia lanata</i>	Unconfirmed	X
Chenopodiaceae	<i>Grayia spinosa</i>	Present in Park	X
Chenopodiaceae	<i>Kochia prostrata</i>	Present in Park	
Fabaceae	<i>Caragana arborescens</i>	Present in Park	
Fabaceae	<i>Medicago sativa</i>	Present in Park	
Fabaceae	<i>Melilotus alba</i>	Present in Park	
Fabaceae	<i>Melilotus officinalis</i>	Present in Park	
Fabaceae	<i>Onobrychis viciifolia</i>	Present in Park	
Lamiaceae	<i>Lamium amplexicaule</i>	Historic	
Lamiaceae	<i>Nepeta cataria</i>	Present in Park	
Linaceae	<i>Linum perenne</i>	Present in Park	
Malvaceae	<i>Sphaeralcea munroana</i>	Present in Park	X
Oleaceae	<i>Syringa vulgaris</i>	Present in Park	
Pinaceae	<i>Pseudotsuga menziesii</i>	Present in Park	X
Pinaceae	<i>Pinus contorta</i> var. <i>latifolia</i>	Present in Park	
Poaceae	<i>Festuca idahoensis</i>	Present in Park	X
Poaceae	<i>Festuca ovina</i> , sensu stricto	Unconfirmed	
Poaceae	<i>Festuca brachyphylla</i>	False Report	
Poaceae	<i>Festuca rubra</i> , sensu amplo	Present in Park	
Poaceae	<i>Festuca trachyphylla</i> , sensu stricto	Present in Park	
Poaceae	<i>Elymus cinereus</i>	Present in Park	X
Poaceae	<i>Elymus elymoides</i>	Present in Park	X
Poaceae	<i>Elymus lanceolatus</i>	Present in Park	X
Poaceae	<i>Elymus spicatus</i>	Present in Park	X
Poaceae	<i>Elymus subsecundus</i>	Present in Park	X
Poaceae	<i>Elymus trachycaulus</i> , sensu amplo	Present in Park	X
Poaceae	<i>Koeleria macrantha</i>	Present in Park	X
Poaceae	<i>Poa ampla</i>	Present in Park	X
Poaceae	<i>Poa nevadensis</i>	Present in Park	X
Poaceae	<i>Poa secunda</i> , sensu amplo	Present in Park	X
Poaceae	<i>Poa secunda</i> , sensu stricto	Present in Park	X
Poaceae	<i>Sporobolus cryptandrus</i>	Present in Park	X
Poaceae	<i>Stipa comata</i>	Present in Park	X
Poaceae	<i>Stipa hymenoides</i>	Present in Park	X
Poaceae	<i>Stipa thurberiana</i>	Present in Park	X
Poaceae	<i>Agropyron cristatum</i> , sensu amplo	Present in Park	
Poaceae	<i>Bromus marginatus</i>	Present in Park	

Poaceae	<i>Dactylis glomerata</i>	Present in Park	
Poaceae	<i>Elymus elongatus</i> ssp. <i>ponticus</i>	Present in Park	
Poaceae	<i>Elymus hispidus</i>	Present in Park	
Poaceae	<i>Elymus junceus</i>	Unconfirmed	
Poaceae	<i>Elymus smithii</i>	Present in Park	X
Poaceae	<i>Elymus wawawaiensis</i>	Present in Park	
Poaceae	<i>Poa bulbosa</i>	Present in Park	
Poaceae	<i>Secale cereale</i>	Unconfirmed	
Poaceae	<i>Stipa occidentalis</i>	Present in Park	X
Poaceae	<i>Triticum aestivum</i>	Present in Park	
Rosaceae	<i>Holodiscus discolor</i>	Unconfirmed	?
Rosaceae	<i>Purshia tridentata</i>	Present in Park	X
Rosaceae	<i>Sanguisorba minor</i>	Present in Park	
Scrophulariaceae	<i>Penstemon barbatus</i>	Present in Park	
Scrophulariaceae	<i>Penstemon cyananthus</i> var. <i>subglaber</i>	Present in Park	?
Scrophulariaceae	<i>Penstemon eatonii</i> var. <i>eatonii</i>	Present in Park	
Scrophulariaceae	<i>Penstemon palmeri</i> var. <i>eglandulosus</i>	Present in Park	
Scrophulariaceae	<i>Penstemon palmeri</i> var. <i>palmeri</i>	Present in Park	

Plants Occurring Mostly in BLM-Administered Areas within CRMO

There are 54 taxa entered in the NPSpecies database that occur mostly in non-foothills BLM-administered areas within CRMO (Table 14 and Attachment 44). Five are unconfirmed and one is probably present.

Many of these taxa, such as *Artemisia tridentata* var. *wyomingensis* and *Artemisia tripartita*, certainly also occur in other areas of CRMO, but are generally most common in non-foothills BLM-administered areas. The Idaho endemics *Astragalus oniciformis* and *Astragalus atratus* var. *inseptus* are the only taxa on this list that are currently tracked by IDCDC (and the BLM). Of note, *Astragalus oniciformis* probably truly is restricted to non-foothills areas administered by the BLM. *Astragalus atratus* var. *inseptus* is unconfirmed, and may be restricted to BLM areas of the Carey Interface, but also may occur in NPS-administered areas like Brass Cap Kipuka, from where it is reported. Other regionally- or at least locally-rare plants on this list are *Ancistrocarphus filagineus*, *Lilaea scilloides*, *Pectocarya setosa*, and *Pilularia americana*. Most of the non-native seeded or planted species in CRMO also appear on this list, reflecting the fact that it is the BLM-administered land that is most often rehabilitated with such species for rangeland improvement or wildfire rehabilitation.

Table 14. Taxa entered in the NPSpecies database occurring mostly in non-foothills BLM-administered areas within CRMO. Number of taxa = 54.

Family Name	Scientific Name	Park Status
Asteraceae	<i>Agoseris heterophylla</i> var. <i>heterophylla</i>	Present in Park
Poaceae	<i>Agropyron cristatum</i> , sensu amplo	Present in Park
Liliaceae	<i>Allium nevadense</i> var. <i>nevadense</i>	Present in Park
Asteraceae	<i>Ancistrocarphus filagineus</i>	Probably Present
Caryophyllaceae	<i>Arenaria franklinii</i> var. <i>franklinii</i>	Present in Park

Poaceae	<i>Aristida purpurea</i> , sensu amplo	Present in Park
Asteraceae	<i>Artemisia cana</i>	Present in Park
Asteraceae	<i>Artemisia tridentata</i> var. <i>wyomingensis</i>	Present in Park
Asteraceae	<i>Artemisia tripartita</i>	Present in Park
Asteraceae	<i>Aster scopulorum</i>	Present in Park
Fabaceae	<i>Astragalus atratus</i> var. <i>inseptus</i>	Unconfirmed
Fabaceae	<i>Astragalus calycosus</i> var. <i>calycosus</i>	Present in Park
Fabaceae	<i>Astragalus cibarius</i>	Present in Park
Fabaceae	<i>Astragalus convallarius</i> var. <i>convallarius</i>	Present in Park
Fabaceae	<i>Astragalus curvicaupus</i>	Present in Park
Fabaceae	<i>Astragalus filipes</i>	Present in Park
Fabaceae	<i>Astragalus iodanthus</i>	Present in Park
Fabaceae	<i>Astragalus lentiginosus</i> var. <i>lentiginosus</i>	Present in Park
Fabaceae	<i>Astragalus lentiginosus</i> var. <i>salinus</i>	Present in Park
Fabaceae	<i>Astragalus malacus</i>	Present in Park
Fabaceae	<i>Astragalus oniciformis</i>	Present in Park
Chenopodiaceae	<i>Atriplex canescens</i> var. <i>canescens</i>	Present in Park
Fabaceae	<i>Caragana arborescens</i>	Present in Park
Poaceae	<i>Elymus flavescens</i>	Present in Park
Poaceae	<i>Elymus hispidus</i>	Present in Park
Poaceae	<i>Elymus junceus</i>	Unconfirmed
Poaceae	<i>Elymus wawawaiensis</i>	Present in Park
Poaceae	<i>Eremopyrum triticeum</i>	Unconfirmed
Chenopodiaceae	<i>Eurotia lanata</i>	Unconfirmed
Polemoniaceae	<i>Gymnosteris nudicaulis</i>	Present in Park
Hydrophyllaceae	<i>Hesperochiron pumilus</i>	Present in Park
Chenopodiaceae	<i>Kochia prostrata</i>	Present in Park
Juncaginaceae	<i>Lilaea scilloides</i>	Present in Park
Linaceae	<i>Linum perenne</i>	Present in Park
Fabaceae	<i>Lupinus polyphyllus</i> var. <i>burkei</i>	Present in Park
Fabaceae	<i>Lupinus polyphyllus</i> var. <i>humicola</i>	Present in Park
Fabaceae	<i>Lupinus polyphyllus</i> var. <i>prunophilus</i>	Present in Park
Fabaceae	<i>Lupinus polyphyllus</i> var. <i>saxosus</i>	Present in Park
Fabaceae	<i>Medicago falcata</i>	Present in Park
Ranunculaceae	<i>Myosurus aristatus</i>	Present in Park
Hydrophyllaceae	<i>Nama densum</i> var. <i>densum</i>	Present in Park
Onagraceae	<i>Oenothera pallida</i> ssp. <i>pallida</i> var. <i>pallida</i>	Present in Park
Fabaceae	<i>Onobrychis viciifolia</i>	Present in Park
Boraginaceae	<i>Pectocarya penicillata</i>	Present in Park
Boraginaceae	<i>Pectocarya setosa</i>	Unconfirmed
Polemoniaceae	<i>Phlox aculeata</i>	Present in Park
Marsileaceae	<i>Pilularia americana</i>	Present in Park
Brassicaceae	<i>Polycstenium fremontii</i> var. <i>fremontii</i>	Present in Park
Asteraceae	<i>Psilocarphus oregonus</i>	Present in Park
Fabaceae	<i>Psoralidium lanceolatum</i>	Present in Park

Rosaceae	Sanguisorba minor	Present in Park
Asteraceae	Stylocline psilocarphoides	Present in Park
Asteraceae	Tetradymia canescens	Present in Park
Poaceae	Triticum aestivum	Present in Park

Performing General and Specialized Queries in the NPSpecies Database

Many queries can be performed. Step-by-step instructions for numerous filters and queries are provided in the *User's Guide*. The following describes how to perform some of the specialized queries.

To filter and return all **rare plants** in CRMO currently tracked by Idaho's Natural Heritage Program (Idaho Conservation Data Center), the Idaho Native Plant Society, or the BLM, as reflected in the most current (February 2007) Rare Plant Conference proceedings, go to the "main menu" (the screen with the NPS shield), click on the *Scientific Names* icon, *Evidence Counts*. Then go to the "filters" icon in the upper left portion of the screen, select "custom" from the pull-down menu, then go to the "management" tab, and in the "management priority?" *details* field, type the character string "23rd". Then click on "filter."

This returns all entries with the character string "Rare plant ("[2007 status]") as per the Idaho Conservation Data Center and Results of the 23rd Annual Idaho Rare Plant Conference, Boise, February 13-14, 2007" appearing in the *Management Priority details*.

To filter and return all plants listed as **Noxious** in the State of Idaho as of March 30, 2007, go to the "main menu" (the screen with the NPS shield), click on the *Scientific Names* icon, *Evidence Counts*. Then go to the "filters" icon in the upper left portion of the screen, select "custom" from the pull-down menu, then go to the "Management" tab, and in either *management priority? details* or *weedy plant? details*, type "noxious". Then click on "filter."

For noxious weeds listed in Idaho, the unique character string "Listed as State of Idaho Noxious Weed as of 3/30/2007" is found in both the *management priority?* and *weedy plant? details* fields.

To filter and return all species that are currently **seeded** or **planted** in CRMO, or that are known to have been or may have been historically seeded in CRMO, go to the "main menu" (the screen with the NPS shield), click on the *Scientific Names* icon, *Evidence Counts*. Then go to the "filters" icon in the upper left portion of the screen, select "custom" from the pull-down menu, go to the "Checklist" tab, "Cultivation" row, and type "seeded" or "planted" in the *details* field. Then click on "filter." This returns the unique words "seeded" or "planted" which are entered in the *cultivation details* field for each taxon that has been or could have been seeded in the Park Unit. Nearly always, the cultivars frequently used are listed (e.g., 'Secar' snake river wheatgrass).

Working Key for Wild Buckwheats (*Eriogonum*) of CRMO

Dr. Reveal has drafted a working key to all wild buckwheats (*Eriogonum*) of CRMO. He may revise it to include *Eriogonum thymoides*, of which he was unaware at the time, and which was inadvertently omitted. All preferred names and synonymy appearing in the NPSpecies database associated with this summary report align with current taxonomic standings as preferred by Dr. Reveal. Taxonomy and synonymy of *Eriogonum* that will be presented in my upcoming 2008 checklist due with my final report in May, 2008, was reviewed and concurred upon by Reveal in December, 2007, and he offered much critical contribution to the taxonomy and notes on distributions. A copy of his working *Eriogonum* key may be included as an attachment in my final report.

Successful Documentation of 90% of Flora Present in CRMO

Under the well-known species area curve, the larger an area, the more plant species usually occur there. (Similarly, the greater the range of different habitats, the more species should occur). But I feel that the area-curve concept becomes a bit relaxed for CRMO. Even though CRMO is large in size (ca. 750,000 acres), significant portions of CRMO are comprised of 1) low-diversity and fairly homogenous plant communities present on the many large lava fields, or 2) depauperate and fairly homogenous non-native seeded grass-herb communities resulting from disturbance and wildfire/rangeland rehabilitation efforts on areas administered by the BLM, especially in the southern portions of the Monument. The significant acreage associated with these low-diversity habitats serves to reduce the number of taxa normally expected at this latitude under a species-area curve with an area the size of CRMO when based on total acreage alone.

The best way to ascertain if one has encountered the majority of plant taxa is to perform repetitive surveys by *competent botanists familiar with the local flora* and note how many new taxa are documented with each additional effort. When the number of new taxa becomes sufficiently reduced – the law of diminishing returns – one can confidently conclude that the majority of taxa have indeed been documented. To be meaningful, this requires that surveys be performed by *qualified* botanists and capture the full range of flora present: that is, that they be conducted across the spectrum of growing seasons, plant phenologies, habitat types, total acreage present with adequate geospatial sampling distribution, and over several years capturing differing growing conditions. This also requires focused visits to sufficiently sample specialized microsites and habitats.

Although estimates are difficult and rather nonsensical, I estimate that the **total number of vascular plant taxa present in this Park Unit is perhaps up to 840** or so, based upon my knowledge of the area and results of past surveys, including my surveys conducted over 12 years in areas administered by CRMO and the BLM. I feel, given this estimate and the fairly solid history of past field surveys, the significant acreage of low-diversity habitat, and with the additional taxa collected in 2006, that **we have now documented as “present” 90 percent (or possibly more) of all vascular plant taxa occurring in CRMO**. It is important to note that if the 23 plants currently defined as “unconfirmed” but having *reliable* field observations by myself and others were to have

their status changed to “present” and were also added, the number of taxa “known to be present” in CRMO would total about 775. **I believe the goal to document 90 percent of the vascular flora occurring in the Park Unit has been achieved.** There is always a chance that this assessment is incorrect, but I assign a fairly high confidence to this statement. Additional focused surveys would help confirm this assessment.

Additional Taxa Suspected and Areas to Search in Outyears

As discussed in the methods section, thorough lists of about 500 taxa suspected to occur upon which to focus our efforts were created (Attachments 44-47). They included unconfirmed taxa, rare plants, weeds, plants known to occur nearby (within ca. 20 air-miles/32 air-km) in areas that have similar habitat to CRMO based on personal knowledge or various checklists, as well as additional taxa from many other sources. They list search priority, data source, anticipated habitats, geographic areas in which to search (sometimes specific locations), and Attachment 54 lists likelihood of occurrence for each taxon. A significant effort over several years was expended in the generation of these lists, and they represent most taxa I believe reasonably possible to occur without citing entire regional floras. I also created maps outlining specific survey polygons most likely to yield additional undocumented taxa (Attachments 58 and 59).

I feel that early spring and late fall flowering plants, although fairly well documented, remain somewhat under-collected. The CRMO checklist is now at the point where, although perhaps 10 percent of all potentially-occurring taxa remain to be documented as “present,” the cost in time and money associated with performing more surveys to successfully encounter significant numbers of additional undetected taxa is on the border of becoming prohibitive. I feel that up to 50 or so taxa could probably be found by competent botanists with moderate to intense effort, but at substantial cost in time and money. Most remaining undocumented taxa to be found are probably reliably captured in my spreadsheets of taxa suspected in CRMO, upon which to focus surveys in outyears. These have been circulated to Wolken, Atwood, and Mancuso, and will be revised and re-submitted as part of my January 2008 Phase II summary report.

Duane Atwood and I recommend that additional field survey efforts to collect early spring and late fall vegetation be conducted in out-years across a sampling of pre-determined sites, including the extreme southern boundary area’s sandy microsites that support plants like *Layia glandulosa*, *Psoralidium lanceolatum*, *Elymus flavescens*, and *Oenothera pallida*, and herb-rich microsites in the foothills, such as aspen glades, draws, and areas of late snow retention. We feel that perhaps the most remaining undocumented taxa may be found in this focused manner, and that this effort is probably most worthwhile given time and money constraints. Simply walking more acreage would certainly yield some, but not many, new taxa unless a particularly rich microsite exhibiting an under-surveyed habitat were chanced upon, which could yield perhaps 5 or more new taxa in a small area. Similarly, searching remaining playas targeted but not visited in 2006 would likely yield some new taxa.

Finally, Duane and I both feel that it is worthwhile and efficient to have knowledgeable park staff collect new taxa on an “as encountered” basis throughout the growing seasons and years while performing their routine field duties. New taxa will always be found as more land is surveyed and more microsites are visited, and with the continual trickling arrival of new plants, principally alien weeds, from adjacent areas. Appropriately, any plant checklist is always subject to revisions and updates, and is never fully “final.”

Use of the Interim 2006 Checklists and NPSpecies Database

It should be noted that this report’s attached 2006 CRMO plant checklists (Attachments 3 and 4) are interim, and are not as current as the attached electronic NPSpecies database (Attachment 1), which is current through January 15, 2008. Therefore, where differences exist between this report’s attached interim checklists and the database, **the NPSpecies database and attached exported spreadsheets supersede the attached 2006 checklists**. Also, when using the NPSpecies electronic database, it is not meant to “tally” taxa in formats conducive to creating “checklists” familiar to most botanists, and there are certain constraints and undetectable redundancies/omissions in list outputs when attempting to use the database in such a manner. Recognition of, and cautions associated with, such discrepancies are noted in the NPSpecies *User’s Guide* (Attachment 2). The full version 2006 CRMO plant checklist (Attachment 3) is currently available on the World Wide Web.

Finally, an additional **final report** will be submitted by myself to CRMO in May, 2008. That report will be performed gratis, and is largely already prepared. It may discuss past efforts and results in more detail, will provide updated printable spring 2008 working checklists of vascular plants for CRMO, and will contain numerous additional important attachments. It will also contain products and results from a similar inventory effort conducted by my team for Hagerman Fossil Beds National Monument from 1994 to 2002 as part of this initiative. The final report will close 14 years of intermittent efforts involving over 30 individuals and expending several thousand person-hours of vascular plant work for CRMO and HAFO under the initiative from 1994 through January, 2008. Following submission of the final report, it is hoped that the NPSpecies databases for CRMO and HAFO, a revised *User’s Guide*, and the CRMO and HAFO plant checklists themselves will be posted on National Park Service sites on the World Wide Web.

Recommendations for Future Work

Office Work

Enter remaining data from voucher collection labels that were not entered as part of this project. Use an electronic wand if possible to transfer numeric location information such as lat/long, UTM, and legal descriptions to minimize transcription errors.

Annually review and organize the CRMO working herbarium with oversight by the responsible CRMO Botanist, Vegetation Ecologist, or vegetation resources manager. Make sure all new specimens maintain the same preferred names and genus folder

schemes and color codes to maintain consistency. If a new preferred name is adopted, retire old folders with the antiquated name and replace them with the new name.

Annually accession new collections. Make sure new specimens are labeled with the collector's number and CRMO accession and catalog numbers on the original plant label as well as on all annotation labels. Pencil the collector and collector's number on the lower right corner of the specimen sheet before affixing the plant label. If a label becomes dis-affixed, it cannot be reliably matched to the specimen sheet without these procedures, and the sheet can lose much of its intended scientific value.

Annually check that all folders are placed in proper order in the cabinets by checking the sequential numbering of the numbers located on the lower left corner of each genus folder. A single misplaced folder forces one to search the entire herbarium, and is extremely frustrating. One could also check that each sheet is in the correct taxon folder.

Annually check for pathogen (e.g., dry molds) or insect damage to the working herbarium. If water damage occurs, isolate and repair immediately to prevent loss of specimens.

Post and enforce rules for proper herbarium use (Attachments 47 and 48).

Make sure future entries into the NPSpecies database follow all the data acceptance and entry rules presented in the *User's Guide* to maintain consistency over time. If rules are changed, document them in a revised *User's Guide*. If rules are not followed, overall thematic consistency and ability to follow customized queries relying on fixed text narratives will be lost.

Consult an *Allium* authority to attempt to re-evaluate for a second opinion the R. J. Davis collection of *Allium confer aaseae* material to attempt to confirm its identification.

Conduct a herbarium search at BRY to confirm all unconfirmed duplicates existing there.

Review results of the herbaria search project conducted in late 1990's by ICDCD and examine county taxa. Compare to counties in CRMO and conduct herbaria searches at herbaria containing the records of taxa that may be new records if occurring within CRMO. I feel this is a low priority because the chance of documenting substantial numbers of new taxa in this fashion is probably small.

Research historical expeditions that may have collected in CRMO, such as the Chas D. Sneller Expedition and the Limbert Expedition. See if there are locations for where their specimens may be housed, and search those herbaria. I feel this is a low priority because the chance of documenting substantial numbers of new taxa is probably small.

Conducting full searches at herbaria ID and IDS and possibly herbaria where Cronquist and others may have deposited specimens may be fruitful, but would be costly and time consuming. Solicit Michael Curto regarding his recommendations for herbaria to search

for Poaceae collections. I feel this is a low priority because the chance of documenting substantial numbers of new taxa is probably small.

It is *not* recommended that additional herbarium searches be conducted specifically for the missing Wunner specimens. Sufficient focused effort by the appropriate people at the most promising herbaria has been expended. Robert Wunner, Urban's widow, Caleb Morse, Robin Bencie, and I have exhausted ideas concerning where they may be. The specimens may not be recoverable. Having said this, however, they may still be locatable once all major herbaria have their accessions cataloged on line. An electronic search could then be attempted at that time.

Field Work

Conduct additional field surveys for taxa suspected to occur as outlined in Attachments 54-57, focusing on reliably observed taxa that do not have collections as well as all other unconfirmed taxa, including unconfirmed taxa that have their only specimen missing (Attachment 42). The attachments will be revised in the final report to remove taxa documented in 2006. Also include additional surveys for any other species not on any lists. Use the detailed 2006 maps outlining survey polygons in Attachment 59 and adjust for areas already searched in 2006.

Specifically attempt to relocate and re-collect at the site where R. J. Davis collected *Allium confer aaseae* and evaluate new material to attempt to confirm its presence.

As a lower priority, conduct additional field surveys for taxa present or unconfirmed that have only one voucher that is in poor quality and is a poor representation. Three of the most pressing examples are *Stipa webberi* (present), *Verbascum blattaria* (present), and *Camissonia parvula* (unconfirmed). Also, there are 226 vouchers with only one specimen (Attachment 43). It is nice to have more than one collection to document presence and distribution, but these are a lower priority.

Focus surveys in under-surveyed areas identified in Attachments 58 and 59 and other microsites fortuitously encountered.

Use competent botanists very familiar with the local flora, or it is a largely an inefficient use of time and money.

Dedicate a specific amount of time to conduct annual pro-active surveys to reach greater than 90% documentation of flora, even if only one week of surveys a year. Incorporate into work plans the ability to capitalize on years when vegetation is well expressed.

Conclusions

Overall survey accomplishments in CRMO from all previous surveys and the NPSpecies efforts are substantial. Survey work from all past efforts are considerable, such as those performed by collectors of the 1930's, Urban, Wunner, Whipple, Elzinga, various

Masters students and NPS staff incidental collections, recent NPS vegetation inventories especially on lava flows and kipukas, and myself and BLM staff efforts from 1992 through 2006. When combined, these efforts have resulted in a fairly comprehensive survey and documentation of CRMO flora.

The amount of manpower and applied expertise by extremely well-qualified individuals expended for the CRMO NPSpecies project is unusual for an inventory workload of this scope and focus, and indicates the high level of commitment assigned to the project. Care has been given to ensure that results are based upon a preponderance of evidence and the best scientific and commercial data available, including assurance of confident specimen verifications. The resulting NPSpecies vascular plant database has been populated. About 850 taxa have been documented for CRMO that are present, probably present, unconfirmed, encroaching, or historic. An additional roughly 400 taxa as well as specific areas and habitats have been identified for future plant surveys. A fully functional working herbarium now resides at CRMO, holding about 3,000 individual specimen sheets, and the NPSpecies database also lists all specimens known to occur elsewhere (except for some duplicates at BRY).

I estimate that 90% of known and suspected plants have been documented in the Park Unit, an accomplishment which meets initiative goals with fairly high confidence, and a vascular plant 2006 working interim checklist has been developed. A final report is due May, 2008, which will provide more details and attachments than appear in this summary report, including a 2008 working checklist incorporating all results from NPSpecies efforts. Staff at CRMO have much to be proud of: from meager beginnings, the current checklist and working herbarium are of high quality and thoroughness, and represent several thousand hours of research by the most qualified individuals most familiar with the local and regional flora. The goal of documenting an estimated 90% of vascular flora in this Park Unit is believed to have been accomplished. Of course, plant lists are never static or “final,” and more plants will surely be documented in the park unit with additional survey efforts or by invasion of new weedy species over time. This report and the NPSpecies database capture the current status of our knowledge of CRMO’s flora. Hopefully, they will soon be outdated as efforts continue to further understand and document the area’s wonderful vegetation resources. *Ad victoriam!*

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