Attachment A. Biological Resources Survey Requirements – FINAL

Exhibit 1. Interim Survey Requirements for Ute Ladies'-tresses Orchid (*Spiranthes Diluvialis*), November 23, 1992
Exhibit 2. Bureau of Land Management (BLM) White River Field Office (WRFO), Little Snake Field Office (LSFO), Kremmling Field Office (KFO) Standards for Contractor Inventories for Special Status Plant Species & Noxious Weed Affiliates Field Season 2019
Exhibit 3. U.S. Fish and Wildlife Service (USFWS) Utah Field Office Guidelines for Conducting and Reporting Botanical Inventories and Monitoring of Federally Listed, Proposed and Candidate Plants, August 31, 2011
Exhibit 4. *Handbook of Field Methods for Monitoring Landbirds*, U.S. Department of Agriculture
Exhibit 5. Mountain Plover Survey Guidelines, U.S. Fish and Wildlife Service, March 2002
Exhibit 6. Surveying for Pygmy Rabbits (*Brachylagus idahoensis*), Interagency Pygmy Rabbit Working Group, February 2008 Version
Exhibit 7. Wildlife Survey Protocols Pinedale Field Office, Version 2.3, January 2011
Exhibit 8. Raptor Nest Survey Protocol
Annex A. Nesting Habitats and Surveying Techniques for Common Western Raptors
Exhibit 9. Colorado Natural Heritage Program Threatened and Endangered Plant Element Occurrence Field Form

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Gateway South Transmission Project

Plan of Development

Appendix B1. Biological Resources Conservation Plan

Attachment A. Biological Resources Survey Requirements – FINAL

Colorado Serial Numbers: COC-72907 and COC-72907-01

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May 2022

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CONTENTS

Exhibits

Tables

ABBREVIATIONS

BLM	Bureau of Land Management
CIC	Compliance Inspection Contractor
Company	PacifiCorp, doing business as Rocky Mountain Power
ESA	Endangered Species Act
GIS	geographic information system
MBTA	Migratory Bird Treaty Act
NTP	notice to proceed
POD	plan of development
Project	Gateway South Transmission Project
USFWS	U.S. Fish and Wildlife Service

1 INTRODUCTION

The purpose of this document is to define the biological resources survey requirements required prior to and during construction of the Gateway South Transmission Project (Project) in Colorado. This document is intended to be used by PacifiCorp, doing business as Rocky Mountain Power, (the Company) and the Construction Contractor(s) to understand biological resources survey requirements. Biological resources survey status, specific biological resources survey methodologies and timing, and reporting requirements are provided in this document. Specific locations where surveys are required are depicted in the biological resource geographic information system (GIS) data that will be provided to the Bureau of Land Management (BLM), Compliance Inspection Contractor, and the Construction Contractor(s). Survey locations areas are not depicted on the Project's plan of development (POD) Volume II.

2 BASIS FOR SURVEYS

Biological resources surveys conducted by the Company in 2019, 2020, and 2021 were used to inform the design of the Project consistent with avoidance and mitigation measures, as defined in POD Appendix B1: Biological Resources Conservation Plan. The Construction Contractor(s) is responsible for conducting additional presence/absence surveys for the identified special-status plants and wildlife that could be affected by the Project during construction. The results of these presence/absence surveys, in conjunction with biological resources surveys completed in 2019, 2020, and 2021, will be used to inform the implementation of avoidance and mitigation measures during construction activities, as defined in POD Appendix B1. Biological resources survey results will also be used to inform construction and resource monitoring needs, which are documented in POD Appendix B1, Attachment B: Biological Resources Monitoring Plan.

3 SPECIES-SPECIFIC REQUIREMENTS

The survey requirements for special-status plant and wildlife species, including survey area, year of last survey, timing, and methodology, are located in Table 1 and Exhibits 1–9. Furthermore, the Construction Contractor(s) will be responsible to hold an annual meeting with the Company, BLM, and Compliance Inspection Contractor (CIC) prior to initiation of year-of-construction surveys to discuss that year's plan for biological surveys. The Construction Contractor(s), in coordination with the BLM and CIC, will confirm the appropriate window for conducting surveys for each special-status species identified in this Plan.

In 2019, 2020, and 2021, the Company completed each of the required special-status species surveys on lands without access restrictions. As identified in Table 1, some of these special-status species survey results are considered valid for only 1 year, while others are valid for multiple years. If survey results are valid for multiple years, additional surveys will not be required by the Construction Contractor(s), provided construction is completed within these survey-validity time frames. If construction occurs outside of these survey-validity time frames or if surveys were not completed by the Company, the Construction Contractor(s) will need to conduct the associated surveys during the appropriate survey window, in accordance with the survey requirements and protocols summarized in Table 1, prior to ground disturbance. The GIS data package includes suitable habitat polygons where special-status species surveys are required prior to ground disturbance.

3.1 Special-Status Plants

The Company conducted presence/absence surveys in 2019, 2020, and 2021 to determine where special-status plant species have potential to occur and to document the presence of populations along the Project. Suitable and occupied habitat areas for special-status plants are depicted in the GIS data package and on POD Volume II, Map Set 3, respectively. A complete list of special-status plant species that require presence/absence surveys prior to initial ground disturbance is provided in Table 1. It should be noted that although Rollin's cat's-eye (*Cryptantha rollinsii*), Graham's beardtongue (*Penstemon grahamii*), and White River beardtongue (*Penstemon scariosus var. albifluvis*) were identified as having the potential to occur along the Project in Colorado, no suitable habitat for these species was identified during the 2019, 2020, or 2021 surveys. Therefore, presence/absence surveys for these species are not required and have not been included in this plan.

Prior to initiating special-status plant surveys, reference populations of the target species shall be visited to confirm that target species are flowering, fruiting, or otherwise identifiable prior to initiating surveys. Multiple site visits may be necessary to ensure that surveys are conducted during the appropriate life stage (usually flowering or fruiting) of all target species. In select locations where more than one target species might occur, multiple site visits may be necessary if the survey windows do not overlap to sufficiently allow surveys to be completed in a single visit. If occurrences of special-status plants are found within the survey area, the entire extent of the continuous local population will be delineated as long as land access is granted.

3.2 Special-Status Wildlife

The Company conducted surveys for special-status wildlife species in 2019, 2020, and 2021 to document suitable and occupied habitat along the Project. Suitable and occupied habitat areas for special-status wildlife species are depicted in the GIS data package and on POD Volume II, Map Set 3, respectively. Raptor nest data is shown on POD Volume II, Map Sets 4 and 5. A complete list of special-status wildlife species that require presence/absence surveys prior to ground disturbance appears in Table 1.

Based on the Project Biological Opinion (U.S. Fish and Wildlife Service [USFWS] 2016), presence/absence surveys for black-footed ferret (*Mustela nigripes*) are not required or included in Table 1 because black-footed ferret occupancy will be assumed in all reintroduction areas known to be occupied by black-footed ferrets and because white-tailed prairie dog (*Cynomys leucurus*) habitat will be surveyed and has overlapping habitat requirements.

Table 1. Survey Requirements for Biological Resources in Colorado

Resource	Conservation Status	Year of Construction Surveys Required by the Construction Contractor(s)?	Survey Area*	Year(s) of Most Recent Presence/Absence Survey	Survey Year and Lifespan†	Survey Date Range	Protocol
Plants Listed under the Endangered Species Act (ESA)							
Ute ladies'-tresses (*Spiranthes diluvialis*)	ESA-listed threatened	Yes (protocol surveys where 3 consecutive years of surveys has not been completed)	Surveys will be conducted in areas of suitable habitat located within 300 feet of all work areas, and new and improved access routes.	2019/2020/2021	*Temporary disturbance areas within suitable habitat*: A total of 3 years of protocol surveys are required for any temporary disturbance in suitable habitat, with at least 1 year conducted prior to the start of the temporary disturbance. Surveys were conducted in 2019, 2020, and 2021; however, not all suitable habitat areas received 3 consecutive years of survey. Where suitable habitat areas were not surveyed all 3 years due to land access restrictions, additional protocol surveys will be required for temporary disturbance in suitable habitat. *Permanent disturbance areas within suitable habitat:* A total of 3 consecutive years of protocol surveys are required prior to any permanent disturbance in suitable habitat. Surveys were conducted in 2019, 2020, and 2021; however, not all suitable habitat areas received 3 consecutive years of survey. Where suitable habitat areas were not surveyed all 3 years due to land access restrictions, additional protocol surveys will be required prior to ground disturbance.‡ Surveys are valid for 3 years. Additional protocol surveys will be required if ground disturbance does not commence by 2024.	Throughout the month of August	Survey techniques are described in *Interim Survey Requirements for Ute Ladies'-tresses Orchid (*Spiranthes Diluvialis*), November 23, 1992* (Exhibit 1). In addition to the BLM Little Snake Field Office, the BLM White River Field Office, the BLM Colorado State Office, and the USFWS Western Colorado Field Office, survey results will be submitted to the following addresses: **Ecological Services** 5353 Yellowstone Road, Suite 308A Cheyenne, Wyoming, 82009 **Lucy Jordan** U.S. Fish and Wildlife Service 529 25 ½ Road, Suite B-113 Grand Junction, CO 81505
Bureau of Land Management (BLM) Sensitive Plants							
Bessey's locoweed (*Oxytropis besseyi* var. *obnapiformis*)	BLM sensitive	No	Surveys will be conducted in areas of suitable habitat located within 328 feet of all work areas, and new and improved access routes.	2020/2021	Surveys are valid for 3 years. Protocol surveys will be required if ground disturbance does not commence by 2023/2024 (dependent on when last presence/absence surveys were completed).	May to July	Surveys will follow the protocol in *Bureau of Land Management (BLM) White River Field Office (WRFO), Little Snake Field Office (LSFO), Kremmling Field Office (KFO) Standards for Contractor Inventories for Special Status Plant Species & Noxious Weed Affiliates Field Season 2019* (Exhibit 2).
Caespitosa cat's-eye (*Cryptantha caespitosa*)	BLM sensitive	No	Surveys will be conducted in areas of suitable habitat located within 328 feet of all work areas, and new and improved access routes.	2020/2021	Surveys are valid for 3 years. Protocol surveys will be required if ground disturbance does not commence by 2023/2024 (dependent on when last presence/absence surveys were completed).	Late April to June	Surveys will follow the protocol in Exhibit 2.
Debris milkvetch (*Astragalus detritalis*)	BLM sensitive	No	Surveys will be conducted in areas of suitable habitat located within 328 feet of all work areas, and new and improved access routes.	2020/2021	Surveys are valid for 3 years. Protocol surveys will be required if ground disturbance does not commence by 2023/2024 (dependent on when last presence/absence surveys were completed).	Flowers April to early June; fruits from late May through June (NatureServe 2012a)	Surveys will follow the protocol in Exhibit 2.
Duchesne milkvetch (*Astragalus duchesnensis*)	BLM sensitive	No	Surveys will be conducted in areas of suitable habitat located within 328 feet of all work areas, and new and improved access routes.	2020/2021	Surveys are valid for 3 years. Protocol surveys will be required if ground disturbance does not commence by 2023/2024 (dependent on when last presence/absence surveys were completed).	Late April through June (NatureServe 2012b)	Surveys will follow the protocol in Exhibit 2.
Gibbens' beardtongue (*Penstemon gibbensii*)	BLM sensitive	No	Surveys will be conducted in areas of suitable habitat located within 328 feet of all work areas, and new and improved access routes.	2020/2021	Surveys are valid for 3 years. Protocol surveys will be required if ground disturbance does not commence by 2023/2024 (dependent on when last presence/absence surveys were completed).	June through September	Surveys will follow the protocol in Exhibit 2.

Resource	**Conservation Status**	**Year of Construction Surveys Required by the Construction Contractor(s)?**	**Survey Area***	**Year(s) of Most Recent Presence/Absence Survey**	**Survey Year and Lifespan†**	**Survey Date Range**	**Protocol**
Graham's beardtongue (*Penstemon grahamii*)	BLM sensitive	No	Surveys will be conducted in areas of suitable habitat located within 300 feet of all work areas, and new and improved access routes.	2020/2021	Surveys are valid for 3 years. Protocol surveys will be required if ground disturbance does not commence by 2023/2024 (dependent on when last presence/absence surveys were completed).	May through June	Per conservation agreement, surveys will follow the protocol in *U.S. Fish and Wildlife Service (USFWS) Utah Field Office Guidelines for Conducting and Reporting Botanical Inventories and Monitoring of Federally Listed, Proposed and Candidate Plants, August 31, 2011* (Exhibit 3).
Narrow-stem gilia (*Gilia stenothyrsa*)	BLM sensitive	No	Surveys will be conducted in areas of suitable habitat located within 328 feet of all work areas, and new and improved access routes.	2020/2021	Surveys are valid for 3 years. Protocol surveys will be required if ground disturbance does not commence by 2023/2024 (dependent on when last presence/absence surveys were completed).	May through June (NatureServe 2012c)	Surveys will follow the protocol in Exhibit 2.
Uinta Basin spring parsley (*Cymopterus duchesnensis*)	BLM sensitive	No	Surveys will be conducted in areas of suitable habitat located within 328 feet of all work areas, and new and improved access routes.	2020/2021	Surveys are valid for 3 years. Protocol surveys will be required if ground disturbance does not commence by 2023/2024 (dependent on when last presence/absence surveys were completed).	Late April to May	Surveys will follow the protocol in Exhibit 2.
Yampa beardtongue (*Penstemon acaulis* var. *yampaensis*)	BLM sensitive	No	Surveys will be conducted in areas of suitable habitat located within 328 feet of all work areas, and new and improved access routes.	2020/2021	Surveys are valid for 3 years. Protocol surveys will be required if ground disturbance does not commence by 2023/2024 (dependent on when last presence/absence surveys were completed).	Late May to early June	Surveys will follow the protocol in Exhibit 2.
BLM Sensitive Wildlife							
Bald eagle (*Haliaeetus leucocephalus*) winter roosts	BLM and state sensitive; protected by the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act	No	Not applicable.	2019/2020	Roost locations identified during the 2019 and 2020 surveys will be considered active throughout the Project. Protocol surveys are not required prior to ground disturbance.	Not applicable.	Not applicable.
Greater sage-grouse (*Centrocercus urophasianus*)	BLM sensitive State sensitive	No	Not applicable.	2020	Annual lek surveys performed by state and federal agencies, in addition to focused aerial sage-grouse lek surveys conducted by the Company in 2020, will be considered adequate to determine sage-grouse occupancy along the Project. Protocol surveys are not required prior to ground disturbance.	Not applicable.	Not applicable.

Resource	Conservation Status	Year of Construction Surveys Required by the Construction Contractor(s)?	Survey Area*	Year(s) of Most Recent Presence/Absence Survey	Survey Year and Lifespan†	Survey Date Range	Protocol
Migratory bird nests	Protected by the MBTA	Yes	Surveys will be conducted within 300 feet of all work areas, and new and improved access routes.	None	Surveys are valid for the duration of that breeding season. Protocol surveys are required prior to ground disturbance.	Elevations below 7,000 feet: New nest surveys from April 1 to July 31. Monitoring of known nests will continue until August 15. Elevations above 7,000 feet: New nest surveys from May 15 to August 15. Monitoring of known nests will continue until August 31.	Nest surveys will be conducted using techniques described in *Handbook of Field Methods for Monitoring Landbirds* (Exhibit 4). Nest surveys will be conducted no more than 7 days prior to the start of Project activities in any given area. All active nests detected will receive a unique alphanumerical designation and have their locations recorded in global positioning system coordinates in a format consistent with BLM data standards. Primary flagging designed to indicate nest presence will be placed at the work area boundary, and secondary flagging designed to assist in re-locating nests for monitoring purposes will be placed between the work area boundary and the nest at an appropriate distance to avoid attracting predators to the nest (no flagging within 60 feet of an active nest). This location will ideally be where it is most efficient to make remote observations using binoculars or spotting scopes so that observer-related disturbance will be kept to a minimum during subsequent nest-monitoring activities. Flagging will be marked with the distance (feet) and compass bearing to the nest. Each nest will be photographed at least once, and perhaps as often as every time it is visited, as long as the act of obtaining the photograph is not likely to cause an incubating or brooding adult to flush from the nest.
Mountain plover (*Charadrius montanus*)	BLM and state sensitive	Yes	Surveys will be conducted in areas of suitable habitat located within 0.25 mile of all work areas, and new and improved access routes.	2020/2021	Surveys are valid for the duration of that breeding season. Protocol surveys are required prior to ground disturbance.	May 1 through June 15	Pedestrian or vehicle (presence/absence) surveys will follow the protocols identified in *Mountain Plover Survey Guidelines, U.S. Fish and Wildlife Service, March 2002* (Exhibit 5).
Pygmy rabbit (*Brachylagus idahoensis*)	BLM and state sensitive; USFWS species of concern	No	Surveys will be conducted in areas of suitable habitat located within 328 feet of all work areas, and new and improved access routes. If individuals are observed, the survey buffer will be expanded to 0.25 mile.	2020/2021	Surveys conducted in 2020 and 2021 are considered valid throughout the duration of the Project. Additional surveys are not required prior to ground disturbance.	Surveys can be conducted any time of year; winter surveys preferred	Pedestrian (presence/absence) surveys will follow the protocols identified in *Surveying for Pygmy Rabbits (*Brachylagus idahoensis*), Interagency Pygmy Rabbit Working Group, February 2008 Version* (Exhibit 6).
White-tailed prairie dog	BLM and state sensitive, USFWS species of concern	Yes	Surveys will be conducted in areas of suitable habitat located within 660 feet of all work areas, and new and improved access routes.	2020/2021	Surveys are valid for 1 year. Protocol surveys are required prior to ground disturbance.	April 1 through September 30	Pedestrian (presence/absence) surveys will follow the white-tailed prairie dog survey protocol identified in *Wildlife Survey Protocols Pinedale Field Office, Version 2.3, January 2011* (Exhibit 7). Note: Motorized vehicle use in the Wolf Creek Management Area is restricted to existing routes only. Off-route all-terrain vehicle travel is not permitted.

Resource	Conservation Status	Year of Construction Surveys Required by the Construction Contractor(s)?	Survey Area*	Year(s) of Most Recent Presence/Absence Survey	Survey Year and Lifespan†	Survey Date Range	Protocol
Raptor nests, including the following BLM sensitive species: • Bald eagle (*Haliaeetus leucocephalus*) • Burrowing owl (*Athene cunicularia*) • Ferruginous hawk (*Buteo regalis*) • Golden eagle (*Aquila chrysaetos*) • Northern goshawk (*Accipiter gentilis*) • Peregrine falcon (*Falco peregrinus anatum*)	Protected by the MBTA	Yes	Surveys will be conducted in areas of suitable habitat located within 1.0, 0.5, or 0.25 mile (depending on the appropriate BLM/USFWS field office spatial buffers for each raptor species) of all work areas, and new and improved access routes.	2020	Surveys are valid for the duration of that breeding season. Protocol surveys are required prior to ground disturbance.	During the appropriate BLM/USFWS field office seasonal buffers for each raptor species	Helicopter and pedestrian surveys will follow the Raptor Nest Survey Protocol (Exhibit 8), which is based on *Nesting Habitats and Surveying Techniques for Common Western Raptors* (Exhibit 8, Annex A), with the following exceptions: 1. Naphthalene crystals will not be used to deter nest predation. 2. Helicopters will maintain a 150-meter distance from all identified nests and will not hover at a nest location for more than 15 seconds. Survey methodology for burrowing owls is based on Phase II burrow surveys identified in the *Burrowing Owl Survey Protocol and Mitigation Guidelines* (Exhibit 8; California Burrowing Owl Consortium 1993). The burrowing owl survey report will be combined with the single biological survey report for all species, as discussed in Section 4 of this Plan.

* Project work areas include all areas of both permanent and temporary ground disturbance associated with transmission line construction, as well as new, improved, and overland access roads.

† The Company conducted presence/absence surveys in 2019, 2020, and 2021. Where survey results are valid for multiple years, additional surveys will not be required if construction occurs within the approved time frame. If construction occurs outside of the time frame, or if presence/absence surveys are not completed by the Company due to land access restrictions, then additional surveys will need to be conducted by the Construction Contractor(s) prior to ground disturbance. Refer to the GIS data provided to the Construction Contractor(s) for both suitable habitat polygons and restricted access areas where special-status species surveys are required prior to ground disturbance.

‡ In the event permanent ground disturbance is required within 300 feet of suitable habitat prior to the third and final year of survey, then the Construction Contractor(s) may proceed if the following conditions are met: 1) ground disturbing activities will not occur during the flowering period (typically August 1 through September 15 depending on location); 2) any piling of dirt or brush and staging of equipment will occur within the work are that is furthest from the Ute Ladies'-tresses suitable habitat (such as, the opposite side of the road being improved); 3) where applicable, geotextile matting, large rocks, or wooden planks will be used to cross existing roads that pass through Ute Ladies'-tresses suitable habitat and where the road surface is moist; temporary crossing structures will be removed upon completion of construction at the site; and 4) repeated crossing on roads that pass through Ute Ladies'-tresses suitable habitat will be limited to the extent possible (personal communication, email from R. Reisor, Botanist, USFWS, to Sarah McLean, Project Deputy, Galileo Project LLC, November 3, 2021).

4 SURVEY REPORTING REQUIREMENTS

Following completion of biological resources surveys, a single biological survey report summarizing the survey results for all species, with the exception of non-raptorial migratory birds, will be prepared by the Construction Contractor(s) and submitted to the BLM Little Snake Field Office, the BLM White River Field Office, the BLM Colorado State Office, and the USFWS Western Colorado Field Office. Non-raptorial migratory bird survey results will be reported twice each month during the nesting season (April 1 to August 31). Refer to Appendix B1 Attachment B: Biological Resources Monitoring Plan for migratory bird reporting requirements.

A draft of the biological survey report will be submitted for agency review and comment, prior to finalization. At a minimum, the following will be included in the biological resources survey report:

- The species surveyed for
- The survey date and a description of the locations surveyed
- Ambient condition data
- An evaluation of environmental conditions that may influence the results of surveys conducted
- The names and qualifications of the surveyors
- A tabular summary of the results of the surveys
- Special-status plant reference population locations, phenology observations, and date of the reference population site visit
- Special-status plant phenology observations of each observation, if individuals are observed
- Representative photographs
- Spatial data and mapping depicting populations or individuals recorded within the species-specific survey area (as outlined in Table 1) in relation to Project impact areas

Any new occurrences of special-status plant species or existing occurrences of special-status plant species impacted by the Project will be documented on the Colorado Natural Heritage Program (CNHP) T&E Plant Element Occurrence Field Form (Exhibit 9) and submitted by the Construction Contractor(s) to CNHP using the address provided on the form.

5 LITERATURE CITED

California Burrowing Owl Consortium. 1993. *Burrowing Owl Survey Protocol and Mitigation Guidelines.* Available at: https://wildlife.ca.gov/Conservation/Survey-Protocols#377281284-birds. Accessed January 2020.

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U.S. Fish and Wildlife Service (USFWS). 2016. *Biological Opinion and Informal Consultation for the Energy Gateway South Transmission Line Right-of-Way Project—Carbon and Sweetwater Counties, Wyoming; Moffat and Rio Blanco Counties, Colorado; and Uintah, Duchesne, Wasatch, Utah, Sanpete, and Juab Counties, Utah*. Cheyenne, Wyoming: Wyoming Field Office.

Exhibit 1. Interim Survey Requirements for Ute Ladies'-tresses Orchid (*Spiranthes diluvialis*), November 23, 1992

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Interim Survey Requirements for Ute Ladies'-tresses Orchid
(Spiranthes Diluvialis)

November 23, 1992

The U. S. Fish and Wildlife Service (Service) has established the following interim requirements and guidelines for surveys to determine the presence or absence of the Federally threatened plant species *Spiranthes diluvialis*, Ute ladies'-tresses orchid. These guidelines were developed by the Service in consultation with biologists and ecologists knowledgeable about the species. These guidelines and recommendations are designed to supplement, not substitute for, professional methods, expertise, and judgment typically used to conduct rare plant surveys.

Because the species is so rare, very little is known about its habitat preferences and population ecology. These interim survey requirements have been developed in order to gain more information about the species, identify potential habitat, streamline and standardize survey procedures. As more information becomes available through these surveys, the interim requirements will be revised and simplified as appropriate.

Documentation of compliance with these requirements and recommendations is accomplished through submission to the Service of a survey report. The Service will respond with a letter indicating acceptance of the report.

All Federal agencies have a responsibility under Section 7(a)(1) of the Endangered Species Act to conserve Federally listed threatened and endangered species. The Service encourages all Federal agencies to review their properties and projects and make funds available to conduct surveys in all appropriate potential habitat, including habitat outside the areas specified in these guidelines.

1. Introduction

Spiranthes diluvialis occurs in seasonally moist soils and wet meadows near springs, lakes, or perennial streams and their associated flood plains below 6,500 feet elevation in Utah, Colorado, and Nevada. Typical sites include old stream channels and alluvial terraces, sub-irrigated meadows, and other sites where the soil is saturated to within 18 inches of the surface at least temporarily during the spring or summer growing seasons. Associated vegetation typically falls into the Facultative Wet wetland vegetation classification category (from the National List of Plant Species that Occur in Wetlands developed by the Service). The species occurs primarily in areas where the vegetation is relatively open and not overly dense, overgrown, or over grazed. Although very rare now, it is estimated that it was once common in low elevation riparian areas in Colorado, Utah and Nevada.

The moist soil conditions and vegetation composition of known *Spiranthes diluvialis* sites suggest that wetlands regulated under the Clean Water Act qualify as potential *Spiranthes diluvialis* habitat. Therefore, jurisdictional wetlands, as well as other drier sites matching the description above, should be surveyed.

2. Qualification of Surveyor

Spiranthes diluvialis is difficult to identify in the field, and since the orchid is rare and flowers for such a short time, few people have had the opportunity to become acquainted with the species. The Service does not want to exclude any person from conducting surveys. Therefore, the Service has developed a minimum set of qualification criteria that demonstrate whether a surveyor is sufficiently acquainted with *Spiranthes diluvialis* to collect consistent and accurate information for the survey report. Documentation that these criteria have been met is accomplished by submitting a statement of surveyor qualifications as part of the survey report.

The survey report shall contain a statement of qualifications of the individual conducting the survey, including:

a. Description of botanical expertise and training (e.g, graduate degree in botany, ecology, or other appropriate discipline).

b. Experience in conducting rare plant surveys (list dates, locations, and plants included in previously conducted surveys).

c. Actions taken to become acquainted with the known locations and appearance of *Spiranthes diluvialis* (such as visiting herbaria to look at specimens, conversations or site visits with others familiar with the species for a description of ecology and likely occurrences).

d. Documentation of correct identification of *Spiranthes diluvialis* in the field. The surveyor is required to enclose a photograph of the species taken at a known site and a statement certifying when and where the photograph was taken.

e. References, particularly documenting contact with known *Spiranthes diluvialis* experts.

3. Areas Requiring a Survey

The following areas in Colorado have been determined to have a high probability of occurrence of *Spiranthes diluvialis* based on current and historical records of the species. Surveys are required for appropriate sites below 6,500 feet elevation within these areas:

a. Boulder and Jefferson counties.

b. The South Platte River 100 year flood plain and perennial tributaries from the Front Range as far east as Brush, Morgan county.

c. The Fountain Creek 100 year flood plain and perennial tributaries from the Front Range to the southern boundary of El Paso county.

d. The Yampa River 100 year flood plain and its perennial tributaries from Steamboat Springs west to the Utah border.

A perennial stream is usually represented by a sold blue line on a USGS 7 ½ minute quad map.

4. Habitat Description and Sites Requiring a Survey

Spiranthes diluvialis is typically found associated with alluvial deposits of silty, sandy, gravelly, or cobbly soil. The species may occasionally also be found in highly organic soils or peat. The species seems to prefer well drained soils with fairly high moisture content (soil around the roots will form a soft ball). Soils may exhibit some gleying or mottling but are generally not strongly anaerobic. *Spiranthes diluvialis* is found in some heavily disturbed sites, for example, old gravel mines that have since been developed into wetlands, and along well traveled footpaths built on old berms. The species is also found in grazed pastures with introduced pasture grasses.

Spiranthes diluvialis is found with grasses, sedges, and rushes, in shrubs, and riparian trees such as willow species. It rarely occurs in deeply shaded sites and prefers partially shaded open glades or pastures and meadows in full sunlight. Common associated species on the Front Range include:

Horsetail *(Equisetum spp.)*
Milkweed *(Asclepias incarnate)*
Verbena *(Verbena hastate)*
Agalinis *(Agalinis tenuifolia)*
Lobelia *(Lobelia siphilitica)*
Blue-eyed grass *(Sisyrinchium spp.)*
Triglochin *(Triglochin spp.)*
Carpet bentgrass *(Agrostis stolonifera)*
Reedgrass *(Calamagrostis)*
Goldenrod *(Solidago spp.)*

Sites below 6,500 feet elevation occurring within the areas described in Section 3 exhibiting the following features shall be surveyed for *Spiranthes diluvialis*:

a. Seasonally high water table (within 18 inches of the soil surface for at least one week sometime during the growing season, growing season defined as when soil temperatures are above 41 degrees Fahrenheit).

b. In or near wet meadows, stream channels, or flood plains.

c. Vegetation falling into the Facultative Wet or Obligate Wet classification, including introduced pasture grasses.

d. Jurisdictional wetlands as specified under the Clean Water Act.

Heavily grazed and weedy sites shall be surveyed for the orchid if they otherwise meet the criteria indicating potential suitability as *Spiranthes* habitat as listed above.

5. Sites Not Requiring a Survey

Some sites are either clearly not appropriate *Spiranthes diluvialis* habitat or have very low potential to be *Spiranthes diluvialis* habitat. A survey for *Spiranthes diluvialis* is not required for such sites. Sites below 6,500 feet elevation occurring within the areas described in Section 3 **not** requiring a survey for *Spiranthes* include:

a. Highly disturbed or modified sites such as:

    1. Highway right-of-ways built on filled and compacted soil material.

    2. Highway right-of-ways build on rock fills, either revegetated or not revegetated.

    3. Rock or soil fills with steep back slopes (may or may not be associated with a road).

    4. Active construction sites where all vegetation has been stripped exposing bare soil.

    5. Construction sites where construction has been completed within the last five years, but the area has not been revegetated.

    6. Landscaped and maintained (mowed) bluegrass lawns.

b. Upland sites, including, for example:

    1. Prairie dog towns.

    2. Short grass prairie.

    3. Sagebrush or shadscale rangeland.

c. Sites entirely inundated by standing water, including, for example, monocultures of cattails *(Typha latifolia)* or Olney's three-square *(Scirpus americanus).* Note that although inundated areas need not be surveyed, mesic slopes surrounding or adjacent to standing water must be surveyed if they otherwise meet the criteria indicating potential suitability as *Spiranthes diluvialis* habitat.

d. Sites composed entirely of heavy clay soils. However, *Spiranthes diluvialis* is found in areas where more well-drained soils or peat overlay a clay layer.

e. Very saline sites. *Spiranthes diluvialis* occurs in alkaline conditions and is somewhat tolerant of saline conditions. However, it has not been found in highly saline sites as indicated by dense monospecific stands of saltgrass *(Distichlis spicata stricta).*

f. Sites entirely composed of dense strands of:

    1. Reed canary grass *(Phalaris arundinacea)*

    2. Tamarisk or Salt-cedar *(Tamarix ramosissima)*

    3. Greasewood *(Sarcobatus vermiculatus)*

    4. Teasel *(Dipsacus sylvestris)*

    5. Common reed *(Phragmites australis)*

6. Timing of Survey

Because *Spiranthes diluvialis* is very difficult to locate unless it is flowering, because timing of flowering varies, and because the species may not flower every year, the following requirements must be met:

a. Reconnaissance may be conducted at any time of year to determine whether a site exhibits the characteristics described in Section 5 and therefore does not require a survey. If potential habitat is found to exist on the site, then a survey must be conducted at the appropriate time.

b. Surveys shall be conducted during the blooming season, which is normally between July 20 and August 31. However, surveys may be conducted earlier or later if flowering is occurring in a nearby known population comparable to the site being surveyed. Surveyors shall verify that a nearby population is flowering at the time the survey is conducted either by calling a Service representative or including a dated photograph of the flower population. The date of the survey shall be noted in the survey report.

c. *Spiranthes diluvialis* does not necessarily flower every year. Therefore, in drainages where *Spiranthes diluvialis* is known to occur, the Service recommends that surveys be conducted annually for three consecutive years. Also, for any site within required survey areas where habitat alteration has not yet occurred following an initial approved survey. Surveys shall be conducted annually for three consecutive years or until habitat alteration commences.

Under very special circumstances, earlier surveys may be possible for sites small enough to allow a complete “hands and knees” search for vegetative parts of *Spiranthes diluvialis*. The Service shall be contacted for prior approval and procedural requirements for such early surveys.

Surveys will be considered final for three years. If habitat alteration has not begun within three years, the Service must be contacted regarding the need for a survey update.

7. Maps

The Service recommends that, where available, Soil Conservation Service (S. C. S.) maps (for location of wetland soils) and National Wetland Inventory maps be consulted prior to site surveys to help identify likely potential habitat. Surveyors should be aware that *Spiranthes diluvialis* is not limited to mapped wetlands. In order to avoid duplication of effort and gain more information about the ecology and distribution of *Spiranthes diluvialis*, a USGS 7 ½ minute quad map must be submitted with the survey report showing routes taken for all search sites regardless of whether a population of the species was located during the search.

For survey sites too small to be adequately represented on a USGS 7 ½ minute quad map, an engineering drawing or more detailed map showing the area that has been surveyed must be included in the report. The site(s) should be indicated and labeled on the accompanying USGS 7 ½ minute quad map.

8. Ecological and Site Features

In order to gain more information about the ecology and site characteristics of *Spiranthes diluvialis*, so that better predictions about its location and distribution can be marked, the following information must be collected and reported for each site surveyed:

a. For sites disqualified as potential *Spiranthes diluvialis* habitat, describe the basis on which the site was disqualified.

b. For sites requiring a survey, the following information must be collected. This information can be brief and qualitative for sites where *Spiranthes diluvialis* is not found (a few words, a phrase, or a descriptive sentence is sufficient).

   1. List the most frequent or dominant associated plant species of both the over story and under story vegetation (e.g., over story of mature cottonwood trees with an under story of orchard grass and smooth brome).

   2. Describe the plant community, including a qualitative assessment of dominance (e.g., riparian willow community, willows dominant, with native grasses *Deschampsia caespitose* and sedges).

   3. Describe the ecological condition/management history of the site (such as cultivated field, old gravel mine, good condition native grassland with winter cattle grazing, recently flooded stream edge).

4. Describe the geomorphology of the site, including, for example, the nature of the material (e.g., alluvium), the landscape position (e.g., bench above old stream bed).

5. Describe the soils including, for example, texture, whether moist, presence of mottling or other hydric soil indicators, and list the map unit from the S. C. S. county soil survey if available.

6. Describe the hydro logic characteristics, for example, depth to water table (if possible to determine without major excavation), inferences about frequency, duration, and season of flooding, presence of standing water, high water mark of a stream or water body in relation to location of surveyed site.

7. Describe any other site characteristics that appear relevant to understanding the ecology, population biology, or distribution of *Spiranthes diluvialis.*

In addition, for **each** site where a population of *Spiranthes diluvialis* is found, the following information must be collected and included in the survey report:

a. Map the population on a USGS 7 ½ minute quad map and on a finer scaled map or engineering drawing if appropriate.

b. Count the number of individuals if fewer than 500.

c. Estimate the number of individuals if more than 500. Include a description of the method used for population estimation.

d. Note the phrenological stage of the plants (e.g., proportion of plants that are flowering, proportion of flowers that have set seed).

e. Note the specific geomorphologic, hydro logic, and soil conditions where the population occurs if it varies from the site description above.

f. Note any other possibly relevant ecological information.

g. Include a photograph of the population that illustrates its setting and habitat.

9. Survey Report

The survey report submitted to the Service should follow the outline below:

a. Name and qualifications of surveyor.

b. Brief project description indicating proposed impact to the site.

c. Site location (address and legal description).

d. Dates surveys were conducted.

e. Ecological and site features as described above.

f. Appendices.

1. Maps

2. Photographs

10. Notification

The Service shall be notified immediately if a new population of *Spiranthes diluvialis* is discovered. For sites located in Colorado, the surveyor shall notify either:

> Bernardo Garza, U.S. Fish and Wildlife Service, P.O. Box 25486 – DFC, Denver, Colorado 80225, telephone 303-236-4377 or
>
> Larry England, U.S. Fish and Wildlife Service, 2369 West Orton Circle, West Valley City, Utah 84119, telephone 801-975-3330

11. Service Approval

Survey reports for sites in Colorado shall be submitted to either of the two Colorado addresses above. The Service will review submitted reports and reply with a written letter of acceptance within 30 days of receipt of the report. If the survey report is judged insufficient for any reason, the Service will notify the author within 30 days and discuss revisions. If the report is judged insufficient due to an inadequate survey, the Service will make every effort to notify the author promptly so that a satisfactory survey may be completed during the allowed survey time. However, given the narrow survey time frame, it may not be possible to rectify an inadequate survey effort during the current field season.

Surveys will be considered final for three years. If habitat alteration has not begun within three years, the Service must be contacted regarding the need for a survey update.

12. Service Follow-up

Survey reports and maps will be retained by the Service. Ecological information will be summarized and used to improve our understanding of *Spiranthes diluvialis* habitat and help predict actual and potential habitat. The Service will prepare periodic reports to keep the public informed about the distribution and ecology of *Spiranthes diluvialis.* The reports will include recommendations for protection strategies and habitat management practices and will identify additional research needs.

Survey requirements will be revised as appropriate based upon the most current available information.

Exhibit 2. Bureau of Land Management (BLM) White River Field Office (WRFO), Little Snake Field Office (LSFO), Kremmling Field Office (KFO) Standards for Contractor Inventories for Special Status Plant Species & Noxious Weed Affiliates Field Season 2019

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Bureau of Land Management (BLM)
White River Field Office (WRFO)
Little Snake Field Office (LSFO)
Kremmling Field Office (KFO)
Standards for Contractor Inventories for
Special Status Plant Species & Noxious Weed Affiliates
Field Season 2019

This survey protocol provides direction and reporting standards for surveyors and companies conducting botanical inventories for Special Status Plant Species on the BLM lands within the WRFO, LSFO, KFO (Offices). The Offices will use the information for;

a) Assistance in determining whether proposed project(s) may affect any listed, proposed, candidate or sensitive plant species,
b) Evaluation of direct, indirect and cumulative effects associated with the project(s) and provide the analysis for biological assessments needed for formal and informal consultation with the United States Fish and Wildlife Service (USFWS),
c) Mapping will be used to prevent fragmentation of existing plant populations and suitable habitats,
d) Assisting the Offices in mapping special status plant species habitats, and
e) Providing the Colorado Native Heritage Program with updated survey information from BLM lands in Rio Blanco, Moffat, Routt, Jackson and Grand Counties.

*** All Oil and Gas projects will work with WRFO Ecologist regardless of which Field Office the project occurs in. Non-Oil and gas projects will work with the respective Field Office in which the project is occurring.

If a different survey approach (e.g. "forensic botany") is desired by the proponent or consultant other than what is described below, the methods must be submitted in writing for BLM's approval.

Definition: ***Special Status Plant Species***

Plant species officially listed as **Threatened** or **Endangered**, **Proposed** for listing, or are **Candidates** for listing under the provisions of the Endangered Species Act, and those that have been designated by the Colorado State Director as BLM Sensitive species. The BLM currently does not treat State tracked species as special status plant species.

When is a special status plant survey required?

When a proposed ground-disturbing action is located within or adjacent to **potential, suitable, or occupied habitat** for one or more special status plant species, **a survey is required during the blooming season (unless otherwise approved by the BLM prior to blooming period)**. This is determined by the BLM on a case-by-case basis and may not coincide with previously mapped habitats.

For all proposed oil and gas activities and other ground disturbing activities within the jurisdiction of the Field Offices, the Field Offices will determine whether a survey is required after reviewing digital data, photos, soil maps, topographic maps, geological maps, maps of known populations, digital and hard copy habitat data, previous surveys, and after consulting the Colorado Natural Heritage Program digital element occurrence and observance layers. In some cases, the decision for survey requirements may be made cooperatively between the USFWS and the BLM, especially if informal or formal consultation is anticipated. You may visit http://ecos.fws.gov/ipac/ to determine the USFWS survey ranges for T&E species. The intensity of the survey will depend upon the probability of occurrence of a special status plant species, characteristics of known and potential habitats, the degree of soil disturbance associated with the proposed action, and potential cumulative effects.

***Please note*:** Special status plant species **surveys expire after 3 growing seasons and the BLM must be consulted on survey protocol after survey expiration.** USFWS recommends conducting surveys every 2-3 years, so, if an area was surveyed in 2017 it would be good for that year, 2018, and 2019. **Concurrently, a survey for any listed State of Colorado noxious weeds is required for all proposed ground disturbing activities.** If noxious weeds are found, they will be treated (if timing is appropriate) or removed (if plants have formed seeds) prior to ground-disturbing activities. Please access the Colorado Department of Agriculture website at https://www.colorado.gov/pacific/agmain for the current list of noxious weed species. All weed spraying on BLM must have a Pesticide Use Permit (PUP) prior to completing treatments.

Which special status plant species require survey(s) for a given project?

After the contractor or botanist receives the digital disturbance boundaries for a project, and prior to initiating inventory, the BLM requests that the Contract botanist contact the WRFO for all oil and gas related projects, and the specific office of interest for all other applications, to obtain a current list of special status plant species known, or likely to occur, in the area of the proposed action. At this time, a discussion regarding the timing, intensity, and extent of the surveys will be coordinated. Appendix A provides the current special status species list as of January 2019.

Please note: **Multiple** site visits during a field season may be necessary to conduct surveys and mapping during appropriate flowering stages, and to accommodate south versus north-facing slopes, microclimates and multiple species.

Concurrently, Colorado noxious weed species on the Colorado "A" and "B" listed weeds will be surveyed and mapped for treatment prior to ground disturbance. Colorado C list species should be noted and mapped if the infestation is present in limited quantities. For C list species such as the annual bromes, notation should be made in the final report regarding an ocular estimate of average abundance within the project boundary, however, mapping of C list species is not required. The proponent will only be able to treat noxious weeds after the approval of a noxious weed PUP by the respective field office in which the proposal will occur in (WRFO, LSFO or KFO).

At this time, we are voluntarily reporting State of Colorado tracked species if noted, and their inclusion in surveys is not mandatory. If noted, however, please do not hesitate to contact the WRFO or complete and return a CNHP survey form for the occurrence, if time permits.

Who may conduct special status plant and affiliated noxious weed inventories?

A degree in Botany, Plant Science, or Plant Ecology or a closely related field is strongly recommended! Surveys will be conducted by qualified field botanists who will provide documentation of their qualifications and experience as an appendix in the final report.
All personnel conducting inventories for special status plants should have strong backgrounds in

plant taxonomy and should have field experience with persons familiar with the involved species and local flora. If you are new to the area, please contact the WRFO to arrange training to identify species properly and associated suitable habitat.

What is the extent and intensity of required surveys?
Threatened, Proposed, and Candidate Plant Species:

Dudley Bluffs bladderpod and twinpod

On April 25, 2010, the USFWS sent a letter to the WRFO BLM regarding changes and its recommendations for assessing impacts to Dudley Bluffs twinpod and bladderpod (*Physaria obcordata* and *Physaria congesta*) relating to oil and gas impacts. This letter expressed their concern regarding development and potential impacts beyond the currently required 200 meter surveys. They have indicated that in order for the analysis of all rare plant surveys to be effective, the minimum survey distance should be expanded from the current 200 meters to 600 meters. Note: In addition, they have requested that the BLM collect and analyze all surface disturbance, past and present, by all proponents, to determine total surface disturbance within 600 meters of a given project area. Therefore, it will also be necessary to include specific spatial data, within 600 meters of the edge of the proposed disturbance, such as all existing access roads, pipelines, well pads, and other infrastructure, as part of the final report.

All Threatened, Proposed and Candidate Plant Species

In 2012-2013, the USFWS released draft Plant Guidance to section 7 consultations which applies to all listed species. The guidance recommends the Likely to Adversely Affect (LAA) buffer is at 100 m from the edge of disturbance while the Not Likely to Adversely Affect buffer is at 300 m, but project specific considerations will be taken into consideration with regards to buffers. Our survey buffers and requirements are as follows:

- All new disturbances for well pads, pipelines, temporary work areas, roads, etc. will require a 600 m buffer. This provides the ability to adjust the location within 600 m without waiting until the next survey season. Once a final location is determined, there must be surveys for all areas within 300 m of the edge of disturbance.
- All existing disturbance (well pad expansions, pipelines in existing corridors, construction on existing well pads/facilities, etc.) will require a 300 m survey buffer.
- All historic populations must be remapped to ensure any expansion/change is documented.
- Contractors must map all historic and new populations in their **entirety**, even if the population extends outside the designated survey buffer. Exceptions may be allowed based on the site specific conditions or large size of the overall habitat identification or recent mapping efforts on the same habitat. This will be based on consultation with FO Ecologist.
- If a project plans on removing listed species, the exact count of individuals to be removed must be obtained.

For well pads and temporary work areas, the inventory will include the buffer from the outer edge of the ground disturbance on all sides. For roads and pipelines a survey of 300 or 600 meters on either side of the edge of disturbance will be minimally required. This distance may be increased on steep slopes to account for potential disturbance due to cut and fill, dust, and erosion, or other factors during and following construction. Additional survey distances will be required if new individuals or populations are encountered, and should include a map showing the extent of the entire new population. If **new** plants, individuals and/or populations are found within the survey area, please notify the WRFO Ecologist within 48 hours for additional population mapping and survey protocol.

Occupied Habitat (this applies to federally list species as well as BLM sensitive species):
Polygon should include every individual found. Plants should be included in one polygon unless they are separated by a distance greater than 20 m apart (unless the surveyor has reason to believe it is one occurrence [e.g. historic population was present]). Within a 10m radius of an individual plant it is considered occupied habitat to account for seed dispersal. Remember to use the point feature to map a cluster of individuals less than 10 square meters in size.

Seismic Surveys:
For federally listed, candidate, and proposed species seismic project required survey and avoidance buffers:

- 100 m survey buffers for vehicle disturbance (buggy, vibes, TWA, staging areas, including these activities on or near two-tracks)
- 50 m survey buffers for walking (receiver lines, heliportables, including these activities on or near two-tracks)
- 25 m buffer for activities along maintained roads (CR, graveled BLM/industry roads)

BLM Sensitive Plant Species:
For well pads and temporary work areas, the inventory will include a 100 meter buffer from the outer edge of the ground disturbance on all sides. For roads and pipelines a survey of 100 meters on either side of the edge of disturbance will be minimally required. This distance may be increased on steep slopes to account for potential disturbance due to cut and fill, dust, and erosion, or other factors during and following construction. Additional survey distances will be required if new individuals or populations are encountered, and should include a map showing the extent of the population. Suitable habitats should also be mapped if they fall within the total survey boundaries. Contractors must map all historic and new populations in their entirety, even if the population extends outside the designated survey buffer. Exceptions may be allowed based on the site specific conditions or large size of the overall habitat identification or recent mapping efforts on same habitat. This will be based on consultation with FO Ecologist. If a project plans on removing sensitive species, the exact count of individuals to be removed must be obtained.

The intensity of the survey technique must include systematic and careful pedestrian inventories of habitats, ground disturbance areas and buffers for the proposed action. Route overlap is advisable to prevent surveyors from missing rare species. Please map survey routes within the survey area. Please also use the prime, moderate, and marginal suitable habitat designations (similar to the designations for the threatened and endangered species). Each sensitive species has different habitat criteria; for WRFO most occupy the Parachute Creek member (Tgp) of the Green River Formation, which would be considered prime habitat. Since little information is known about the sensitive species, please identify what classifies as prime, moderate, and marginal habitat in the survey report and designated the polygons accordingly in the GIS attribute table.

Noxious Weeds: For all ground disturbance areas, the inventory will include a **100 meter buffer**

from the outer edge of the ground disturbance on all sides.

Seismic Surveys:
For BLM sensitive species seismic project required survey and avoidance buffers:

- 50 m survey buffers for vehicle disturbance (buggy, vibes, TWA, staging areas, including these activities on or near two-tracks)
- 30 m survey buffers for walking (receiver lines, heliportables, including these activities on or near two-tracks)
- 20 m buffer for activities along maintained roads (CR, graveled BLM/industry roads)

Please map suitable and occupied habitat as well as track-lines of survey. Seismic activities will avoid federally protected plants by 100 m and BLM sensitive by 50 m. Exceptions may be allowed for specific activities with an appropriate mitigation plan however, (i.e. walking receiver lines through populations dependent on site characteristics).

What time of year should surveys be conducted?

Reconnaissance of special status plant species habitats may be conducted at any time of year to determine site characteristics and to familiarize surveyors with the landscape and its flora (see Appendix A). As with most flora, special status plants species and occurrences are most effectively located, and identified, when in flower. **An official plant survey will only be approved if the plant survey was conducted during the blooming season (unless otherwise approved by the FO Ecologist). If non-blooming surveys are submitted follow-up surveys may be required during the next bloom season (which is likely during the following year).** The flowering period varies by species please see Appendix A for typical blooming periods. The flowering season will be determined by examining nearby known populations comparable to the site being surveyed, via existing literature, and from existing floristic data and field experience. Flowering seasons vary considerably from year to year based on slope, precipitation, soil temperature and many other factors. If available, use a regional or local reference population to obtain a visual image and specifics of a target species and associated suitable habitat. **Reference populations should be documented with digital photos of the target species and habitat. Documentation of reference populations should be provided in the survey report.**

Adverse or unforeseen conditions may prevent surveyors from determining presence/absence of target species and suitable habitat delineation. Disease, drought, predation, or herbivory may influence identification and in some cases additional surveys in subsequent years may be required. Contractors should discuss such conditions with the FO Ecologist immediately, if they are encountered.

Results are important. If you are unsure of look-alikes or identification of **Threatened** species, **PLEASE** call the FO Ecologist, visit and study specimens in your local herbarium, and/or consult with a known and experienced field consultant.

Mapping requirements for special status plant and noxious weed locations

All special status plant species occupied and suitable habitats, and noxious weeds found within the survey boundaries shall be mapped with a GPS unit. The contractor must provide the BLM with data in a format compatible with the WRFO's ESRI ArcGIS Geographic Information System (GIS) to accurately locate and identify all:

- Mapped occupied polygons
- Mapped suitable polygons
- Surveyed polygons
- Surveyed routes (GPS tracks)
- Point data *
- Photo point data

*The BLM will not accept point data for special status plants with the following exception where points maybe used in the field if habitat is less than 10 square meters in size. If point data is provided, you must complete the field specifying the size of the point (to be buffered), or you can buffer the point prior to submitting the final reports to the BLM. The complete data and mapping requirements required by the BLM must be submitted by the contractor as described in the following paragraphs.

Special status plant survey mapping requirements: All special status plant species occupied and suitable habitat surveys shall use a resource grade GPS unit (i.e. Magellan, Ashtech, Trimble), for point, line, and polygon data collection. Special status plant species surveys can use a recreational grade GPS unit for survey routes (GPS tracks) only. However, using a mapping/resource grade GPS unit for survey routes (GPS tracks) is preferred by the BLM.

*Note: The BLM does not endorse any GPS manufacturer or GPS software.

Data acquired by the contractor using a mapping/resource grade GPS unit shall be post-processed (differentially corrected) by the contractor when using a mapping/resource grade GPS. The minimum data and map accuracy must be stated at the Root Mean Square Error (RMSE) 95% confidence level to be in compliance with the BLM's and Federal Geographic Data Committee (FGDC) reporting requirements.

The spatial accuracy of special status plant surveys is < 3 meters. The contractor must use the following GPS settings in-order to meet this data and map accuracy.

All positions should be logged according to the following specifications:

- PDOP of 6 is recommended, however if this is too low of a setting due to terrain, maximum
- PDOP can be set at 8
- Minimum of 5 Satellites, if satellite geometry is bad then it can be changed to a minimum of 4
- Minimum elevation mask of 15 degrees
- Minimum logging for points will be 60 positions at a 1 second interval
- Antenna height should be set to the appropriate height above the ground

The BLM realizes that special status surveys are often in very rugged terrain and that satellite geometry is not always good enough to meet the stated standards required by the BLM. In such cases the BLM does not require the area to be resurveyed by the contractor, and data acquired during the survey must have metadata describing the accuracy obtained.

Datum and Coordinate System must be summited by the contractor to the BLM according to the following specifications:

- Datum: NAD83
- Coordinate System: UTM Zone 13

The submitted GIS data by the contractor to the BLM must have written metadata for each dataset meeting ISO 19139 metadata format. For further information about the ISO 19139 Metadata Implementation Specification requirements, this is found in ArcGIS 10.x version metadata properties.

For special status plant species occupied and suitable habitats surveys, the WRFO staff will provide the contractor with an ESRI File Geodatabase that will have predefined domains (drop down menus) for all BLM required attributes for special status surveys. The contractor can use this Geodatabase to create AXF files for use on GPS units with ESRI ArcPad to conduct field surveys. If the contractor doesn't have ArcPad, then the WRFO must supply the contractor with a Trimble TerraSync Data Dictionary for point, line, and polygon features. At this time the WRFO can only support ESRI compatible GIS data and Trimble GPS units. However, the contractor may request technical support from WRFO GIS staff in-order for the contractor to meet these data requirements using non-Trimble mapping/resource grade GPS units.

The contractor before submission of completed survey data to the FO must fill out all field attributes of the appropriate feature classes supplied in the Geodatabase. This ensures that the botanist is collecting (electronically) the same data as requested by WRFO. GIS data submitted to the BLM from the contractor must be corrected for geometry errors for polygon features.

If the contractor chooses to use a recreational GPS unit for survey routes (GPS tracks), the contractor must populate all field attributes in the supplied ESRI Geodatabase (SSPS_Tracks_Ln (Line) and Weeds_Track_Ln (Line)). The data must be submitted to the BLM in the datum and Coordinate System specified previously.

IF the attribute table is incomplete or does not match the BLM geodatabase, the BLM will not accept the survey and send it back to the contractor to complete. The data will be normalized (e.g. everything must be spelled the same way with same format [same uppercase/lowercase should be used for names, etc]). Example within the same field: Observer Mary Ann Smith must be always be entered the same way every time as opposed to MAS vs mas vs marysmith with different surveys.

Special note about using recreational grade GPS units for survey routes:

Recreational GPS units record all data in WGS 84 Geographic Coordinate System ALWAYS! Once converted into a new ESRI shapefile, that new shapefile needs to match WGS 84 Geographic Coordinate System. The contractor must do a transformation on that "new" shapefile and project it to Datum: NAD 83, Coordinate System: UTM Zone 13, as the new Projected Coordinate System.

Due to the amount of data required for completion of special status plant species occupied and suitable habitat surveys the WRFO will provide the contractor with additional plant occurrence field forms. These forms are in addition to those already supplied by Colorado Natural Heritage Program (CNHP) and are intended by the WRFO to aid the contractor with filling out the large number of fields required for special status species occupied and suitable habitat surveys (polygons and points). The WRFO does not intend for these forms to be returned upon submission of completed survey data.

Noxious weed mapping requirements:

All noxious weed surveys must use a GPS unit with submeter accuracy for polygon and point data collection (mapping/resource grade GPS unit). Noxious weed surveys can use a recreational grade GPS unit for survey routes (GPS tracks) only. However, using a mapping/resource grade GPS unit for survey routes (GPS tracks) is preferred by the BLM.

Data acquired by the contractor using a mapping/resource grade GPS unit can be collected using real time differential collection mode of your GPS unit. If the contractor chooses to use a recreational GPS unit for survey routes (GPS tracks), the WRFO will provide the contractor with a predefined ESRI Geodatabase that the contractor shall populate with data collected during the survey. The data must be submitted to the BLM in the datum and Coordinate System specified previously.

For noxious weed plant surveys, the WRFO staff will provide the contractor with an ESRI File Geodatabase that shall have predefined domains (drop down menus) for all BLM required attributes for noxious weed surveys. The contractor can use this Geodatabase to create AXF files for use on GPS units with ESRI ArcPad to conduct field surveys. If the contractor doesn't have ArcPad, then the WRFO will supply the contractor with a Trimble TerraSync Data Dictionary for point, line, and polygon features. At this time the WRFO can only support ESRI compatible GIS data and Trimble GPS units. However, the contractor may request technical support from WRFO GIS staff in-order for the contractor to meet these data requirements using non-Trimble mapping/resource grade GPS units.

If the contractor chooses to use a recreational GPS unit for survey routes (GPS tracks), the WRFO will provide the contractor with an ESRI Geodatabase that the contractor must populate with data collected during the survey. The data must be submitted to the BLM in the datum and Coordinate System specified previously.

Special note about using recreational grade GPS units for survey routes:

Recreational GPS units record all data in WGS 84 Geographic Coordinate System ALWAYS! Once converted into a new ESRI shapefile, that new shapefile needs to be match WGS 84 Geographic Coordinate System. The contractor must do a transformation on that "new" shapefile and specify Datum: NAD 83, Coordinate System: UTM Zone 13, as the new Projected Coordinate System.

The submitted GIS data by contractor to the BLM must have written metadata for each dataset meeting ISO 19139 Metada Implementation Specification standards.

What are the BLM's noxious weed mapping standards?

The minimum data and map accuracy must be stated at the Root Mean Square Error (RMSE) 90% confidence level to be in compliance with the BLM's and Federal Geographic Data Committee (FGDC) reporting requirements.

Mapping standards for point features: Infestations of the same species must be forty (40) meters apart to be a unique infestation. If the distance is greater than (40) meters, the contractor must record the centroid of the infestations of <0.5 acre and estimate the size of the infestation according to the following 1 of 2 size groupings within the predefined BLM dataset. These 2 size groupings are:

<=0.1 acre
0.1-0.5 acre

If the estimated size of the infestation is >0.5 acre, then the contractor shall record the infestation as a polygon.

Mapping standards for polygon features: Infestations of the same species must be forty (40) yards apart to be a unique infestation. The contractor must record all infestations with a polygon if the infestation is greater than 0.5 acres.

All weeds positions should be logged according to the following specifications:

- Maximum PDOP 8
- Minimum of 4 Satellites
- Minimum elevation mask of 12 degrees
- Antenna height should be set to the appropriate height above the ground

Questions about these requirements can be directed to the WRFO GIS staff at 970-878-3800.

Occupied and Suitable Habitat Mapping for Special Status Plants:

Final report and maps should clearly provide the BLM with the surveyor's best professional judgment regarding mapping for occupied and suitable habitats for special status plant species and their associated flora. Suitable habitat may be found in defined potential habitat areas, if available, but may also occur outside of the known parameters for a given species' current habitat descriptions. (Example: Four new populations of *Physaria* were discovered in 2008, and more in 2009, by a contractor surveying on Channery loams. The loam provided a thin veneer covering the Thirteen-mile tongue of the Green River formation within habitat considered previously unsuitable and outside of mapped potential habitat.)

Suitable habitat and occupied habitat maps will reference habitat information that includes a general description of the area, plant communities, soil types and/or geological formations found, as well as elevation, aspect, slope, slope position, and a description of the area's surrounding vegetation. See the following table for *Physaria* species regarding survey requirements for the types of habitat. A description of five dominant plant species' associates (minimum) should be given for the mapped area and an estimate of their relative abundance (see Appendix B for a list of potential associated species with species codes).

All areas within buffers must be surveyed on foot using the suitable habitat guidelines found below. The surveyor may use GIS geologic data and/or satellite imagery to determine possible locations of the suitability survey requirements (the width of transects walked). However, areas may not be eliminated from ground surveys using satellite imagery.

WRFO

Only in areas with no potential habitat may survey transect widths of more than 50 m be used, with line of sight to ensure all slight outcrops of white shale are identified. This improves the potential of finding suitable habitat outside of the known parameters. Within the secondary potential areas, areas designated high, moderate, and marginal suitability due to other suitable habitat characteristics should be mapped. This accounts for the possibility of finding exposed green river formation tongues in unexpected areas (the 1:24,000 USGS maps are very crude and outdated). Secondary potential habitat is only for defining surveying transects widths and Uintah formations are not to be mapped. If black sulphur creek tongue is found suitable due to the other habitat characteristics, please map this as marginal. Even though threatened species have not been found on black sulphur creek tongue, we want to retain it as potentially habitat if either species expands their range to this substrate.

Other new guidelines to highlight:

- Suitable habitat patches smaller than 10 m by 10 m can be recorded by a point with all attribute information. Areas larger than 100 m^2, even slightly so, must be mapped by a polygon feature.
- Suitable habitat is considered on the following geologic potential *Physaria* spp habitat formations: 13 mile creek tongue, including upper and lower (Tgtu, Tgt, Tgl, Tgte), Yellow Creek member (Tgy), Dry Fork member (Tdg), Parachute Creek member (Tgp, Tgpl, Tgpu), and Garden Gulch member (Tgg, Tggl, Tggu).
- Secondary potential *Physaria* spp habitat (where marginal surveys are required) is considered on the following geologic formations (Uintah): Tu5, Tu4, Tu7, Tua, Tuc.
- Again, all the areas within the survey buffers must be walked and ground-truthed to account for any unknown exposed green river formation tongues.
- No recreation GPS units (e.g. Garmin) will be allowed for mapped habitat polygons.

Suitable Habitat Survey Guidelines for WRFO Physaria Species

Physaria congesta	Dudley Bluffs bladderpod	Late April – Late May	15 meters in high or moderate suitability habitat 30 meters in marginal habitat High and moderately suitable habitat should be mapped as polygons if larger than 100 square meters but can be mapped as a point if less than 100 square meters. Mapped areas should be identified as either high or moderate suitability. Only moderate suitability (where white shale outcrops occur, associated species, or other suitable characteristics) polygons needs to be mapped in marginal areas	**Section 7 Range** – based on the habitat model done by the Colorado Natural Heritage Program and geological formations **Comments** – Suitability cannot be determined when tongues are wet from any precipitation and so surveys should not be done during these times **High Suitability** (places where plants are often found) **Soils** – white shale barren **Tongues** – Thirteenmile Creek, Yellow Creek **Geology** – where the Thirteenmile Creek Tongue of the Green River Formation is exposed along downcutting drainages and level surfaces at the points of ridges or shelves **Aspect** – various, often south facing **Slope** – level surfaces at the points of ridges **Elevation** – 1,860 to 2,010 m (6,140 to 6,644 ft) **Habitat** – barren areas often with less than 5% vegetation (ground cover), although some sites in open pinyon-juniper with higher percent cover because of canopy **Common Associates** – *Pyrrocoma uniflora, Juniperus osteosperma, Phlox hoodia, Linum lewisii, Tetradymia canescans, Asclepias cryptoceras, Penstemon caespitosus, Astragalus lutosus* **Moderate Suitability** (places where plants are occasionally found) **Tongues -** Uintah (less white soils) but may have Thirteenmile Tongue nearby or just below; plants have been found in these areas; alluvial deposits associated with appropriate tongues. Possibility within 50 meters of highly suitable tongues. **Aspect** – various, north facing less suitable **Habitat** – higher vegetation cover (> 5%), sometimes among sparse bunchgrasses **Other** – Characteristics as above such as associated species **Proximity** – generally nearer to occupied habitat than marginal habitat **Marginal** (places with some suitable characteristics but where no plants have been found) **Tongues** – Uintah (Tua, Tuc, Tu4, Tu5, Tu7), Black Sulphur Tongue but this habitat appears suitable **Other** – Characteristics as above such as associated species **Proximity** – further from occupied habitat than moderate or high suitability habitat

Physaria obcordata	Dudley Bluffs twinpod	Mid May - June	20 meters in high or moderate suitability habitat 30 meters in marginal habitat although all slopes and aspects must be included in line of sight High and moderately suitable habitat should be mapped as polygons if larger than 100 square meters but can be mapped as a point if less than 100 square meters. Mapped areas should be identified as either high or moderate suitability. Only moderate suitability (where white shale outcrops occur, associated species, or other suitable characteristics) polygons needs to be mapped in marginal areas	**Section 7 Range** – based on the habitat model done by the Colorado Natural Heritage Program and geological formations **Comments** – Suitability cannot be determined when tongues are wet from any precipitation and so surveys should not be done during these times **High Suitability** (places where plants are often found) **Soils** – white shale barrens, deltaic and fluvial sandstones and siltstones **Tongues** – Thirteenmile Creek, Dry Fork, Garden Gulch, Parachute Creek, Yellow Creek **Geology** – where the Thirteenmile Creek Tongue and Parachute Creek Member of the Green River Formation are exposed along downcutting drainages **Aspect** – various, typically south facing **Slope** – moderate to steep slopes **Elevation** – 1,806 to 2,255 m (5,960 to 7,440 ft) **Habitat** - barren areas often with less than 5% vegetation (ground cover), although some sites in sagebrush-steppe alluvial areas (gullies) **Common Associates** – *Ericameria nauseosa, Mentzelia multicaulis, Pascopyrum smithii, Atriplex canescens, Cirsium barnebyi, Abronia argillosa, Achnatherum hymenoides, Eriogonum longifolium, Sphaeralcea coccinea, Astragalus lutosus* **Moderate Suitability** (places where plants have occasionally been found) **Tongues** – alluvial deposits associated with the tongues listed above; areas that are mapped as Green River but resemble Uintah **Aspect** – typically south, less often north **Slope** – flatter areas such as lower and upper slopes generally around occupied habitat **Other** – Characters as above such as associated species **Proximity** – generally closer to occupied habitat than marginal habitat **Marginal** (places with some suitable characteristics but where no plants have been found) **Tongues** – Uintah (Tua, Tuc, Tu4, Tu5, Tu7), Black Sulphur **Other** – Characters as above such as associated species **Proximity** – further from occupied habitat than moderate or high suitability habitat

KFO

All eight Threaten, Endangered or BLM Sensitive species that fall within the Kremmling Field Office should be surveyed prior to oil and gas permitting approval or any other ground disturbing activities. Of the eight species, North Park Phacelia *(Phacelia formosula)* is the main species of concern in that it is likely to have the highest chance of overlapping with potential oil and gas or other ground disturbing activities in North Park. North Park Phacelia is known to occur on eroded soil outcorps within the Coalmont Formation in Jackson County with some sightings in northwestern Larimer County. The most suitable habitat falls between 8,000 and 8,300 feet within a 10 by 10 mile area just west of Walden. The typical soils where plants have been found but not limited to are similar to that of the Tealson-Rock land association (Te), Fluetsch-Tiagos association (Fh), Cryorthents (CyF) or Coalmont-Fluetch complex (Cf). North Park Phacelia is a biennial, therefore it forms a rosette the first year and flowers during the second year. It can grow to a height not more than 12 inches. It typically flowers during July and extending into August. When found, plant counts for this species must include all rosettes and flowering plant tallies with GPS data as outlined in this document. Suitable habitat must also be mapped (using GIS) in its entirety as outlined in this document.

How should the inventory be documented?

A copy of the written report documenting results should be prepared and submitted to the WRFO Ecologist electronically. A hard copy report with a CD or jump drive may be requested by the WRFO BLM ecologist, addressed as ATTN: WRFO Ecologist. The report should include, at a minimum, the following information:

- Prepared for/Prepared by information, project name and well or lease number if applicable, date(s) of the inventory(s), personnel involved, and contact information.
- Discussion of special status plant species and/or significant natural plant communities searched for and any special status species/communities and weed species known or likely to occur in the project area. Discuss the characteristics in the suitability guideline for the threatened plant species.
- GIS- produced map with aerial or topographic map as the base layer showing the proposed disturbance boundary, survey perimeters for all disturbance areas, and known special status plant populations and/or noxious weed locations as points, lines or polygons as appropriate. Including:
    - Mapped occupied polygons
    - Mapped suitable polygons
    - Surveyed polygons
    - Surveyed routes (GPS tracks)
    - Point data (if provided, remember to specify size of area)
    - Photo point data
- Provide a route(s) map within the delimited survey area. This needs to include GPS/GIS data that include the specific linear paths surveyed. Contractor can refer to Mapping Requirements stated previously.
- Provide survey technique(s) used and clearly show the intensity of the inventory,

according to the suitability guidelines. In the results section, provide *written acreage* summations for survey area, mapped populations (occupied), habitats (suitable), and provide distances between the survey area populations and the suitable and occupied habitats respective to the surface disturbance in the written report. Include description(s) of the general habitat of the area, plant communities, dominant associated species, soil types, and/or geologic formations. Please provide a description of at least five dominant species' associates in the suitable and occupied mapped habitat areas and their estimated relative abundance.

- If federally listed (occupied) plants are within 600 m of the Proposed Project, an analysis using the USFWS Plant Guidance must be completed and provided to the WRFO. Sections III, IV, and V of the Plant Guidance must be completed with this plant survey report. All maps and figures must be provided, as well as the GIS to complete the analysis. (If your firm has been contracted to also write the Biological Assessment, then you are not required to complete this step since you will be completing it for the BA).
    - Included in the analysis is the following requirement from past plant survey protocols (previous to 2013): The BLM must collect and analyze all surface disturbance, past and present, by all proponents, to determine total surface disturbance within 600 meters of a given project area. Therefore, it is necessary to include specific spatial data, within 600 meters of the edge of the proposed disturbance, to include all existing access roads, pipelines, wellpads, and other infrastructure, as part of the final report. This should include an estimate of total acreage disturbed, number of occupied acres within 600 m of the project, and number of suitable acres within 600 m of the project. This data should be included for the proponent company's disturbance acreage, the BLM will compile additional needed information from NAIP and other datasets.
- If habitat (occupied or suitable) may potentially be removed by the proposed project, please provide the exact count of plants to be removed and exact acreage of habitat (occupied or suitable) to be removed.
- If special status species are **not** found, include a thorough assessment of whether or not the site is believed to contain potential or suitable habitat, and a clear rationale for this determination.
- At times it is not possible to ascertain whether a specific project location comprises potential habitat based on available maps and other data. If, during the site visit it is determined that the area **clearly** does not contain special status plant habitats, the rationale must be well-documented. Please keep in mind that new populations or individuals of special status plants have been located in habitats previously discounted.
- GPS should be used to accurately map special status plant habitats and noxious weeds found in the project area. GPS data should be submitted as noted in the mapping section. The contractor must complete all fields in the BLM supplied Geodatabase for each feature class pertaining to that specific survey type. <u>GPS units (with sub-meter accuracy) should be used to accurately record locations of special status plant habitats and noxious weeds occurrences.</u> In ALL cases the data must be submitted either in UTM Zone 13N, NAD 83, in units of meters. If digital elevation data is submitted, a vertical datum is needed as a reference.

- If a reference population is used, provide a written narrative describing the population used, date and useful observations. Please include the location on one of the digital maps referenced in the report.
- **(Optional):** Although it is not required at this time, if ground nesting bees are observed, other flowering species should be noted in abundance within 1 km of occupied or suitable habitats, delineation and notation of this information would be useful to the BLM and the USFWS.
- For BLM Sensitive species on known or in new populations, metadata and reports should provide an estimate of the number of individuals of the species per occupied unit area with clearly demarcated suitable habitat as noted above. Surveys should include digital photos, clearly labeled with a GPS location and date. Information should accompany the photos that include close-up and a local area view of the special status plant species in their associated habitats and photos of unoccupied suitable habitats, as mapped, to support of the final report.
- If *new* individuals or populations of Threatened, Proposed, or Candidate species are located, contact the WRFO Ecologist for survey intensity requirements within the population or occurrence. Subsequent findings, metadata and reports should also provide an estimate of the number of individuals of the species per occupied unit area, survey techniques used, survey estimation strength based on technique selected, and clearly demarcated suitable habitats as noted above. Contractors will provide digital photos, clearly labeled with accompanying metadata as above, of the species in occupied habitats and photos of unoccupied suitable habitat, to support information and descriptions in the report.
- Contractors are required to document *new* special status plant species, occurrences and/or populations by completing a Plant Field Form available on the Colorado Natural Heritage Program (CNHP) website under the "*Data Requests and Environmental Review*" section, subset "*Field Data Submission Forms*". Please submit forms directly to the CNHP program, and provide a legible copy to the WRFO Field office in your report. Documentation of determinations and/or voucher specimens may be useful in cases of taxonomic ambiguities, habitat or species range extensions. Vouchers for BLM Sensitive plant species should be collected with the approval of the Colorado BLM State Botanist and the WRFO Ecologist or via a USFWS Section 10 permit for Threatened plant species. In no cases should Threatened plants, plant parts, soils or seeds be removed from an occurrence without obtaining prior written approval.
    - You may use the CNHP Plant Field form as a field data collection form to enter any info into the GIS database at a more convenient time.
    - **Vouchering. For Threatened species, a Section 10 permit is necessary from the USFWS prior to any removal, including seeds. For BLM Sensitive species, CO State rare, or other plants, the CU Boulder herbarium is a good depository for new locations and rare species found in Rio Blanco, Moffat, Grand and Jackson Counties. The Denver Botanic Garden and the Smithsonian will also do timely vouchering. Please be certain to share any vouchering information with the Colorado Natural Heritage Program on their forms, so the state database will reflect the records.

- Additional photographs and descriptors of the project area may be included that provide information on soil biological crusts, unique or significant natural plant communities, and/or creative mitigation ideas. State listed species may also be provided, and are appreciated, but are not required.
- It is understood that the **responsibility for the survey performance rests with the contractor(s) and their personnel, by having a thorough understanding of floristic field identification skills.** Prompt submission of survey results will allow for spot-checking for location and identification accuracy and may be performed by WRFO Ecologist or designee prior to final acceptance of reports. Failure to provide timely and complete survey reports may directly result in the delay of approval for projects, and/or additional survey requests.
- HAVE FUN and be safe out there!

If you have questions or need assistance please feel free to contact the WRFO. We look forward to working with you in 2019 and beyond.

White River Field Office – All Oil and Gas Projects
220 Market Street
Meeker, CO 81641
Fax: 970-878-3805
Phone: 970-878-3800
Email GIS reports to: Eric Allen, eallen@blm.gov
Email survey reports to: Heather Woodruff, hwoodruff@blm.gov

Little Snake Field Office
455 Emerson Street
Craig, Colorado 81625
Phone: 970-826-5071
Fax: 970- 826-5002
Email survey and GIS reports to: Aimee Huff, ahuff@blm.gov

Kremmling Field Office
2103 E. Park Avenue
P.O. Box 68
Kremmling, Colorado 80459
Phone: 970-724-3028
Fax: 970-724-3066
Email survey and GIS reports to: Vacant at this time, call field office for contact.

Citation: White River Field Office Document, "Standards for Contractor Inventories for Special Status Plant Species and Noxious Weed Affiliates, Field Season 2019.

Kent E. Walter 06/04/2019
Kent E. Walter
Field Manager-White River Field Office

Bruce Sillitoe
Field Manager- Little Snake Field Office

Bill Mills
Field Manager- Kremmling Field Office

Appendix A

WRFO, LSFO, KFO Special Status Plant Species for 2019

	Common Name	Scientific Name	Status	County	Blooming Season
WRFO	Dudley Bluffs bladderpod	*Physaria congesta*	Threatened	Rio Blanco	Mid April – May
WRFO	Dudley Bluffs twinpod	*Physaria obcordata*	Threatened	Rio Blanco	Mid May – late June
WRFO	Ute Ladies'-tresses	*Spiranthes diluvialis*	Threatened	Moffat, Larmier	Early July – October
WRFO	White River beardtongue	*Penstemon scariosus var. albifluvis*	Proposed	Rio Blanco	Late May – June
WRFO	Graham's beardtongue	*Penstemon grahamii*	Proposed	Rio Blanco	Late May – early June
WRFO	Narrow-stem gilia	*Aliciella stenothyrsa*	BLM Sensitive	Rio Blanco, Mesa	Late May – June
WRFO/ LSFO	Duchesne milkvetch	*Astragalus duchesnensis*	BLM Sensitive	Moffat, Rio Blanco	Late April – June
WRFO/ LSFO	Debris milkvetch	*Astragalus detritalis*	BLM Sensitive	Moffat, Rio Blanco	Late April – mid June
WRFO/ LSFO	Tufted cryptantha	*Cryptantha caespitosa*	BLM Sensitive	Moffat	Late April – June
WRFO	Rollins' cryptantha	*Cryptantha rollinsii*	BLM Sensitive	Moffat, Rio Blanco	May – June
WRFO/ LSFO	Ephedra buckwheat	*Eriogonum ephedroides*	BLM Sensitive	Rio Blanco	June – July
WRFO	Cathedral Bluffs dwarf gentian	*Gentianella tortuosa*	BLM Sensitive	Rio Blanco	July – August
WRFO	Piceance bladderpod	*Lesquerella parviflora*	BLM Sensitive	Garfield, Rio Blanco	June – early July
WRFO/ LSFO	Flaming Gorge evening primrose	*Oenothera acutissima*	BLM Sensitive	Moffat	May – June
WRFO/ LSFO	Colorado feverfew	*Parthenium ligulatum*	BLM Sensitive	Moffat, Rio Blanco	May – June
WRFO	Cathedral Bluff meadow rue	*Thalictrum heliophilum*	BLM Sensitive	Garfield, Rio Blanco	June – July
WRFO	Bessey locoweed	*Oxytropis besseyi var.*	BLM Sensitive	Moffat	May – July

		obnapiformis			
LSFO	Hairy Townsend daisy	*Townsendia strigosa*	BLM Sensitive	Moffat	May – June
LSFO	Rock tansy	*Sphaeromeria capitata*	BLM Sensitive	Moffat	May – July
LSFO	Gibbens' beardtongue	*Penstemon gibbensii*	BLM Sensitive	Moffat	June – Sept.
LSFO/ WRFO	Colorado feverfew	*Parthenium ligulatum*	BLM Sensitive	Moffat, Rio Blanco	May – June
LSFO/ WRFO	Flaming Gorge evening primrose	*Oenothera acutissima*	BLM Sensitive	Moffat	May – June
LSFO	Clay hill buckwheat	*Eriogonum viridulum*	BLM Sensitive	Utah but to be expected in Moffat	July – October
LSFO	Woodside buckwheat	*Eriogonum tumulosum*	BLM Sensitive	Moffat	Late April – early July
LSFO	Singlestem buckwheat	*Eriogonum acaule*	BLM Sensitive	Moffat	May – July
LSFO	Uinta Basin springparsley	*Cymopterus duchesnensis*	BLM Sensitive	Moffat, Rio Blanco	Late April – May
LSFO/ WRFO	Tufted cryptantha	*Cryptantha caespitosa*	BLM Sensitive	Moffat	Late April – June
LSFO/ WRFO	Duchesne milkvetch	*Astragalus duchesnensis*	BLM Sensitive	Moffat, Rio Blanco	Late April – June
LSFO	Yampa beardtongue	*Penstemon acaulis var. yampaensis*	BLM Sensitive	Moffat	Late May – early July
KFO	North Park Phacelia	*Phacilia formosula*	Endangered	Jackson, Larimer	June – August
KFO	Kremmling milkvetch	*Astragalus osterhoutii*	Endangered	Grand	Late May – July
KFO	Pendland beardtounge	*Penstemon pendlandii*	Endangered	Grand	Late May – June
KFO	Crescent Bugseed	*Corispermum navicula*	BLM Sensitive	Jackson	Late July – September
KFO	Fragile rockbrake	*Cryptogramma stelleri*	BLM Sensitive	Eagle, Garfield, Grand	New growth in spring
KFO	Harrington's Penstemon	*Penstemon harringtonii*	BLM Sensitive	Eagle, Garfield, Grand, Pitkin,	Late May – June

				Routt, Summit	
KFO	Pale blue-eyed grass	*Sisyrinchium pallidum*	BLM Sensitive	Jackson, Larimer	Mid June – July

*County data is based on Ackerfield's *Flora of Colorado*, 2015 and is determined on the best available data. At times, species may be found outside the listed counties.

Appendix B

Associate *Physaria obcordata and congesta* plant species and corresponding species codes

Scientific Name	**Code**
Abronia argillosa	ABAR
Achnatherum hymenoides	ACHY
Agropyron cristatum	AGCR
Aletes anisatus	ALAN3
Alyssum alyssoides	ALAL3
Amelanchier utahensis	AMUT
Antennaria spp	ANTEN
Artemisia frigida	ARFR4
Artemisia tridentata	ARTR2
Asclepias cryptoceras	ASCR
Astragalus lutosus	ASLU2
Astragalus spatulatus	ASSP6
Astragalus_spp	ASTRA
Atriplex confertifolia	ATCO
Bassia hyssopifolia	BAHY
Bromus tectorum	BRTE
Cercocarpus montanus	CEMO2
Chaetopappa ericoides	CHER2
Chamaesyce glyptosperma	CHGL13
Chenopodium berlandieri	CHBE4
Chrysothamnus viscidiflorus	CHVI8
Cirsium barnebyi	CIBA
Cirsium undulatum	CIUN
Cryptantha flavoculata	CRFL6
Cryptantha humilis	CRHU2
Elymus elymoides	ELEL5
Ephedra sp	EPHED
Ericameria nauseosa	ERNO10
Erigeron compositus	ERCO4
Eriogonum lonchophyllum	ERLO4
Euphorbia brachycera	EUBR
Galium spp	GALIU
Gutierrezia sarothrae	GUSA2
Halogeton glomeratus	HAGL
Hesperostipa comata	HECO26
Hordeum jubatum	HOJU
Hymenopappus filifolius	HYFI
Juniperus osteosperma	JUOS
Juniperus scopulorum	JUSC2
Koeleria macrantha	KOMA
Krascheninnikovia lanata	KRLA2
Linanthus pungens	LIPU11
Linum lewisii	LILE3
Lonicera morrowii	LOMO2
Lupinus argenteus	LUAR3
Machaeranthera grindelioides	MAGR2
Mahonia repens	MARE11
Mentzelia dispersa	MEDI
Mentzelia multicaulis	MEMU2
Oenothera villosa	OEVI
Packera cana	PACA15
Pascopyrum smithii	PASM
Penstemon caespitosus	PECA4
Penstemon pachyphyllus	PEPA6
Penstemon watsonii	PEWA
Phacelia sericea	PHSE
Phlox hoodii	PHHO
Physaria acutifolia	PHCA4
Physaria congesta	PHCO
Physaria obcordata	PHOB
Physaria subumbulata	LESU
Pinus edulis	PIED
Pseudoroegneria spicata	PSSP6
Pseudotsuga menziesii	PSME
Purshia tridentata	PUTR2
Pyrrocoma uniflora	PYUN2
Quercus gambelii	QUGA
Rhus trilobata var trilobata	RHTRT
Sarcobatus vermiculatus	SAVE4
Sphaeralcea coccinea	SPCO
Stephanomeria runcinata	STRU3
Streptanthus cordatus	STCO6
Symphoricarpos rotundifolius	SYRO
Tetradymia canescens	TECA2

Exhibit 3. U.S. Fish and Wildlife Service (USFWS) Utah Field Office Guidelines for Conducting and Reporting Botanical Inventories and Monitoring of Federally Listed, Proposed and Candidate Plants, August 31, 2011

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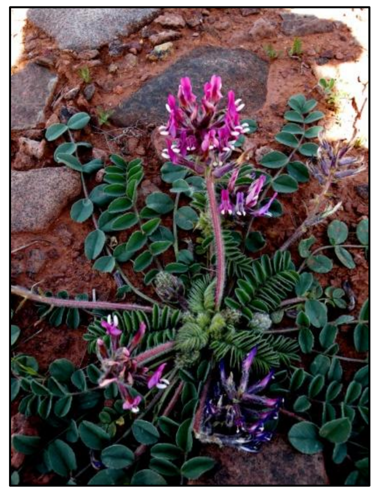
U.S. Fish and Wildlife Service (USFWS) Utah Field Office Guidelines for Conducting and Reporting Botanical Inventories and Monitoring of Federally Listed, Proposed and Candidate Plants

August 31, 2011

Barneby ridge-cress
Jessi Brunson, USFWS

Jones cycladenia
Daniela Roth, USFWS



Holmgren milk-vetch
Daniela Roth, USFWS

Uinta Basin hookless cactus
Bekee Hotze, USFWS

Dwarf bear-poppy
Daniela Roth, USFWS

Last chance townsendia
Daniela Roth, USFWS

INTRODUCTION AND PURPOSE

These guidelines were developed by the USFWS Utah Field Office to clarify our office's minimum standards for botanical surveys for sensitive (federally listed, proposed and candidate) plant species (collectively referred to throughout this document as "target species"). Although developed with considerable input from various partners (agency and non-governmental personnel), these guidelines are solely intended to represent the recommendations of the USFWS Utah Field Office and should not be assumed to satisfy the expectations of any other entity.

These guidelines are intended to strengthen the quality of information used by the USFWS in assessing the status, trends, and vulnerability of target species to a wide array of factors and known threats. We also intend that these guidelines will be helpful to those who conduct and fund surveys by providing up-front guidance regarding our expectations for survey protocols and data reporting. These are intended as general guidelines establishing minimum criteria; the USFWS Utah Field Office reserves the right to establish additional standards on a case-by-case basis.

Note: The Vernal Field Office of the BLM requires specific qualifications for conducing botanical field work in their jurisdiction; nothing in this document should be interpreted as replacing requirements in place by that (or any other) agency. Contact the BLM for additional information when working in areas under that agency's jurisdiction.

I. PERSONNEL QUALIFICATIONS

If the work is performed under contract, resumes should be included for every surveyor who will be working on a botanical survey or monitoring project. Resumes should include educational background (colleges and universities attended, and any diplomas and degrees received), botanical survey work history, and any related work experience. The following minimum qualifications are recommended:

A. Field Crew Leaders

Field crew leaders must meet the same qualifications as a botanist working for the Federal government (Botanist series 0430), namely:

- Degree: botany; or basic plant science that included at least 24 semester hours in botany. Two field seasons of surveying experience for special status species in the geographic area are highly recommended.

OR

- Combination of education and experience -- courses equivalent to a major in botany or basic plant science that included at least 24 semester hours in botany, as shown in A above, plus appropriate experience or additional education. Two field seasons of surveying experience for special status species in the geographic area are highly recommended.

Field crew leaders must be present with their crew during surveys and must have the ability to identify vascular plant species using whatever means necessary (e.g., dissecting microscopes, technical keys, and monographs, etc.). A crew leader should supervise no more than 5 technicians/field assistants. Crew leaders should possess a wide array of skills necessary to plan, oversee and conduct vascular plant surveys, particularly: training and experience with vascular plant survey methods; familiarity with the flora and geological formations of Utah; and the knowledge and ability to locate and identify target plant species.

Section III (GPS Data) establishes minimum standards for documenting and reporting survey efforts using GPS/GIS technology. Field crew leaders must either possess the skills to document the work of their entire crew in accordance with these standards, or ensure that at least one member of their crew is capable of doing this on behalf of the entire field crew.

B. Technicians/Field Assistants

Field assistants must possess at least one year of biological coursework at the college level, to include:

- At least 6 semester hours in any combination of scientific or technical courses (biology, entomology, geology, or botany); and
- At least 1 course in plant taxonomy

Field assistants must have the ability to recognize special status plant species in Utah and use technical botanical keys appropriate to the area. While it is not necessary for every field assistant to possess GPS skills, every assistant should be capable of supporting the field crew's efforts to document surveys using field notes, paper maps, GPS, or other means necessary (see Section III for more information on how location data should be documented and reported).

II. SURVEY GUIDELINES

In this section, we first describe general survey guidelines applicable to most botanical surveys. These are followed by recommendations specific to three types of survey efforts frequently conducted for special status plant species: clearance surveys, status surveys, and monitoring efforts.

The recommendations in this section specifically address information that should be gathered while in the field. Sections III and IV addresses how this information should be summarized for purposes of reporting.

A. General guidelines

1. Botanical surveys must be conducted in a manner that will maximize the likelihood of finding target species. For example, one of the most common reasons that we consider surveys inadequate is because they were conducted during portions of the year when

target species were not visible. Refer to Appendix A for appropriate species-specific survey dates based upon flowering and/or fruiting periods.

2. Multiple site visits may be necessary during a single field season to ensure that surveys are conducted during the appropriate life stage (usually flowering or fruiting) of all target species in the area.
3. Reference populations (i.e., other known occurrences of the target species) must be visited to confirm that target species are flowering, fruiting, or otherwise identifiable prior to initiating surveys. Reference populations should be documented with digital photos of the target species and habitat. For assistance in locating a reference population, contact the land management agency or the USFWS species lead (http://www.fws.gov/utahfieldoffice/EndSppLeads.html).
4. Document the overall biological setting, plant communities, topography, and soils, and any other environmental conditions (e.g., local precipitation patterns) that could influence the emergence of (and therefore the ability to detect) target species. To the maximum extent practical, include a comprehensive list of other vascular plant species associated with the areas where focused surveys were conducted for target species.
5. Document the level of survey effort, including the number of persons involved and the amount of time spent conducting surveys for target species.
6. At the outset, define whether the target species will be counted by clumps, rosettes, vegetative stems, flowering stems, and/or some other unit. Clearly indicate the unit used for all counts in all field notes and data collection forms.
7. Obtain separate counts of alive/dead, vegetative/reproductive, and adult/juvenile plants. Identify the life stage of all individuals of the target species that are located on the surveys. If actual seedlings (evidenced by cotyledons) are observed, make specific note of this important piece of evidence that recruitment is occurring.
8. Document the presence of target species using GPS. Refer to Section III (GPS Data).
9. Document the presence of target species with at least one high quality photograph of the plant and one of occupied habitat. If a large area is covered during the survey, take photographs at a representative number of locations, and make note of the unique identifier(s) of photos taken at specific GPS coordinates.
10. Photographs used in place of actual voucher specimens should be of sufficient scale and resolution to show the identifying characteristics of the given target species. Physical collection of plants (actual voucher specimens) may be necessary in cases of taxonomic ambiguities, habitat or range extensions. However, the collection of federally listed species on Federal lands requires a permit from the USFWS and typically also requires a permit from the Federal land management agency. Ensure that you have all necessary permits before collecting voucher specimens.
11. If species that could be confused with the target species are observed within the areas surveyed, identify them (by scientific name), and describe how these species were distinguished from the target species.
12. Specifically note the presence of existing or potential threats to the target species or its habitat (e.g., invasive exotic species, grazing, unmanaged or excessive recreational use). Assess the relative severity of these threats across all sites surveyed. If multiple threats are present at a given location, assess the relative importance of each threat at that site.

13. Use standard field forms for field observations, with clear and standardized means of assessing presence/absence and abundance of target species at a given location. Refer to Appendix C for some examples of commonly used field data collection forms.

B. Clearance surveys

The objective of clearance surveys is to cover 100% of a given project area to determine presence of target species, and their distribution and abundance prior to ground-disturbing activities. These surveys are particularly used to document compliance with the provisions of Section 7 of the Endangered Species Act. Therefore, clearance surveys represent the primary means of assessing a proposed action's direct, indirect and cumulative effects to target species.

"Project area" refers to the specific area in which impacts may occur to target species in association with a proposed activity. As such, project areas may be linear features (e.g., rights-of-way) or polygons (e.g., well pads).

1. Clearance surveys must include an assessment of all potential habitat within the project area, including a buffer. The standard buffer for clearance surveys is 300 feet from the project area, however the necessary buffer may vary depending on the scope of the project and target species. For additional guidance and to define an appropriate buffer, contact USFWS species lead in our office prior to conducting surveys (http://www.fws.gov/utahfieldoffice/EndSppLeads.html).
2. Clearance surveys are typically conducted by walking belt transects (of a fixed width) throughout all areas of potential habitat. Refer to Appendix A for species-specific transect widths to be used in clearance surveys. Use of other survey techniques may be appropriate in limited instances, however these exceptions must be discussed ahead of time with our office and the lead action agency.
3. Unless otherwise specified by our office, clearance surveys are valid for a period of one year.
4. If the target species is not found, clearly indicate whether or not the surveyed habitat appeared suitable for the target species, and provide photographic documentation:
    a. If habitat appeared suitable but the target species was not observed, indicate whether or not the species may have gone undetected, and why. Asses the likelihood that the target species was present but undetected.
    b. If surveyed habitat is deemed unsuitable for the target species, provide an explanation of the criteria used for making this determination.
5. Recognize that adverse conditions may prevent field crews from determining presence or identifying some target species in areas of potential habitat. Disease, drought, predation, or herbivory may preclude the presence or identification of target species in any year. We may require botanical inventory(-ies) in subsequent year(s) if adverse conditions likely reduced the ability to observe the target species in areas of potential habitat(s). Discuss such conditions with our office's species lead and the lead action agency.
6. If the target species is present and is associated with wetlands, make note of the direction and integrity of flow of surface hydrology. If the target species is (are) affected by off-site hydrological influences, make note of these factors.

C. Status surveys

Status surveys document the distribution and abundance of one or more target species over a specific geographic area at a specific point in time. Status surveys typically consist of visits to previously known locations and areas not previously known to be occupied. These surveys usually encompass a substantial portion of the total known range of the species, and frequently the entire range. Relative to clearance surveys and most monitoring efforts, status surveys tend to involve less intensive survey effort at any given site, in exchange for surveying across a wider geographic area (i.e., larger number of potential sites). Status surveys are similar to monitoring efforts (see the section on monitoring, below) in that they can involve repeated observations at the same location(s) over time, but are typically less quantitative. Although every effort should be made to conduct status surveys in a manner that enables some degree of assessment as to whether conditions have changed relative to previous surveys, these types of surveys primarily characterize only coarse spatial patterns as opposed to the fine-scale, quantitative trends in populations that monitoring efforts seek to detect.

1. Status report surveys must include visits to all known populations/sites within the geographic scope of the survey effort; usually this means visits to all known (current and historical) populations of the species.
2. To the maximum extent possible, these surveys should also include visits to areas with the potential to contain the target species (potential habitat). Criteria used to identify potential habitat (prior to field surveys) should be explicitly stated.
3. While in the field, all areas identified as potential habitat should be assessed for the presence of the target species (e.g., occupied habitat). Areas found not to contain the target species should be assessed for the presence of conditions suitable for the target species (e.g., suitable habitat that is apparently unoccupied).
4. While in the field, make note of existing and former patterns of land use within the surrounding landscape.

In addition to documenting the presence of target species, characterize the density and abundance of the target species in absolute numbers (e.g., via direct and precise counts) or in relative terms (e.g., by estimates using standardized categorical ranges). Structure field observations to provide meaningful comparisons of abundance and density among all locations visited during the course of the survey.

D. Monitoring surveys

In contrast to clearance or status surveys, “monitoring” typically involves structured, repeated assessments of a target species in a manner that investigates the species response to one or more environmental or human-caused factors. Monitoring programs can take many different approaches depending upon the target species, the number of monitoring locations, site conditions, and the objectives of the effort. The nature of the questions being addressed and the level of certainty expected from the data will largely dictate the methods used. Refer to Appendix B for some resources that may assist in the design of monitoring objectives and sampling regimes; a review of the principles and contents of these sources is beyond the scope of these guidelines.

There are fundamental components of any successful monitoring program. At a minimum, monitoring efforts must consist of the following:

1. Monitoring plans must be developed prior to initiating the effort. Section IV contains specific recommendations for the basic components of a monitoring plan.
2. Monitoring reports must be produced for each discrete period of data collection (typically annually), in accordance with the frequency specified in the monitoring plan. Section IV provides general reporting guidelines, as well as reporting recommendations specific to monitoring efforts.
3. Electronic files (spreadsheet format) must be developed to track and evaluate the raw data.
4. Adaptive management mechanisms must be in place for key parties (agencies and their contractors) to review and comment on the monitoring program, and to revise the program as necessary. In most instances, this should consist of regular face-to-face meetings among appropriate personnel, with site visits as needed.

III. GPS DATA: DATA COLLECTION AND REPORTING

While in the field, the location information of target species must be documented according to the standards set by Utah's Geospatial Technical Committee. This committee, which is made up of Federal, State, and County officials, has standardized data collection for our state to be in UTM Zone 12, NAD 83. The location, expressed in x (or easting) and y (or northing) coordinates, and additional site/attribute data should be provided in electronic file format. Electronic data must be provided in a manner that allows them to be directly imported into a GIS without the additional time and error associated with transcription. At a minimum, location data must be reported as follows:

1. A statement indicating the make, model, precision capabilities (e.g., recreational, mapping, or survey grade) and the datum and coordinate system of the GPS used to collect the data.
2. The electronic file containing location coordinates must be provided in one of the following *electronic* file formats:
    i. any one of the many commonly used file formats for vector data (e.g., shapefile, coverage, feature class, geodatabase, digital line graph, computer-aided design (CAD, or AutoCAD)),
    ii. a spreadsheet, or
    iii. a delimited text file.
3. Each unique location (whether a point, line or polygon) must be accompanied by the following information in separate fields:
    i. unique location identifier (e.g., waypoint number, ID field, etc.)

ii. target species present

iii. date of observation

iv. waypoint accuracy, in meters

v. unique photo identifier (e.g., filename of any photographs associated with that specific location)

vi. the number of plants at that location (if data is collected separately by seedling/juvenile/vegetative/flowering/fruiting, these data should be presented in separate fields with field names clearly identifying the nature of the data in that field)

vii. comments on threats to the target species (as appropriate, if specific to a given location)

viii. comments on the vigor of the target species (as appropriate, if specific to a given location)

ix. additional fields, as necessary

GPS data should be differentially corrected while in the field (using real-time methods) or postprocessed later in the office before being submitted to our office. Refer to the following URLs for background information for, and methods of, differential correction:

http://www.esri.com/news/arcuser/0103/differential1of2.html

http://www.spatial-ed.com/gps/gps-basics/135-differential-correction-methods.html

If the GPS data contains a combination of positive and negative survey data (with respect to the presence of target species), it should be possible to quickly identify negative survey data by querying or sorting on a single field – this should not require manual review and sorting of records based upon narrative data found in one or more comment fields (or the accompanying report).

IV. REPORTING

A. <u>General Guidelines</u>

Regardless of the type of survey (or monitoring) effort being conducted, botanical field reports must include:

1. A description of the biological setting, including plant community, topography, soils, potential habitat of target species, and an evaluation of environmental conditions, such as timing or quantity of rainfall, which may influence the performance and expression of target species.
2. An overview map showing the location(s) surveyed, with sufficient scale and resolution for someone unfamiliar with these areas to locate them.
3. Survey methodologies and dates.

4. A description of the level of survey effort, specifically including the number of people conducting surveys and amount of time spent surveying each project area.
5. If the survey encompasses current or historical locations for the target species that were previously mapped by the Utah Natural Heritage Program (UNHP), provide a map depicting the specific locations where UNHP mapped the species, accompanied by a unique UNHP identifier (typically the Element Occurrence number) for each location. In the map and accompanying report, clearly indicate whether the survey results include new locations, or updated information for previously mapped locations.
6. A summary of abundance (count) data for the target species, with separate tallies for alive/dead, vegetative/reproductive, adult/juvenile. The unit of measurement (clumps, rosettes, stems, or other) should be clearly specified.
7. Assessments of the vigor of the target species (e.g., disease, predation, and/or mortality), regardless of whether the causes are known. If certain factors are suspected as contributing to these patterns, identify them and assess the likelihood that they are actually contributing to reduced vigor in the target species.
8. Assessments of threats to the target species (e.g., invasive exotic species, unmanaged and excessive recreational use, over-grazing, etc.). To the extent possible, distinguish between threats that are clearly affecting the status (vegetative vigor and/or reproduction) of the target species, and those that are present but do not yet appear to be affecting the target species.
9. Copies of field data sheets.
10. Electronic copies of all photographs. Photographs captured using film (as opposed to digital) cameras should be scanned at high resolution, and saved in a universally recognized file format for images (e.g., JPEG, TIFF, etc.).

Copies of the full report (including appendices) should be sent to:

- Utah Natural Heritage Program (with copies of NHP field survey forms)
- Applicable/affected land owners and/or management agencies
- USFWS Utah Field Office (mailing address: 2369 West Orton Circle, West Valley City, Utah 84119).

B. <u>Clearance Surveys</u>

In addition to the general guidelines above, reports for clearance surveys should also include:

1. Map(s) depicting the specific properties surveyed, with the following information clearly indicated:
   i. Scale bar and map orientation (e.g., North arrow)
   ii. Project/parcel boundaries
   iii. Map quadrangle name
   iv. Specific areas where target species was found to be present, with clear relationships to areas to be affected by project activities.
2. Descriptions of the spatial extent (in acres or river/stream miles, as appropriate) of habitats occupied by the target species;

3. Descriptions of the spatial extent of apparently suitable but unoccupied habitat;
4. Comprehensive list of vascular plant species occurring on the project site, by habitat (plant community) type;
5. Assessments of the overall biological significance or ecological quality of the project site, in a local and regional context;
6. Assessments of the significance of the project site to the target species, in a local and regional (range-wide) context; and
7. Descriptions of the direction and integrity of flow of surface hydrology, particularly if the target species are associated with wetlands. If target species is (are) affected by adjacent off-site hydrological influences, describe these factors.

C. Status Surveys

In addition to the general guidelines above, status survey reports should also include:

1. Assessments of the ecological condition and integrity of the landscape(s) in which surveyed locations occur, with specific emphasis on patterns of disturbance or fragmentation, or other threats to the ecosystem (e.g., invasive exotic species, unmanaged and excessive recreational use, over-grazing, etc.).
2. Assessments of land use(s) within the larger landscape as well as the specific areas of occupied and potentially suitable habitat.
3. Assessments of the relative density of target species among all areas surveyed.
4. Separate calculations of the acres of occupied habitat of the target species at each discrete survey location and cumulatively over all areas surveyed. The appropriate geographic scales at which to summarize this information will require professional judgment as well as coordination with our office and the entity funding the survey.
5. Assessments of how each of the above factors has changed relative to any prior status surveys conducted for the target species (this is the historical reference point against which all assessments of current conditions should be gauged). However, these discussions should appropriately state any known limitations in comparisons to prior surveys (e.g., different survey methods, different personnel, climate conditions such as drought). Refer to the discussion under Section II.C regarding these and other cautions, and do not overstate the ability to detect changes in abundance or density of the target species (or other factors).

Draft copies of status reports should be circulated to our office's species lead for preliminary review and comment. Failure to satisfactorily address our comments in final versions may result in these reports not being accepted by our office.

D. Monitoring Reports

Because monitoring activities usually involve repeated assessments of a target species over a period of time that usually spans several years, clear and consistent reporting of monitoring activities is particularly challenging. Although monitoring programs will vary significantly depending upon a variety of factors (as discussed above), nearly every monitoring effort must be accompanied by the following documents:

1. Monitoring plan describing:
   - i. objective(s) of the effort;
   - ii. methods of data collection, a rationale for the methods chosen and a brief discussion of any alternative methods considered but rejected;
   - iii. questions to be addressed during data analysis;
   - iv. anticipated frequency of data collection and reporting;
   - v. format for monitoring reports; and
   - vi. entity(-ies) responsible for conducting monitoring, analyzing and reporting on the monitoring data, and distributing the monitoring reports.

2. Monitoring reports that include:
   - i. A format modeled after peer-reviewed scientific papers, with an Introduction, Materials/Methods, Results, and Discussion sections;
   - ii. References to applicable monitoring plans, and explain any deviations from those plans;
   - iii. References to prior years of monitoring reports, as applicable;
   - iv. Map(s) of monitoring locations at a sufficient spatial scale that someone unfamiliar with these areas could locate them;
   - v. Summaries of data for the most recent period of data collection (in tabular, graphical and narrative format, as appropriate);
   - vi. Analysis of apparent trends over the entire period of time for which data are available;
   - vii. Assessments of apparent threats to the target species, and the relative severity of these threats;
   - viii. Specific, focused assessments of
     - 1) management recommendations, and
     - 2) whether revisions are needed to the monitoring plan;
   - ix. Copies of field data collection forms (examples provided in Appendix C).

Draft copies of monitoring plans and reports should be submitted to our office's species lead for preliminary review and comment. Failure to satisfactorily address our comments in final version(s) of these documents may result in these reports not being accepted by our office.

APPENDIX A: SPECIES SPECIFIC SURVEY PERIOD AND TRANSECT WIDTH

SPECIES	***SURVEY PERIOD***	***TRANSECT WIDTH*** [a]
Arctomecon humilis	Mid April – May	10 – 20 ft
Asclepias welshii	June – September	25 – 50 ft
Astragalus anserinus	May – June	10 – 20 ft
Astragalus ampullarioides	April – May	10 – 20 ft
Astragalus desereticus	May – June	10 – 20 ft
Astragalus holmgreniorum	April – May	10 – 20 ft
Astragalus montii	July – August	10 ft
Carex specuicola	May – September	N/A, habitat not suitable for transects
Cycladenia humilis var. jonesii	April – June	10 – 20 ft
Eriogonum corymbosum var. nilesii	September - October	10 – 20 ft
Eriogonum soredium	Mid June - July	10 – 20 ft
Lepidium barnebyanum	May – June	10 – 20 ft
Lepidium ostleri	Mid June - July	5 ft
Lesquerella tumulosa	May – June	5 – 10 ft
Pediocactus despainii	April – May	3 ft
Pediocactus sileri	April – June	3 – 6 ft
Pediocactus winkleri	March – April	3 ft
Penstemon scariosus var. albifluvis	May – June	10 – 20 ft
Penstemon grahamii	May – June	10 ft
Phacelia argillacea	June	10 ft
Primula maguirei	May	N/A, habitat not suitable for transects
Ranunculus aestivalis	July	5 ft
Schoenocrambe argillacea	May to early June	3 – 5 ft unless habitat too steep for transects and then habitat is assumed occupied
Schoenocrambe barnebyi	May to early June	5 – 10 ft

[a] Transect widths represent the average distance (width) that can be adequately surveyed per person in each pass through potentially occupied habitat, for purposes of clearance surveys. Some transect widths are expressed as a range (minimum – maximum). The actual transect width used may depend upon site conditions and other factors (timing and purpose of survey); work with the USFWS species lead and the lead action agency (e.g., the permitting or land management agency) as appropriate to determine the widths to be used for any specific survey effort.

SPECIES	***SURVEY PERIOD***	***TRANSECT WIDTH*** [a]
Schoenocrambe suffrutescens	Mid April – early August	10 ft
Sclerocactus brevispinus	Mid March – June 30	3 – 6 ft
Sclerocactus wrightiae	Mid April – early June	3 – 6 ft
Sclerocactus wetlandicus	Anytime without snow cover	3 – 6 ft
Sphaeralcea gierischii	April to Early June	10 – 20 ft
Spiranthes diluvialis	August	In some areas, habitat restricted to narrow band along water edge, not wide enough for multiple transects; in other habitats (wet meadows) transects up to 6 feet apart may be walked
Townsendia aprica	April – May	3ft
Trifolium friscanum	May - June	10 – 20 ft

[a] Transect widths represent the average distance (width) that can be adequately surveyed per person in each pass through potentially occupied habitat, for purposes of clearance surveys. Some transect widths are expressed as a range (minimum – maximum). The actual transect width used may depend upon site conditions and other factors (timing and purpose of survey); work with the USFWS species lead and the lead action agency (e.g., the permitting or land management agency) as appropriate to determine the widths to be used for any specific survey effort.

APPENDIX B.

Resources for developing and implementing monitoring programs

The following resources address the many considerations of developing and implementing monitoring programs addressing many issues within the broad arena of natural resource management. As evidenced by their titles, some of these documents specifically address the issue of monitoring target (rare) species, and plant species in particular.

Bureau of Land Management, Measuring and Monitoring Plant Populations.
Available at http://www.blm.gov/nstc/library/pdf/MeasAndMon.pdf.

Elzinga, C.L. et al. 2001. Measuring and Monitoring Plant and Animal Populations. Blackwell Science, Inc. ISBN 0-632-04442-X. 360 pp. Includes appendices.

USFS. Photo point monitoring handbook: part A – field procedures. Gen. Tech. Rep. PNW-GTR-526. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 48 p. 2 parts.

APPENDIX C.

EXAMPLE FIELD DATA COLLECTION FORMS

The following examples should help to encourage consistency in observation and reporting among field crews and among survey sites. Deciding which form to use will depend upon the objectives of the survey effort – e.g., clearance surveys or status surveys. Due to the complex and species- or site-specific nature of most monitoring efforts, it is unlikely that any single example will adequately suit the needs of any given monitoring program. Refer to Appendix B for resources to help in the design of monitoring programs, including field data collection forms.

Example 1. The Utah Natural Heritage Program's Plant Sruvey Form is available at: http://dwrcdc.nr.utah.gov/ucdc/viewreports/Plant_Field_Form.pdf.

Example 2. The Bureau of Land Management (BLM; Ritchfield and Price Field Offices), National Park Service (NPS, Capitol Reef National Park) and the USFWS (Utah Field Office) have formed an Interagency Rare Plant Team to focus on rare plant conservation in central Utah. This team has drafted a form to standardize repeat inventories of rare plants (last version dated March, 2011). This form is not yet available online, but is provided on the following pages.

REPEAT INVENTORY MONITORING FORM (SITE VISIT ACCOUNT (SVA))

DB#________ entered into database on _________by ________
Verified DB on ___________ by ________
Entered into GIS on ___________ by ________
Verified GIS on ___________ by ________
Photo files renamed on ___________ by ________

New Site? yes no

Revisit? yes no

If revisit, plants found again? yes no

Site Name: ____________________________**Date:** _____________ **Time:** ______________

Source of lead: ____

Species Found: __________________________________**Species Code:** ______________

Surveyor(s):____

Quad Name(s):_____ __________________**State:** ____ **County(ies):** __________________

Township(s): __________ **Range(s):** ___________ **Section(s):** ________________________

UTM North: _______**UTM East:** _______**UTM Zone:** ____**Datum:** ____________

UTM Precision (Circle one)**:** Corrected GPS Field Recorded GPS Determined from map

GPS unit(s) used: ____________________**GPS File Name(s):** _______________________

Site Location/Directions to site: Start directions from a specific known location and describe in detail the roads, trails, and routes taken to get to general area, then refer to nearby landmarks to concisely describe the site's location. Also describe the location of plants within the site, especially if plants would be difficult for someone not familiar with the site to relocate using only attached maps.

____
____
____
____
____

Written Description (Describe the site, including such things as vegetation, significant species, aquatic features, notable landforms, natural disturbances, natural hazards, etc)**:**

____
____
____
____
____

Transect Width:____

Landowner (Circle one)**:** BLM USFS NPS State of Utah Private Other:

Owner unit (Circle one)**:** CARE Dixie NF Fishlake NF Richfield BLM Price BLM Other:

USFS subunit (Circle one)**:** Beaver RD Escalante RD FillmoreRD Fremont River RD Richfield RD

Current use of site:

____

Surrounding land use (Describe physical structures and land use practices in the <u>surrounding</u> area, such as housing, agricultural, recreational, etc.)**:**

____

____

HABITAT

(Circle appropriate categories)

ASPECT	**SLOPE** (degrees)	**LIGHT**	**TOPOGRAPHIC POSITION**	**MOISTURE**
W NW	flat	Open	Crest	Inundated (hydric)
E NE	0-10	Partial	Upper slope	Intermittently flooded
S SW	10-35	Filtered	Mid-slope	Saturated (wet-mesic)
N SE	35+	Shade	Lower slope	Moist (mesic)
none	vertical		Bottom	Dry-mesic
multiple			All	Dry (xeric)

Elevation Range: _______ ft /m **to** ______ ft /m **Elevation at GPS Point:** _________ ft /m

Associated plant community:

____

Associated plant species (list in order of dominance):

____

____

____

____

Soil/Geologic Formation:

____

Full extent of occurrence mapped? (Circle one)**:** yes no

Estimated # of acres of potential habitat in the immediate area: **(**check only one category)

< 1 acre	6 – 20 acres	41 – 80 acres	121-160 acres
1 - 5 acres	21- 40 acres	81 – 120 acres	> 160 acres

BIOLOGY

PHENOLOGY *(must sum to 100%)*	***POPULATION ESTIMATE*** *(check one)*	***ACTUAL PLANT COUNT***	
%in leaf	1-10	**At Site:**	
%in bud	11-50		
%in flower	51-100	**In Polygon:**	
%immature fruit	101-1000		
%mature fruit	1001-10,000	Note: The count within the survey polygon **includes** the site count.	
%seed dispersing	10,000-50,000		
%dormant	> 50,000		

AGE STRUCTURE (must sum to 100%)	**VIGOR** (check one)
%seedlings	very feeble
%immature	feeble
%mature	normal
%senescent	vigorous
%unknown	exceptionally vigorous

Comments on biology:

____

____

____

____

Evidence of reproduction: yes no **Explain:**__________________________________

Evidence of disease, predation, etc: yes no **Explain:** ______________________________

IDENTIFICATION

Do other members of the same genus occur at this site? If yes, list species, any hybridization, etc.?

____

Identification problems? If yes, explain:

____

____

Specimen(s) collected? (Circle one)**:** yes no

PHOTOGRAPHS

Photograph(s) taken? (Circle one)**:** yes no **Camera(s) used:** ______________

Describe photographs (Use photo #'s. State if it's a close-up or habitat view, direction or bearing faced, etc.)**:**

____

____

____

____

CONSERVATION

Site Risk Category	Yes
High Risk	
Moderate Risk	
Low Risk	

(see definitions below)

Check the box or boxes that apply as justification for selection of risk category. Write comment in notes section below if further explanation is needed.

High Risk:		**Moderate Risk:**	**Low Risk:**
Adjacent to an actively used OHV play area or trail (designated or undesignated)	**Within ¼ mile of livestock concentration area:** (circle which) *Stockpond or other water source *Corral * Mineral supplements * Livestock trail * High value forage area * Shaded area	More than ¼ mile from livestock concentration area.	Area inaccessible to livestock and OHV's due to topography or geology.
Within ¼ mile of maintained primary road (collection issues)	Currently or recently occupied by livestock	Evidence of past livestock use in the area	Area within protective fencing
Visitor use; Hikers (trampling or collection issues)	Evidence of recent ATV use in the area	Evidence of past ATV use in the area	Lack of vegetation to attract livestock

Evidence of disturbances (describe any unnatural on-site disturbances)**:**

____

____

____

NUMBER OF SURVEYORS: ______ **SURVEY TIME FOR SITE:** _______hours

SURVEY TIME FOR ENTIRE SURVEY AREA (including time at site)**:** ______ hours

You **MUST** attach a map showing the site location, the area occupied by the plants (if able to determine this), and the area surveyed. Use some facsimile (copy machine or GIS-generated) of the appropriate portion of the standard USGS topographic quadrangle as your base. The site name, date, species name, and number of plants found should be indicated on the map. You may also draw a sketch of the site on the back of this sheet to show finer detail.

Exhibit 4. Handbook of Field Methods for Monitoring Landbirds, U.S. Department of Agriculture

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United States
Department
of Agriculture

Forest Service

**Pacific Southwest
Research Station**

General Technical
Report PSW-GTR-144-www

Handbook of Field Methods for Monitoring Landbirds

C. John Ralph
Geoffrey R. Geupel
Peter Pyle
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Ralph, C. John; Geupel, Geoffrey R.; Pyle, Peter; Martin, Thomas E.; DeSante, David F. 1993. **Handbook of field methods for monitoring landbirds.** Gen. Tech. Rep. PSW-GTR-144-www. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 41 p.

This handbook is a compilation of methods that can be used to assay population size, demographics, and status of many species of birds occurring in a wide variety of habitats. The handbook will prove useful to field biologists, managers, and scientists anywhere in the New World from the arctic through the tropics. The methods include four types of censuses for determining population size and trends, mist-netting and nest searches to determine demographic parameters, and other methods that will be useful in operating a monitoring station, including habitat and weather observations, and suggestions for training personnel and possibilities for detailed studies. Suggestions of specific methods and data forms are included.

Retrieval Terms: bird populations, census, mist-nets, monitoring, nesting birds

Acknowledgments:

The late L. Richard Mewaldt was the first among equals in setting high standards and maintenance of accurate records. His contributions are detailed by Ralph (1992). We take great pleasure in dedicating this handbook to him.

This handbook is a direct outgrowth of the landbird program started more than 25 years ago at the Point Reyes Bird Observatory to monitor landbird populations in coastal California, and much of this handbook is the result of the methods developed and adapted there. Over this period, many people contributed to the development of this landbird monitoring program.

The handbook benefitted greatly from discussions and correspondence by Bruce Bingham, Grant Ballard, Danny Bystrak, Barbara Carlson, Brenda Dale, Sam Droege, John Faaborg, Kevin J. Gutzwiller, Denise Hardesty, Kimberly Hollinger, Bill Howe, David W. Johnston, Stephanie Jones, Cherry Keller, Kathy Klimkiewicz, Rolf R. Koford, Karin Kozie, Borja Milá, Sherri Miller, Michael Morrison, Barry R. Noon, Nadav Nur, Raymond J. O'Connor, Will Peach, Carol Pearson Ralph, Martin Raphael, Dan Reinking, Christopher C. Rimmer, Sharon Ritter, John T. Rotenberry, John R. Sauer, Tom Sherry, Sue Sniado, John Tautin, Jared Verner, Dennis Vroman, George E. Wallace, Dan Welsh, and Joseph M. Wunderle, Jr.

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Publisher:

Pacific Southwest Research Station
Albany, California

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May 1993

Handbook of Field Methods for Monitoring Landbirds

C. John Ralph Geoffrey R. Geupel Peter Pyle Thomas E. Martin David F. DeSante

Contents

Contents

In Brief . . .

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The increased attention devoted to the status and possible declines of populations of smaller species of terrestrial birds, known collectively as "landbirds," has resulted in an immediate need for specific methodology for monitoring their populations. This handbook is derived from several sources and is based on the authors' collective experiences in operating monitoring stations. Presented here are a compilation of methods that can be used to assay population size, demographics, and status of virtually all species of landbirds in a wide variety of habitats, from grassland and tundra to temperate and tropical rain forests. Rare species, or those with unusual habits, will require some modifications. The handbook will prove useful to field biologists, managers, and scientists anywhere in the New World. The handbook first suggests priorities for selecting a monitoring method and determining station locations. Then, general tasks that determine which species can be monitored, and methods of establishing and maintaining a study plot, journal keeping, and training of personnel are presented. Two demographic methods are described, one involving mist nets, and the other finding nests during the breeding season. Detailed suggestions are given for both methods which should allow a trained person to successfully operate a station. Both methods involve monitoring at a station at regular intervals during the breeding season. The handbook also includes descriptions of four types of censuses for determining population size and trends: spot mapping of territories, area searches of specific sites, strip transects along predetermined routes, and point counts. The latter method has been accepted as the standard method, is treated in most detail, and involves a person standing in one spot for 3 to 10 minutes and recording all birds seen or heard. In addition, methods are suggested for measuring habitat, recording weather, and color-banding individuals to determine specific demographic parameters. Throughout the handbook, sources of materials are given that are needed for each method, as well as specific references to published works.

Introduction

Throughout the New World attention is now being focused on the status of populations of landbirds, which are the many species of smaller birds, sometimes referred to as "non-game" birds. Landbirds have not usually been the focus of management activities except in a few cases of threatened or endangered species, such as the Kirtland's Warbler. Recent evidence suggests that some landbird species are declining in abundance, fueling much speculation upon the causes of these declines, the species involved, and their habitat preferences. Hypotheses about the causes of these declines are varied, ranging from tropical deforestation to nest parasitism by the cowbird. However, part of the difficulty in determining the status of landbirds results from problems in monitoring these small birds, as compared to larger, more easily-studied species. To determine population changes, and to hypothesize possible causes of these changes, more basic information needs to be gathered.

Much of the evidence for these population declines in the New World has come from the results of the Breeding Bird Survey coordinated by the U.S. Fish and Wildlife Service and the Canadian Wildlife Service (Robbins and others 1986, 1989). These roadside counts provide excellent baseline data. However, they do little to identify the factors contributing to changes in landbird populations, and are limited to areas with major roads.

The use of population size as a measure of health of a species has been a common tool of biologists for many years (Hutchinson 1978; Lack 1954, 1966). Methods for surveying population size have been detailed by Ralph and Scott (1981), in the excellent compendium by Cooperrider and others (1986), and the manual by Koskimies and Vaisanen (1991). Population size, however, is only a retrospective tool. It tells only after the fact that a species has enjoyed an increase or suffered a decline. To ponder causes of changes, the biologist must couple information on population size with data on the internal composition of a population—its demographics (Temple and Wiens 1989). For example, data on sex ratio, age distribution, nesting success, survivorship, average weight, and population movements can all give valuable cues to factors or events regulating a population. Moreover, such primary population characters can provide early warning signals of population problems prior to actual declines. Many studies have used data such as these to describe the dynamics of various populations (DeSante and Geupel 1987, Hutchinson 1978).

Several other efforts have been under way to document changes in adult populations and in productivity. For example, in the late 1970's, the Germans and Austrians started the "Mettnau-Reit-Illmitz-Programm" (Berthold and Scherner 1975). Since 1981, the British Trust for Ornithology has conducted their Constant Effort Sites (CES) Scheme (Baillie and others 1986; Baillie and Holden 1988; Peach and Baillie 1991; Peach and others 1991). Martin has started a program involving nest searches (Martin and Geupel in press). DeSante (1991, 1992a,b) has started a cooperative mist-netting program in North America known as "Monitoring Avian Productivity and Survivorship" (MAPS) along these same lines. The Point Reyes Bird Observatory has been monitoring landbird populations in coastal California for more than 25 years (Ralph 1967, Geupel and DeSante 1990b).

In this handbook we outline the steps that might be followed in monitoring many species of landbirds. We cover methods used in monitoring of population size, productivity, age and sex ratios, survivorship, habitat relationships, and other parameters. We provide details of four methods that estimate population size, two methods that measure demographic factors, and two suggestions for conducting habitat assessment. We have tried to give the land manager, biologist, and others complete information on basic requirements, tools, resources, and methods to carry out a successful landbird monitoring program. Depending on funding and staffing, any combination of the techniques we describe is applicable to virtually any site and budget. This handbook does not provide the objectives of each study that might be conducted, or what analyses can be conducted. These both must be examined carefully before monitoring begins. We hope that this handbook will generate interest in monitoring programs using methods that can give insight into causes, as well as the facts, of population changes.

Objectives of a Monitoring Program

A monitoring program ideally should provide three types of data. One is an estimate of the population size and trends for various species of birds. The second is an estimate of the demographic parameters for at least some of those populations. The third is habitat data to link the density and demographic parameters of bird populations to habitat characteristics. Ideally a monitoring program should take a community approach and monitor all avian species in the area.

We have recently seen a marked increase in interest in monitoring, far outstripping available personnel, training, and resources. Indeed, this increase is the impetus for this handbook. While this has been gratifying, we think that it is essential that people first determine why they might want to establish a census, mist netting, or nest searching program. Not everyone requires a monitoring program to meet their goals. We have sometimes seen the establishment of a monitoring program first, followed by an attempt to decide what type of information can be obtained. We very strongly suggest that, before a monitoring program is put in place, the following steps be carried out: (1) decide the objectives and goals desired; (2) determine whether monitoring is the way to accomplish these; (3) with the goals firmly in mind, write down the questions being asked, clearly and objectively; (4) determine which monitoring methods most directly answer the questions posed; (5) review the types of data that can be obtained from these methods, and outline exactly how these data will answer the questions; (6) outline the analytical methods that can be employed; (7) determine the cost, logistics, availability of personnel, and probable length of commitment to the project; and (8) write a study plan and have it reviewed by a person competent in research and statistics. This procedure is vital, because accumulation of a data base does not itself lead to meaningful analyses later.

Participants in a monitoring program can include private, state, provincial, and federal groups. Our premise is that the basic entity for this exercise is an administrative unit, such as a Forest Service District or a State Park. Not all such units will want or need such a program. Each unit should outline its needs and goals before starting, suggest monitoring programs to meet those needs, and have them reviewed by a competent biostatistician. We do believe, however, that our recommendations below have generality among many types of administrative units. These units can be very heterogeneous, and thus a variety of methods may be needed.

Glossary

Landbirds: the general term used for the generally smaller birds (usually exclusive of raptors and upland game birds) not usually associated with aquatic habitats. By contrast, waterbirds include seabirds and other aquatic species.

Region: an area of several thousand acres, often including several drainages, that the biologist wishes to sample. Here, extensive point counts are conducted on roads to monitor overall population sizes and their changes.

Administrative unit: the basic entity that conducts monitoring. Examples are a Forest Service District or Forest, a State Park, a National Wildlife Refuge, a private nature center, or a commercial forest.

Monitoring station: an area of usually less than about 50 ha (125 acres) within a region. Here, intensive censuses, nest searching, and mist netting are conducted.

Capture array: the generally rectangular or circular configuration of mist net locations at a station.

Nest search or census plot: an area of, preferably, a single habitat type where spot mapping or area searches are conducted.

Census grid: the arrangement of intensive point counts overlaying a demographic mist net array or nest search plot.

Census point: the place where a single point count census is taken.

Net location: the place where a single net is placed.

Nest site: the place where a single nest is found.

A 10-day time: **interval** is the basis for most monitoring and analyses.

Selecting Monitoring Methods and Location of Monitoring Stations

Before beginning work, careful attention should be given to selecting the appropriate method for the questions being asked, and great care should be given to selecting locations of monitoring stations to best answer these questions.

Selection of Methods

The standardized set of methodologies described below should be followed closely to ensure compatibility with those of other monitoring stations. These methodologies are integrated and hierarchic, so as to allow a region's sampling schemes to complement other programs and to allow comparisons between monitoring stations in a region, and between regions.

Methods recommended should be employed for a minimum of three years, and preferably longer. However, depending on individual objectives, some results may be obtainable in a year or two.

What Will the Data from This Program Provide?

These data will be used at two geographic scales. At the level of the managed forest, for instance a large National Forest District, they will provide a local assessment of the status and trends of landbirds. The scheme below samples the landscape as a whole within the unit and will permit statements such as: "Scarlet Tanagers have significantly increased on the sampled units in the forest," "Hermit Thrushes have had high mortality during migration or the winter in the past two years," or "15 of 20 neotropical migrants have increased over the past 3 years." Such a local scheme will permit some investigation of patterns of population change (e.g., "are declining trends more prevalent in units of the northern half of the forest?", "do increasing trends appear to be associated with certain forestry practices?"). Their primary purpose, however, is to estimate the status and trends of the population. Assessment of the *cause* of population change, or associations with environmental factors such as cutting practices, are more efficiently studied by other research programs with more appropriate techniques.

At the larger scale, perhaps a Forest Service Region, a state, or a province, the program will permit evaluation of geographic patterns of various attributes of landbirds. It is important to realize that the program cannot evaluate the population status of birds of the entire geographic area, whether regional, state, federal, or continental. If, for example, samples are only from forested environments, only statements about birds using forested lands can be made. Additionally, because sites are chosen by the unit, and are not a random sample of all available units or sites, the program can investigate only the *patterns* of population change, rather than the population's overall status. Questions this approach can answer, for example, are: "are population increases or reproductive failures in a group of species more prevalent in some regions or states?"; "what is the association between forest management and population status of a group of species?"; "do some forest types have more neotropical migrants than others?"; or "are populations increasing in some forest types, but not in others?"

Coverage

While it would be best to have complete coverage of any state, province, or region, we do believe that it is acceptable and inevitable that gaps will exist. These gaps will occur within habitat types, forests, states, provinces, or regions. At a minimum, we hope to have several units involved in each state, province, or region. We strongly urge that each unit have both population and demographic methods in operation, and cover anything from a few hundred to several thousand acres. Further, we suggest that sampling within a unit should be stratified by at least general habitat type, such as "mixed coniferous forests," "tropical thorn forest," or "coastal chaparral." Samples in an analysis, in general, should not be pooled across habitat types. The data from these units would be searched for large-scale patterns, e.g., species showing consistent declines over the entire region or within a given habitat type. Results from these investigations will identify patterns that need further research or greater intensity of monitoring to determine their causes. The overall program could be considered a large-scale hypothesis-generating mechanism.

Table 1—*Census and demographic monitoring methods*

Variables and characters	Census			Demographic	
	Point count	Spot map	Area search	Mist nets	Nest search
Variables measured					
Index to abundance	yes	yes	yes	yes	partly
Density	no	yes	no	no	partly
Survivorship (adult)	no	no	no	yes	no
Survivorship (juvenile)	no	no	no	yes	partly
Productivity	no	no	no	yes	yes
Recruitment	no	no	no	yes	no
Habitat relations	yes	yes	yes	little	partly
Clutch size	no	no	no	no	yes
Predation/parasitism	no	no	no	no	yes
Individuals identified	no	no	no	yes	yes
Breeding status known	no	yes	no	partly	yes
General characters					
Habitat types measured	all	some	most	some	few
Habitat specificity	good	good	good	fair	good
Rare species measured	many	few	many	some	few
Canopy species measured	all	all	all	some	few
Area sampled known	partly	yes	yes	partly	yes
Size of area sampled	moderate	small	small	large	small
Training necessary	much	much	moderate	much	much
Observer error potential	high	high	moderate	moderate	moderate
Use in non-breeding	yes	no	yes	yes	no
Cost per data point	low	high	low	high	very high
Applicable scale	broad	local	broad	broad	local

Priorities

Methodologies are compared in *table 1*. At a minimum we recommend that the following programs of demographic and population monitoring be implemented in each unit, in the following order. Although this handbook describes three censusing methods, the point count method has been adopted as the recommended standard, and its implementation is suggested below. Each recommended method is in segments of 10 person-days, other than the first which takes one person-day. For example, if funding is available for 21 person-days of field work, then only Priorities I through III (outlined below) would be implemented. These estimates of time do not include set-up or training. These will vary depending upon qualifications of personnel. The minimum numbers of counts or netting sites, noted below, are derived from our experiences with many such population monitoring programs. We believe they are useful, but not restrictive, minima for a unit's effort.

Priority I. Breeding Bird Survey—If the unit is in North America and has an unsurveyed Fish and Wildlife Service Breeding Bird Survey route within or near it, we recommend that the standard survey be conducted. This involves 50 3-minute point counts along roads at 0.5-mile (1-km) intervals. The effort takes one person-day at the height of the breeding season, usually in early June. The surveyor must know all of the vocalizations of species likely to be encountered. This Survey will help detect regional trends in many species in the unit, or its vicinity.

Priority II. On-Road Point Counts—As a second priority, we recommend that the unit put in point-counting stations in multiples of about 250 stations to monitor overall population changes and responses to habitats. We suggest that the stations be in habitats representative of the unit, stratified by these major habitats, systematically placed, and placed primarily along secondary roads. This level of effort will require about 10 person-days during the early breeding season, usually in May or June. It is based on the assumption that in the 10-day period, an average of about 25 stations can be censused in each day. While we acknowledge the fact that an on-road monitoring program is not without bias, the benefits are considered by most workers to outweigh the disadvantages, and are at least partly offset by Priority IV, below.

Priority III. Demographic Monitoring—We recommend that the unit establish at least one site to measure demographic parameters. Either constant-effort mist netting or nest searches (both, if possible) should be conducted on usually about six plots within each unit. These monitoring stations will estimate demographic variables that influence the density estimates.

Constant-Effort Mist-Netting Sites—Operating mist nets through the breeding season, at most North American stations, will require about 10 person-days per site, beginning about June and continuing through the end of August. In Latin America, the season would be longer. The program will provide information on productivity, survivorship, and movement of many species. Mist netting involves capturing birds, banding them, and taking data on age, sex, breeding status, molt, and survivorship. At a minimum each monitoring station should operate 8-12 nets at least once every 10 days throughout the breeding season. It has become well established that results from constant-effort mist netting provide excellent indexes of productivity and recruitment for a variety of species (e.g., DeSante and Geupel 1987, Peach and others 1990, Peach 1992). It is the only method that estimates survivorship and recruitment using mark and recapture. Its major weakness is that the recruitment data are not habitat specific, especially late in the summer. The survivorship data are excellent, and all data are most habitat specific for adults, especially early in the breeding season. As the season progresses, influx of peripheral birds and young from other areas dilutes this specificity.

Nest Searching Sites—Nest searches involve intensively finding nests in a plot. Typically, one plot can be done in about 20-40 person-days, beginning about May and continuing to about August. Nest searching involves finding nests, monitoring their outcome, and measuring associated vegetation. A study plot needs to be visited at least once every four days to find and check nests. Nest searches provide direct measures of reproductive success (rather than an index) and can provide direct data on influences of habitat on reproductive success and the incidence of nest parasitism. Nest searching, however, is quite labor intensive and is applicable to fewer species than mist netting.

A drawback to both demographic methods is that they will assay the population health of only certain species in an area. As a general rule of thumb, usually about 10 species at any one station will be monitored. However, when data from several stations are combined over a larger geographical area, meaningful insights may be gained on many species.

In addition, within each demographic plot, at least 9-16 intensive point count censuses should be conducted at least twice during the peak of the breeding season. Other census methods (i.e., spot mapping, area search) may also be employed, depending on objectives, size of study area, and availability of personnel. Vegetation measures should also be made at each census point and within each demographic plot.

Priority IV. Off-Road Point Counts—As a fourth priority, we recommend that the unit conduct point counts in segments of approximately 100 points off-roads in habitats not covered by the on-road point counts. Each segment of 100 points will require up to 10 person-days during the same period as on-road counts, and assumes about 10 stations per day are covered along trails or cross-country.

Priority V. Additional Work—When resources are available, we recommend that the unit add programs, in increments of 10 person-days, of the three programs (II-IV) above. We do encourage additions of programs in the order they are recommended. However, local conditions, variety of habitat types, length of sampling season, areas of management concern, and consultation with biostatisticians will modify the order and magnitude of additional work in each unit. Additionally, at some point a unit will be best served collecting information other than that outlined above.

Selection of a Station Location

A monitoring station should be located in representative habitat for a given region, or in a habitat of concern. A station may have a variety of habitat types, and some will have a higher density of birds than others. Because the derived population and demographic parameters are likely to be highly sensitive to successional changes in the habitats sampled, stations should not be placed in very young habitats. However, young habitats are acceptable if they are held in a lower successional stage by active management.

If the census methods involve extensive point counts, the points can be spread out along a road or trail network, over a fairly large area of the region. This makes for a robust data set, because each point is at a location somewhat representative of the habitats in the region. In spot mapping and nest searches, a plot is usually established in a single habitat type, and is usually square or rectangular. Plots in heterogeneous habitat are often not as useful because they are more difficult to generalize about.

For constant-effort mist netting, we suggest the capture array be placed where a high rate of capture can be achieved. By contrast, extensive census points and the nest search plot should be placed in the representative habitats of the region.

Permanent Stations

While the need for broad-scale monitoring is of vital importance, in-depth studies in small, protected areas, such as natural areas, nature reserves, and parks, can contribute greatly to our knowledge of landbird populations. In-depth studies of bird life histories (normally using individually color-banded birds) can provide important insights into vulnerability and management of species. Other biological studies concurrently conducted at the station can add greatly to our knowledge of the factors affecting local landbird populations. Monitoring stations with active field programs or living quarters for biologists are ideal for intensive programs in remote areas and can often attract volunteers.

Obtaining institutional sponsorship of permanent stations can provide long-term commitment over many years. A monitoring program with such a commitment will continue despite turnover in personnel and can provide some stability in funding. Furthermore, by using local volunteers to collect data in such a program, a community outreach and education program can be established. Bird observatories and some university field stations in North and Latin America have been conducting programs similar to this for many years.

General Monitoring Procedures

Species To Be Covered

Although many species will be censused at a single station, fewer will be captured, and still fewer species will have their nests found. However, biologists at a single station should get a good sample of the population size of perhaps 30 species and some indication of demographics on about 10 species. In a region with perhaps six stations, more species will be monitored. Over a wide geographic area, these data can be combined to produce patterns of the population sizes and demographics of many species.

Monitoring Period

Breeding Season

The period of study for the breeding season differs, depending upon the individual species, latitude, rainfall pattern, temperature, elevation, or even year. Therefore, each region should establish its own monitoring period on the basis of the local breeding season and the criteria described below.

Demographic monitoring, by mist nets or nest searches, should span the entire breeding season. Censusing, by contrast, is usually conducted only during approximately the first half of the breeding season, when birds are most active, paired, on territories, and vocal.

For all monitoring, we recommend the use of the sampling interval time period of 10 days, as used in the British CES project, for several reasons. This interval allows at least one weekend for making up for inclement weather, and divides the month into three approximately equal portions. It also provides a basis for direct comparison between stations.

Operation of the demographic monitoring station by mist netting or nest searching should begin no sooner than the 10-day interval when virtually all of the breeding birds have established territories, but before many have begun laying eggs. For most lower elevation areas in temperate North America this will be about May 1 or May 11. The date, however, should be adjusted to conform with the local situation. For example, in the more northern parts of the United States, the first period can begin May 21 or May 31. In Alaska or northern Canada, or at high altitudes, the first period may begin as late as June 10. In the southwestern United States or coastal southern California, where 90 percent of the species have begun nesting activities by mid to late March, the starting date could be April 1 or 10. In Mexico, it could be even earlier, and in much of Latin America it could be much earlier. It is considered important by some investigators to avoid netting before migrant individuals of breeding species have finished moving through. Early netting might result in later net avoidance during the breeding season, thus biasing a few of the demographic estimates. However, some adjustment for this factor can be made during analysis and many stations do this with good results.

A good measure of the establishment of territories is increased singing. Also, captured males will show a pronounced cloacal protuberance. Individuals carrying nesting material is another excellent indication that the breeding season is under way. The best measure of the start of the breeding season is the beginning of egg laying. Females normally develop a brood patch when the first egg is laid.

The termination of the demographic monitoring should be no earlier than when the local population begins to be augmented by fall migrants, or by an increase of dispersing individuals known to have not bred in the local area. In most of temperate North America, this will usually be about the second or third 10-day interval of August.

For uniformity, May 1 of each year should be considered the first 10-day period. If a season in a region begins earlier, it should be backdated from May 1. In fact, the season of monitoring for most areas in temperate North America will begin May 1 and continue for a maximum of twelve 10-day intervals until August 28. If a station begins before May 1, it should continue until late August, unless a pilot project's data indicate that all breeding individuals and their young have left earlier.

For most of temperate North America, we recommend, therefore, the following periods: May 1-10, May 11-20, May 21-30, May 31-June 9, June 10-19, June 20-29, June 30-July 9, July 10-19, July 20-29, July 30-August 8, August 9-18, and August 19-28.

Censuses conducted on demographic study stations, such as mist netting stations, need be done only in the first five 10-day intervals when birds are on territory and actively singing. In temperate North America, this will be usually from May 1 through June 19. In northern latitudes or higher elevations, the period could be as late as June 1 to July 9. Point censuses, and also area searches, should be done once on each plot in each of the five 10-day intervals, and preferably about the mid-point of the interval.

Migration Operation

Operating a monitoring station in the spring or fall is an option in many areas. Spring and fall migration data from mist nets and censuses are confounded by many factors, particularly local weather, and the questions migration data can answer are different from those netting during the breeding season can answer. The data can provide interesting and insightful information about the timing, composition, and extent of migration (e.g., Ralph 1978, 1981a; Robbins and others 1959). The fall migration in particular gives a measure, derived from many source areas, of the overall productivity of a species. As mentioned previously, if a mist net program is operated in the spring in the same area as a breeding mist net array, a few demographic measures may be altered somewhat.

Nonbreeding Season

The value of winter studies is quite high. Winter is a time when populations are resident and relatively stable, thus providing excellent data on survivorship and mortality. It is very likely that habitat associations, for example, are much more defined in the winter than in the summer (e.g., Huff and others 1991, Manuwal and Huff 1987). The methods outlined here have full applicability in the non-breeding seasons, both in North America and Latin America. In the tropics, mist netting throughout the year at the same site would clarify many questions about molt, skull, and plumage patterns.

Maintenance of a Study Plot

Plots should be permanently marked with stakes, markers, or flagging that will survive over at least one winter. Rebar (steel reinforcing bar), rock cairns, or tags driven into landmarks all work well. Tags are available from biological supply companies. In general, markers should be laid out along a compass direction, be placed at regular intervals, and be visible at any point between the markers. Each marker should correspond to a numbered grid point on a map. In colder areas, be aware that in years with heavy snowfall, plot markers can still be buried in the spring. Net and census points should also be permanently marked. Be sure to record in your journal net height and angle of placement (use stakes or give a compass direction).

Customized maps of the study area should be traced from a large scale map or from aerial photographs. Landmarks, grid points, and net and census points should also be sketched. Blank maps can be used for spot mapping censuses, vegetation mapping, and other figures.

Each monitoring station ideally should be operated indefinitely. Although objectives will vary, we suggest that at a minimum, capture arrays of nets and nest searches should be operated for four consecutive years, and census plots for three years.

Journal Keeping

Journal keeping is an essential tool of all field biologists. The importance of regular, accurate journal keeping cannot be overemphasized. It is not uncommon for journals to be subpoenaed in court. The Grinnell method (Herman 1989) is the most widely used by vertebrate ecologists and is extremely detailed. Here we provide guidelines for basic information that may be useful for monitoring landbird populations.

As a minimum we recommend recording the following on a daily basis:

• Netting information: (a) the number and location of each net operated; (b) the exact hours of each net operated; and (c) the total capture and recapture rate for each species at each monitoring array.

• Censuses and nest searches: the number, location, and timing of each census conducted and the hours of nest searches.

• Personnel information: list the activities of each biologist conducting field work, including areas censused, net locations operated, and other activities.

• List of all birds seen or heard: basically presence/absence data; provide any interesting notes on potential breeding or other behavior of note.

• Weather data: in addition to the basic weather data that should be taken (see below), a general one- or two-sentence statement on the day's weather is also helpful.

• Plant phenology: a list of what is blooming or in seed may help interpret changes in bird distribution.

• Interesting observations of mammals, herptiles, insects, and other natural history observations should also be included.

Training and Numbers of Personnel

Training is extremely important because the level of training and experience will greatly affect the reliability of the data collected. Training *must* be something that is continuous throughout the field season. It is necessary to transmit expectations early and often in data taking or responsibilities for certain tasks.

The length of time to train personnel will vary greatly depending upon the quality and interest of recruits. For many census procedures, the mechanical aspects can be taught in two or three 2-hour sessions. However, for a person who has minimal skill in identification of plant or animal taxa, it can take a week or longer, depending upon the taxon, and the person's previous experience. The suggestions for censusers in Kepler and Scott (1981) are especially relevant. For a completely untrained person to learn to remove birds from mist nets takes at least 2-3 weeks of intensive training. This training should include at least 3-4 hours of removing birds from nets each day. Training for nest searching requires a similar time commitment.

Probably the most important aspect of training is the testing of the observer. This should be done regularly in the field by the most experienced personnel available to make sure that data are accurate, and of high quality. This can also be accomplished by regularly checking data sheets *as they come in from the field*. Any delay prevents feedback to the field crews.

The number of persons required to operate a monitoring station depends upon several factors. If nets are the method of choice, we suggest a minimum of two people, one of whom is well-trained in removing birds from mist nets, and one of whom is well-trained in identification of birds by sight, song, and call. The less skilled person can be of great assistance, and with proper training can contribute much to the monitoring. Censuses and netting are both morning activities, and under some circumstances they can be conducted concurrently if the censuser's position is known to the netter and he or she can be called upon for help if capture rate is moderately high. The health of the birds is of paramount importance, and all efforts to prevent injury must be taken. Nest searches can be conducted throughout the day, although it is most productive in the morning.

When conducting censuses, it is best to rotate observers, if at all possible, so that no observer censuses any given point more than the others.

Syllabi for training in the methods contained in this handbook have been prepared. These are for the use of persons experienced in the methods, so that they can efficiently pass on the methods to others. The syllabi are available from the senior author.

Data To Be Taken

Below we outline several types of data to be taken and provide sample forms for each. We have also prepared data entry programs using IBM compatible computers for these forms. Clean forms for reproduction and these programs can be obtained by contacting the senior author. These programs can use either standard entry systems such as dBASE or simple BASIC compilers.

For each point count census point, mist net location, and nest site, we suggest that the "Location and Vegetation Form" be filled out. It is described in detail in the Habitat Assessment section and contains important location information for data base files. At the minimum, for all monitoring programs, this location data should be taken.

All the data forms have constant the following information, to help relate between data bases:

• State or province—The 2-column code for each.

• Region—An 8-column code, designated by the investigator. Often, the name of the USGS quad, a prominent landmark, or a nearby town will provide the best code name.

• Station/Location—This is a 6-column unique identifier designated by the investigator to separate, within each region, the location of the various data points. We recommend that the station be a 4-letter code. The net location, point count census point, or nest number will be a 2-number code.

Constant-Effort Mist Nets and Banding

Scope

The capture of birds in nets can give the biologist an insight into the health and demographics of the population of the birds being studied. For instance, the proportion of young birds captured in mist nets has been shown to be a good measure of the productivity of birds during the previous few weeks (Baillie and others 1986). The sex ratio of a population can be used to assess the species' differential survivorship the previous year and the ability of the population to increase. The mist net capture rate gives a measure of the number surviving during the previous winter. The marking of individuals gives the biologist insight into degree of dispersal between different habitats and survivorship between years (e.g., Peach and others 1991). Finally, weight, when compared to measures of body size such as wing length, can give a measure of individual fitness.

Mist nets have been used for a long period to capture birds. Recently they have been used to monitor populations. Although some have used them to assay population size (e.g., Karr 1981), for most species, censuses are the best method for this, as netting provides relatively fewer data points per unit time. Netting, however, is the method of choice to provide information about the various attributes of the population, for instance, age and sex ratios and physiological condition.

Over the years numerous aids have been developed for field workers, with an emphasis on capture techniques and data taking (e.g., Baldwin 1931, Bub 1991, Lincoln 1947, Lincoln and Baldwin 1929, Lockley and Russell 1953, McClure 1984). O.L. Austin introduced mist nets to North American biologists in 1947 (Keyes and Grue 1982), and he, Low (1957), and Bleitz (1957) were all pioneers in their use.

The procedure detailed below is essentially identical to the "Constant Effort Sites" (CES) Scheme of the British Trust for Ornithology (Baillie and others 1986). The standards of operation are also identical to those of the Monitoring Avian Productivity and Survivorship Program (MAPS) (DeSante 1992a). We suggest the use of a series of mist net arrays, as in the British program, to be operated on 10 to 12 intervals during the breeding season, coupled with point count censuses. These data will provide an index of **adult population** size and changes at each station. The proportion of young birds in the catch will provide a measure of post-fledgling **productivity**. And finally, between-year recaptures can provide a sensitive measure of adult **survivorship** and **recruitment**. With these data, managers will have information on the possible causes of landbird declines or their remedies.

The monitoring of populations with mist nets is no more complicated than other techniques, but placement and operation should be done rather uniformly; thus we present below more details about this method than about others.

Net Placement

Operating a capture array of mist nets is a complex undertaking, but very rewarding. Much useful information can be gained from reading Bleitz (1970), Keyes and Grue (1982), or McClure (1984). We outline below some guidelines for operation of nets and their placement *(fig. 1).*

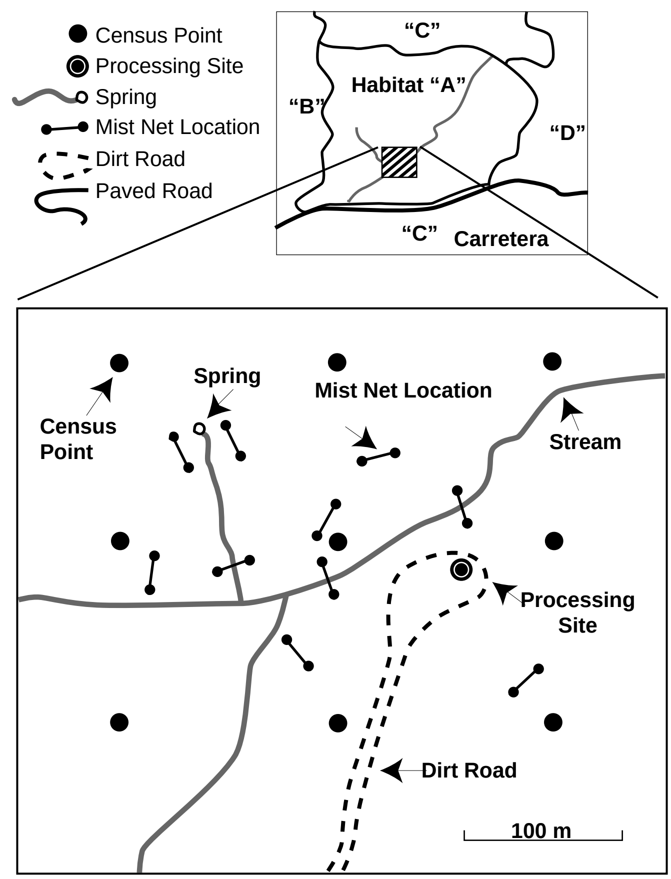


Figure 1—An idealized capture station of about 40 acres (16 ha) set in an area of more than 250 acres of habitat "A." Nine census points are set at uniform spacing of about 150 m to estimate population levels. Ten net locations are placed in sites where high capture rates are likely, along a stream, near a spring, and other areas where vegetation is dense, in order to monitor population and demographic parameters.

A field crew of two people can usually set up and monitor an array of 8-12 mist nets quite easily. We suggest 10 as an appropriate number. If the biologists are especially skilled, or the bird density quite low, a few more nets may be operated. However, if too many nets are established in an array early in the season when capture rates are relatively low, the likely influx of post-breeding birds later in the season, in July and August, may severely tax the crew's resources.

Distance between nets is a very important consideration because of the effect of net dispersion on the precision of data from capture-recapture analyses. In order to increase the probability of capturing a bird banded the previous year, one should place the nets as far apart as possible, thus intersecting the most territories. However, it is absolutely critical that nets also be close enough to each other that a person can visit all net locations in a maximum of 10-15 minutes walking, preferably less, if no birds are caught. On flat, level terrain, this array would be about 0.5-0.6 miles (800-1000 m) in length. If 10 nets are placed in a circle or rectangle, this would allow about an average of 75-100 m between nets, and would cover approximately 5-10 ha. In steep or rough terrain, nets should be closer, and the area covered less. In all cases, nets should be spread out as uniformly as possible.

Nets should be placed at the same location and orientation for all 10-day intervals in each year and preferably between years. In the event the vegetation changes between years at a given location, the nets will measure this change, rather than changes in population of the birds. For this reason, care should be exercised in placing nets in locations where the vegetation will remain relatively stable through the life of the study. For example, successional changes, for instance, from a clear-cut to pole-sized trees over 10 years, would be unacceptable for a site. However, when the changes over a decade would be much less marked, the site would be permitted. If, due to unforeseen circumstances, the vegetation is changed markedly at one or two net locations of an array, the nets can be moved to locations with similar vegetation to allow better between-year comparisons. This should be a last resort, and only done after consultation with knowledgeable participants in the program.

Although few problems arise from placement of census points in areas of relatively high human impact, capture arrays must be located with more care. In some areas nets can be left in place (but closed) between capture days if the chance of encounter by visitors is extremely low. In most areas, it is advisable to rig the nets to allow easy removal at the close of a day's effort.

Baiting, artificial water, or taped vocalizations should not be used at any time to attract birds to the nets.

Net Locations

The best locations for the nets are usually on an edge of a habitat. Examples of edges include the boundary between a forest and a field, the boundary between two forests types (e.g., an upland pine and a pine/alder association in a valley), brushy portions of wooded areas, at the edge of a pond, and along a riparian corridor. Especially productive are areas where a habitat type has a narrow section, for instance a hedgerow, that narrows at a gate or where a natural gap funnels the vegetation along a watercourse. Birds, especially shrub species, will naturally be funneled into a net at that spot. Observations of bird movements will often suggest appropriate net locations.

The highest rate of capture is usually found in wetter areas within a given habitat type. If at all possible, natural running or pooled water should be available throughout the summer in the capture array, as it will draw birds from the immediate area. An array aside a major watercourse with a well-developed and wide riparian corridor will tend to monitor this habitat, but will also monitor the surrounding habitats. In many regions of the country, the riparian zone is the only place where sufficient numbers of birds can be captured.

The major goal of a mist net array is to capture birds, not to monitor the birds of a specific habitat. Census methods or nest search are more appropriate for this. An array set in a uniform habitat, such as an old-growth stand of coniferous trees, will usually catch relatively few birds, even if located along a watercourse in that habitat. There are possible exceptions to this, such as eastern deciduous forests (T. Sherry, pers. comm.).

A reasonable goal for capture rate is approximately two birds per net per day. This would result in the capture of approximately 200 or more birds during the season. Typically, the capture rate in the breeding season will be high during the first 10-day period, decline thereafter, and usually increase again during post-breeding dispersal, in July and August in temperate North America.

Erecting and Operating Nets

In order to operate nets properly, the trammels (the horizontal shelf strings that support the net) should be taut horizontally. Except with 6-m nets, this usually involves the use of tie cords bracing the pole upright. These can be arranged at 120^{o} angles to the net, with one end secured to the pole and the other to nearby rocks, bushes, or stakes. When operated, the netting material should not be stretched apart to its full extent, but should allow some slack between the trammel lines; otherwise birds will bounce off the tight net.

If the habitat is higher than the typical net height of 2.5 or 3 meters above the ground, a stacked net can be considered. Although some birds may be missed, it is better to use single nets, rather than to stack them one above another, unless a particular location has a great abundance of birds. Even canopy-dwelling species invariably spend at least some time at lower levels, whether to nest, take water, or forage. The additional time spent putting up a stacked net can usually be better employed by establishing another net in the array. McClure (1984) describes several plans to stack nets; the simplest is to use a strong metal pole, perhaps 8-10 feet long, such as metal electrical conduit pipe. Connect two lengths together with a sleeve (a 10-cm section of conduit slipped over a 20-cm long pipe and glued in place), and tether the pole with a rope. The net can be easily lowered and raised using this method.

For single nets, we suggest the following simple method of putting them in place, adapted from Dennis P. Vroman (pers.

comm.). Clear all vegetation from a net lane 2 m wide to prevent vegetation from becoming entangled in the net. Drive one piece of 1-m by 3/8-inch piece of steel reinforcing bar (rebar) into the ground with a small hand sledge hammer at one end of the net lane on a slight backward angle to the net. Insert a 5-foot section of sawn 10-foot, 0.5-inch or larger, galvanized steel conduit over the rebar. Repeat at the other end of the net lane.

A single net can be kept on a round metal spool (used to hold bulk electrical wire), with a 6.5-inch diameter rim and 3.5- to 4-inch long axle or shaft. Place the loops of the net over the top of the upright conduit; then unroll the net towards the second pole, being careful to keep the loops in order. A second 5-foot section can be placed on each pole in a conduit connector or a sleeve atop the first conduit to allow the net to be fully opened.

When a net is to be closed, it should be spun to keep it from unraveling. To do this most effectively (preferably with two people from both ends simultaneously), leave the topmost trammel separated from the others on the pole, and spin the net on the lower trammels into a tight roll. Then quickly bring the top trammel down atop the roll to keep it from unraveling. This will allow the net to be opened much more quickly than if the net had been spun around all the trammel lines.

To roll up the net, keep all the support cords together and centered on the axle as the net is rolled up to allow easy unrolling. Use a rubber band to hold the loops in place at the end of the rolled net. Poles and rebar can be hidden under vegetation near the net location to save set-up time.

Nets are also commonly put in cloth bags. To take down the net, it is rolled up on small folds and put into the bag, as the biologist moves from one end towards the other.

Net Specifications and Maintenance

A variety of net types can be purchased, but we strongly suggest that the same type be used throughout the life of the study. The net color should be black in forest or brush habitats. The net mesh should be either 30 mm or 36 mm in stretched diameter. The larger net catches more thrush-sized birds, but smaller birds can become more severely tangled. Nets 12 m in length are preferred, although in certain sites a half-net of 6 m long can prove useful. (If a 6-m net is used, its use for one hour equals a half net-hour.) In addition, some suppliers offer "extra-full" nets that provide more capture area. They also offer "tethered" nets that are resistant to bunching by the wind because they are fastened to the trammels. If a nontethered net is obtained, it can easily be tethered by placing drops of a liquid cement along the top trammel.

A net should be replaced when it fades badly or becomes degraded by the sun so that it breaks very readily. A net can be tested by putting two fingers into the net and gently parting them. Nets sustain damage from branches, misuse, large birds, and from the rare occasions when a badly tangled bird must be cut out of the netting. The life can be prolonged by repairs with a strong black nylon twine or thread. Holes should be repaired promptly, or the net replaced, as they affect the efficiency of capture, and make it difficult to figure out how to extract a bird.

Operation of Nets

Net Hours

To minimize variability and make comparisons from different locations, standardization of the number of nets and the number of hours nets are operated has long been advocated. It is extremely important that nets be operated on the same schedule between years, so as to allow direct comparisons. A standard "net" is considered to be 12 m long and 2.5 m high. For calculating effort, one standard mist net operated for one hour is a "net-hour." Two nets stacked atop one another would be considered two nets, although one net location. If operated for one hour, they would total two net-hours.

Although there are methods of compensating for varying number of nets operated in different time periods (Ralph 1976), these are best implemented during migratory periods when there is a high turnover of individuals between days. During the breeding season, when populations are more stable, it is best to operate nets on as regular a schedule as possible. This includes the number of nets, the number of hours, the time of day, the number of days, and the number of days between operations.

We recommend that biologists use the "Record of Net-Hours" form *(fig. 2)*. The data are recorded on a daily basis, as follows:

- State or province—The 2-column code for each.
- Region—An 8-column code, designated by the investigator. Often, the name of the USGS quad, a prominent landmark, or a nearby town will provide the best code name.
- Station—A 4-letter code for the station that contains the mist net array.
- Year.
- Operator(s).
- Net location—Place a 2-column number identifying each net location. Most arrays will have no more than 10 locations, and thus would be numbered 1-10.
- Number of nets—This number is usually one, but if a stacked net is used, or if a net is within 10 m of another, they are considered the same location, and the number of nets is entered here.
- Month and day—One line for each day of operation, but if a net location is operated for more or less time than the other nets, it should get a line to itself.
- Open and close times—Using the 24-hour clock, record the time of starting to open and the time of starting to close the nets.
- Hours open—Calculate the number of hours open to the nearest tenth of an hour (e.g., 4 hours, 20 minutes is 4.3 hours).
- Number of net-hours—Multiply the number of nets by the hours open, and enter here.
- Total net-hours—For each day, total the number of net-hours.

Time of Day and Number of Checks

Nets should be opened within 15 minutes of local sunrise and operated for a minimum of 4, and preferably 6, hours per

RECORD OF NET- HOURS

STATE CA REGION MTSHASTA STATION BEVA YEAR 1992 OPERATOR(S): JANE BIRDER, BILL BASS

	NET LOCATION:			1	2	3	4	5	6	7	8	9	10							TOTAL NETS
	NUMBER OF NETS:			1	1	2	1	1	1	3	1	1	1							13
MO./DAY	OPEN TIME	CLOSE TIME	HOURS OPEN	NUMBER OF NET- HOURS PER LOCATION																TOTAL NET-HOURS
6/6	0530	1030	5.0	5.0	5.0	10.0	5.0	5.0	5.0	15.0	5.0	5.0	5.0							65.0
6/7	0535	1035	5.0	5.0	5.0	10.0	5.0	5.0	5.0	15.0	5.0	5.0	5.0							65.0
6/8	0530	1050	5.3	5.3	5.3	10.6	5.3	5.3	5.3	15.9	5.3	5.3	5.3							67.9
6/9	0530	1030	5.0	5.0	5.0	10.0	—	5.0	5.0	15.0	5.0	5.0	5.0							60.0
6/9	0830	1030	2.0	–	–	–	2.0	–	–	–	–	–	–							2.0
6/10	0540	1040	5.0	5.0	5.0	10.0	5.0	5.0	5.0	15.0	5.0	5.0	5.0							65.0

3/23/92

Figure 2—The “Record of Net-Hours,” for recording and summarizing net-hours.

day. Nets should be checked every 45 minutes (more often in inclement or very hot weather) and absolutely not more than once each hour. That is, the net round should begin no longer than 45 minutes after the *start* of the previous round. Nets should be opened in the same order each day, and closed in the same order that they were opened. It is very desirable that the number of hours for each net location should be the same for all 10-day intervals and for all years. Each station should be operated once per 10-day monitoring interval throughout the breeding season. We recommend that arrays be run no more than once per 10-day interval. Running arrays more than twice per interval greatly lowers capture probability per net hour. If sufficient time is available, it is far more productive to set up another array, rather than increasing effort at a single station.

When To Close Nets

The nets should not be operated in rain, wind, and extreme heat. If already open when these conditions occur, they should be closed, because precipitation is heavy enough for the birds’ feathers to become wet enough to lose their insulation. Strong winds can cause severe tangling. In general, a steady wind of more than 10 mph or occasional gusts to more than 15 mph should be watched carefully for their effect on netted birds, and the nets should be closed if necessary. Finally, in situations with excessive heat and direct sunlight with little wind, netted birds can quickly overheat and die. On such hot days, birds should not remain in an exposed net for more than 15 minutes.

A certain amount of mortality may occur whenever wildlife is handled or trapped. However, mortality rates in most netting projects usually approach zero, and generally average less than 1 percent when mortality does occur. If mortality consistently occurs in nets, or exceeds an average of 1 percent, it is likely that birds are not being processed quickly enough, probably during their removal from the nets. Under these circumstances, scrutinize closely the criteria for closing nets and the expertise of the people running the station.

Removing Birds from Nets

Below we suggest some methods for extracting birds from mist nets. The methods are used by most netters, were derived from ideas of Shreve (1965), and were later modified and augmented by Ralph (1967, 1988). Practice and careful review of these techniques are essential. Most importantly, be careful. The life and health of the birds are of primary concern.

As you work on a badly tangled bird, it is important to remember that the bird can usually be backed out easily, unharmed, in the direction from which it entered the net. You *must first* take the time necessary to figure out exactly how the bird went into the net. Observe carefully from which side the bird entered the net, and between which trammels it went, in order to find the opening of the pocket the bird made. Do not just grab the bird, tempting as it may be. Start on the side of the net which the bird entered; part the trammels and netting loosely, and look into the pocket caused by the weight of the bird. Because the tail is the last to enter, look at its position to get a clue about how the bird entered the net. Back the bird out the way it went in, step by step. A light touch is the most important prerequisite for all methods. After determining where the bird entered, several standard procedures are used for removing birds, but different species and different problems will require some improvisation.

We describe the various methods used to remove birds from nets below. No one method will suffice for all birds, because each bird flies into a net differently. Combinations of methods will often be necessary. In all methods it is often desirable to know where the strands of net are amongst the bird's feathers. This knowledge can help you decide where to move your fingers next. By far the best method is to pull gently at the exposed netting and see where feathers move on the bird. This will tell you where the net strands are binding, leading to quicker removal.

Body Grasp Method

This method has recently been used by some stations, and it has been found to surpass other methods in ease of learning, reduced injury to the birds, and speed of removal. About 9 of 10 birds can be removed with this method.

1. Find out from which side of the net the bird entered. Find the opening of the pocket caused by the weight of the bird.

2. You have three choices at this point. (1) If the bird's body is accessible, without any netting in the way, and the net free of the back and head, just put the bird into the "bander's grip," with your palm against its back, your index and middle fingers on either side of the neck, the left wing held with your thumb, and the other fingers curled around the body and the right wing. Then proceed to step #7 below. (2) If the net is tangled around the head and wing, just slip your fingers over the body and under the wings. This usually involves your thumb around the breast and your fingers over the bird's back, and down over its sides and under the wings and carefully around the curve of the body. (3) If the body is too tangled to be available for a body grasp, then one of the other methods below must be used.

3. With the body now firmly secured, back the body out of the net to expose at least the bend of one of the wings. Then, remove the net from the wings. Flick net threads from the bend of the wings, working from the underside. Generally your thumb should be placed under the thread(s) on the underside of the wing and your forefinger placed on the outer bend of the wing as a fulcrum to flick the thread over. Often at this stage it is helpful to pull gently on the exposed portions of the still tangled threads in order to free them or to see where they are caught.

4. When one wing is free, slip your fingers over the now-exposed wing, securing it against the bird's body. Then, pull remaining loops from around the neck, working from the back of the head forward, in the manner of removing a T-shirt.

5. Remove the net from the other wing, as above.

6. The bird should now have gradually been put into the "bander's grip."

7. Pull the bird up and away from the net, and it will usually free its own feet in an effort to fly. If the toes are caught, untangle them by pulling strands gently. You will notice that if the heel joint is straightened out, the bird's toes have a tendency to relax, so that the netting can be more easily removed. If the bird is clutching the net firmly, extract the feet by (1) first freeing the opposable toe (the "thumb") by sliding the threads over it and lifting it away from the other toes; (2) with the fingers, straightening the other three toes out; and (3) sliding the netting over the toes with repeated strokes.

This method, when administered with a nimble hand and a light touch, is very easy on the bird because the only firm contact is on the sides of the neck. It is also a time saver, because feet untangle themselves. The method works best with a recently caught bird that has had little time to entangle itself, but is applicable to most birds.

Feet First Method

The original, and perhaps still the most widely used method, is somewhat slower but is usually the way that beginners are taught. Its main disadvantage is that it requires holding the legs, sometimes causing injury or breakage. It involves the following steps:

1. As before, find the side of the net the bird entered.

2. If you (the bander) are right-handed, grasp both tibiae (the tibia is the feathered part of the leg above the bare tarsus) from the rear of the bird using your left hand so that your fingers point towards the bird's head. The bird should be upside down in the net when you have your grip.

3. Put your index finger between the tibiae, and press your thumb against the bird's right tibia and your middle finger against the left tibia. This leaves your right hand free to remove net strands from the entangled legs and feet.

4. Most importantly, make certain that all threads are pulled down and off tibiae and thighs below the heel joint, the prominent joint between the tibia and tarsus. These threads are sometimes high up on the thigh at the flank.

5. Untangle the toes by the method described in the body grasp method above.

6. Pull the bird up and away from the net, still holding the bird upside down by the feathered tibiae, above the bare tarsus. Flick net threads from the bend of the wings, working from the underside. Generally the thumb should be placed

under the thread(s) on the underside of the wing and the forefinger placed on the outer bend of the wing as a fulcrum to flick the thread over. Often at this stage it is helpful to pull gently on the exposed portions of the still tangled threads in order to free them or to see where they are caught.

7. When both wings are free, pull remaining loops from around the neck, working from the back of the head forward. Be sure to secure the bill by placing the thumb against the tip while pulling the net over the head in order to protect the delicate neck.

Rollover Method

A third method requires a little practice but is applicable to almost every situation:

1. As always, determine the side of the net entered.

2. Grasp the left (or right) leg above the tarsus and release the foot.

3. Release the left (or right) wing; release the head, then the other wing. Grasp the bird normally with the "bander's grip." Finally, free the right foot.

This method requires an experienced "feel"—the bird is rolled over and released in order of foot, wing, head, wing, and foot. This method is especially recommended when one of the legs is particularly badly tangled. Work so as to free that leg last.

Processing

Once the birds are removed from the nets, put each individual in a separate, small cloth bag, and transport to the processing site. It is probably best to have a central processing site, rather than to process birds at each net as they are captured, because: (1) a biologist rapidly circulating around the nets can better monitor the captures, in case of an influx of birds that might necessitate shutting down some nets temporarily; and (2) it lessens the disturbance in the vicinity of the nets. Further, if processing becomes delayed, it is always preferred to have the birds out of the nets and stored in bags. Bags should be made from opaque cloth, and sewn so that the seams (and possible loose threads that can catch toes) are outside. Hang bags from hooks or branches to prevent them from being stepped on, and out of direct sunlight. They should be washed often.

Birds should be released at the processing site except for females (indicated by a brood patch) and dependent juveniles (indicated by a frizzy appearance and a growing tail). They should be released at the point of capture.

Recaptures provide the most important data in a constant-effort mist netting program. We suggest, if some birds have to be released without processing, that recaptures have a much higher priority for processing than unbanded birds. If birds have to be released without complete processing, we suggest that the following be regarded as the priorities, in order: (1) band number (if a recapture); (2) species; (3) age (usually involves skulling, or diagnostic plumage characters); (4) new band number (if previously unbanded); (5) sex; and (6) other measurements or data. Please notice that the species and age are the two variables which are considered absolutely critical. If these are not accurately and completely recorded, the time and money spent in the monitoring has minimal value to the objectives.

Special Problems

Tongue Caught in Net

The mouth structure of birds, especially thrushes, thrashers, and woodpeckers, allows net threads to catch behind the tongue. While the bird's head is held between your index and middle finger, your third and fourth fingers and thumb can hold the net near the side of the mouth and relieve pressure on the tongue by pulling the net backward along the side of the head. A pencil, crochet hook, or a sharp twig can be manipulated with your free hand to lift the thread from behind the cleft of the tongue. Until one becomes deft at releasing the tongue in this manner, a small pair of a scissors is invaluable. Usually, clipping a single strand of mesh will do the trick.

Badly Caught Birds

As a last recourse, to remove a strand from a tongue, or to rapidly extract a bird in distress it is sometimes necessary to cut a few threads with a scissors, a stitch ripper (sewing tool that cuts threads along seams), or a sharp knife. The most rapid method is to find an area with few (or only one if possible) layers of netting. Clip as few strands as possible, just enough to bring the bird through the net. Then free the bird in the normal manner. It should be very rare to need to cut more than three strands. Before releasing such a bird, look carefully to ensure that no net remains on the bird.

Data Collection

One of the first steps a biologist must take to make the capture work more meaningful is to properly record the data presented each time that a bird is caught. Much of the following was extracted from Pyle and others (1987) and Ralph (1967, 1988). The identification guide by Pyle and others (1987) should be included in all netting kits.

At each net location, we suggest that the Location and Vegetation Form *(fig. 15*, discussed in detail below) be filled out. The Location information on the first three lines of the form is vital to data base management.

For each individual captured or recaptured, we recommend that the following data be recorded. In addition to date, time, and location, it is imperative that the species be accurately identified. It is also vital that the age and the sex of the birds be determined. We highly recommend that determining the amount of skull pneumatization be a top priority, as essentially all analyses depend upon accurate ageing. Age and sex determinations are generally complicated by the highly variable nature of size, plumage, and molt patterns in each species. We recognize that a certain percentage of individuals cannot be reliably aged, sexed, or identified with any one or even all of the published criteria. Remember that with age and sex it is better to be cautious than inaccurate. If the bander is unsure of an age/sex class, we recommend that the record be conservative, by recording the age or sex as unknown, and separately noting which class seems likely. By using the skull pneumatization and the literature carefully, determinations can be made with above 99 percent confidence. Information on how the bander aged and sexed the bird can be used to screen improperly processed birds. We also highly recommend that the breeding condition of adults, the extent of juvenal plumage and molt, and the wing chord also be recorded.

For the various attributes below we suggest a letter or numeric code. We strongly suggest that whatever codes are used at a station should be used consistently between years, or certainly within a year. Alpha (letter) codes have the advantage of being mnemonic in nature, increasing accuracy. Numeric codes have the advantage of retaining the order of progression from small, none, or few, to large or many.

Plumage Attributes

The first plumage (subsequent to the natal down) acquired by the nestling and retained by the juvenile fledgling is called the juvenal plumage (note the difference in spellings). The body feathers of this plumage are replaced during the first prebasic molt, which almost always occurs within three months of fledging and usually takes place on the breeding grounds. Juveniles are readily aged by many criteria and are generally sexually indistinguishable by plumage. The juvenal plumage is usually more streaked or spotted than that of the adult, and juveniles will often have wing bars where the adult has none. Juvenal feathers also have a more loosely structured contour *(fig. 3)*, most evident in the feathers of the nape, back, and undertail coverts. In addition, many nestling characteristics are evident in young juveniles which can also be helpful in separating them from adults. The gape of nestlings and early juveniles is swollen and more brightly colored than that in adults, and the inside of the mouth is also brighter in tone, or paler in hue, or both, in juveniles than in adults. Several characters useful for separating first-year birds from adults can be applied to juveniles. In particular, summer adults in alternate (breeding) plumage should show very worn flight feathers while those of juveniles should be relatively much fresher. And, of course, the pneumatization process is just beginning in juveniles, whereas it should be complete (or nearly so) in adults. Finally, eye color is useful for separating juveniles of many species, being generally grayer and paler in juveniles and redder and darker in adults. In summary, biologists should have no trouble with the separation of juveniles from adults during the summer months, when all criteria are used.

In most passerine species, however, birds in juvenal plumage cannot be reliably sexed by in-hand criteria alone. Only in a few species, in which differences occur in the color pattern of the flight feathers, can juveniles be sexed by plumage.

As juvenile birds go through their first molt, normally in the fall, they assume a plumage that is often similar to that of adults, especially to that of the adult female in sexually dimorphic (having a male and female plumage) species. Inspecting the skull is now recognized as being the most reliable technique for ageing these birds.

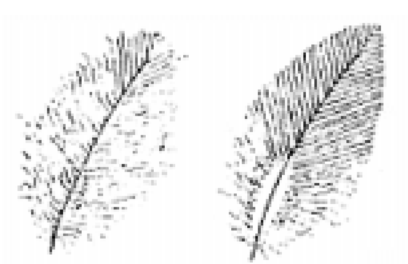


Figure 3—The contrast between juvenal and nonjuvenal body feathers. The differences are most apparent with undertail coverts and feathers of the nape and back. Taken from Pyle and others (1987).

Age Classes

The various age codes suggested below follow, for the most part, the system used by the U.S. Fish and Wildlife Bird Banding Laboratory and the Canadian Wildlife Service Bird Banding Office, as listed in the North American Bird Banding Manual (CWS and USFWS 1991). The system is based primarily on the calendar year. Following are the age designation, the alpha code used by the Services, a suggested one-letter abbreviation (or optional numeric code) for purposes of this handbook (where different from the Services' code), and a definition of the age class.

Unknown (**U** or 0). Age cannot be determined with absolute confidence.

Local (**L** or 4). A young bird incapable of sustained flight.

Hatching Year (HY) (**H** or 2). A bird in its juvenal or first basic plumage during its first calendar year (i.e., from its fledging until December 31 of the year that it fledged).

Second Year (SY) (**S** or 5). A bird in its second calendar year (i.e., January 1 of the year following fledging through December 31 of the same year).

After Hatching Year (AHY) (**A** or 1). A bird in *at least* its second calendar year. This code is more significant after the breeding season, when it implies an adult. Before the breeding season, it essentially means "unknown" (either SY or ASY).

After Second Year (ASY or 6) (**O** [older]). An adult in at least its third calendar year (i.e., a bird in at least the year following its first breeding season and second prebasic molt). A bird known to be in its third year, or older, should be indicated by "O," and a note should be made in the Notes columns.

Skull Pneumatization

Determining the amount of skull pneumatization, also known as ossification, is the best method of ageing most species of birds during the summer and fall months and, for some species, is proving useful through the early winter and even into spring. The importance of this method cannot be understated. If you take only one datum besides species, skull pneumatization is quite probably the next most important.

This technique came into common usage in the late 1960's. Biologists are strongly urged to become proficient at skulling and to skull most passerine species throughout the year. When a fledgling passerine leaves the nest, the section of the skull overlaying the brain (frontals and parietal) consists of a single layer of bone. From fledging until the bird is four to 12 months old (depending mostly on the species), a second layer of bone develops underneath the first. The two layers are then separated slightly by spaces or air pockets and joined by small columns of bone. This process is called skull pneumatization.

The pattern generally follows one of the two progressions illustrated in *figure 4*, but may show other variations. Smaller species tend to show the peripheral pneumatization pattern, and larger species the median line pattern. Individuals of certain species may show either pattern, however, and the exact shapes of the unpneumatized areas or "windows" will also show substantial individual variation.

Any passerine found with a partially pneumatized skull *(fig. 4a-c)* can be reliably aged as a hatching year bird, with the exception perhaps of occasional summer or early fall birds with small windows *(fig. 4d)*. In most North American passerine species, the skulls of the earliest hatching year birds become completely pneumatized in October and November, and the latest birds become complete between November and January, but for purposes of this monitoring effort during the breeding season, all hatching year birds will have incomplete pneumatization.

In some (perhaps many) species, small unpneumatized windows may normally be retained until spring and even early summer. This is most commonly seen in the longer distance migrants such as certain flycatchers, swallows, thrushes, and vireos. Birds with windows greater than one millimeter in diameter *(fig. 4d)* are probably reliably aged as Second-years through June of their second year. Birds with smaller windows are not necessarily in their hatching year, because some small proportion (probably less than 1 percent) of individuals will never show complete pneumatization. Birds with small windows in July and August are most likely to be advanced young of that year.

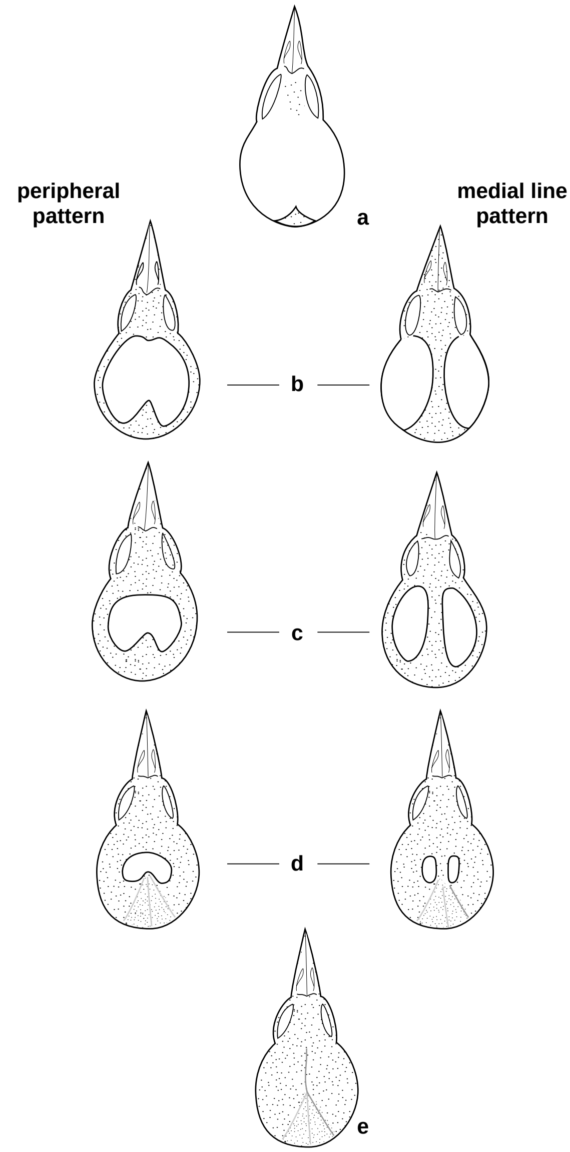


Figure 4—The two common patterns of skull pneumatization, from a very young bird ("a"), to a completely pneumatized bird ("e"). Taken from Pyle and others (1987).

The Process of Determining the Extent of Skull Pneumatization

Unpneumatized areas of the passerine skull usually appear pinkish or dull reddish, whereas pneumatized areas appear grayish, whitish, or pinkish-white, with small white dots indicating the columns of bone. The color or contrast between these two color patterns, or both, can usually be seen through the skin of the head, especially after the head has been wetted to allow parting of the feathers, and to make the skin more transparent.

To skull a passerine, start by holding the bird in the position shown in *figure 5*. This hold facilitates skulling because the skin can more readily be moved around the skull, allowing a large area of the skull to be viewed through a small area of skin. In order to see the skull, the feathers need to be parted such that a small opening of bare skin is created. This can be accomplished without wetting the feathers, but is much more easily done if a small amount of water is applied to the head (do not apply detergent or alcohol solutions). During cold weather, the few drops of water used to make the skin more transparent should have no effect on the bird's ability to

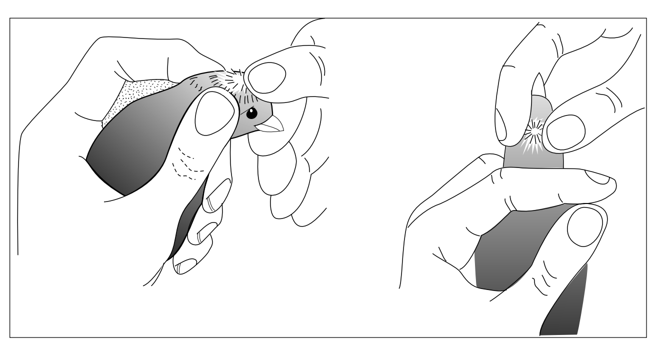


Figure 5—Two good holds for skulling a bird. It is best to look to the side of the mid-line of the skull. Taken from Pyle and others (1987).

maintain its temperature. If there is concern about this, simply put the bird out of the wind in a dry bag for a few minutes before releasing it.

It is usually easiest to part the feathers by running your thumb or finger forward over the crown, against the direction in which the feathers lie, and then moving the feathers off to each side. In the summer and early fall, when most young birds are just beginning the pneumatization process, it is good to start at the rear and the side of the skull and work up towards the crown. Later in the fall, the parting should be made higher up on the crown (in the areas just above and behind the eyes), where the last unpneumatized windows usually occur. With thicker-skinned birds, one can improve viewing by parting the feathers on the side of the head or neck (where the skin is more transparent) and moving the skin up to the crown. When the skulling process is finished, the feathers can be smoothed back into place.

It is usually best to hold the bird under a fairly strong lamp or in indirect sunshine to achieve the best lighting conditions for viewing. Very bright light often creates a glare off the skin. It is often helpful to move the head around, because different angles of light can make it easier to see through the skin. We strongly recommend using a magnifying device such as a visor that slips over your head.

Move the skin back and forth—the spots will be stationary, and thus visible. *If the tiny white dots are not visible, one is not properly viewing the skull,* or the bird is a very young juvenile with an entirely pinkish skull. "Seeing" a boundary between whitish and pink areas is not enough, because one might be seeing only bone structure unrelated to pneumatization. Start looking at the skull at a point at its base and slightly to one side. Continue looking forward until just halfway between the eye and the top of the crown. If at no point the dots disappear and are replaced by a clear pink area, the skull is fully pneumatized. Because the pneumatization usually proceeds centripetally and anteriorly, be sure to examine the area between the eyes of all birds with pneumatized skulls, to make sure that they are not "advanced" immatures.

Also look for entirely pinkish skulls in very young birds *(fig. 4a)* in June-July and for contrasts between the pneumatized and unpneumatized areas in older birds (most frequently after August). Small windows *(fig. 4d)* should be carefully looked for at all times.

Any of several factors may make it difficult or impossible to see the pneumatization of the skull. These include: the skin of the head being too thick; large amounts of fat in the skin during fall migration and winter; and dark, or otherwise opaque, skin (especially in molting or injured birds). It is especially difficult to see the pneumatization of the skull in molting birds, because of the thickening and the excessive flaking of the skin.

We suggest codes for categories of skull pneumatization. Because the critical differences are often in the 0-5 percent or 95-100 percent categories, care should be taken. It can make a great deal of difference in evaluating the age during the breeding season to know that a skull had only small windows (e.g., 98 percent pneumatized) and could have been either a second-year bird or perhaps a young bird, as opposed to one that was perhaps 70 percent and almost assuredly a young bird.

The codes we suggest are:

N or 0 - **N**o white spots showing, only a single, thin layer of bone covers the entire brain.

T or 1 - **T**race of pneumatization at the very back of the skull, usually appearing as an opaque, grayish crescent or a very small triangular area. Between 1 and 5 percent of the skull is pneumatized.

L or 2 - **L**ess than one-third pneumatized, but some is obvious. Generally the posterior part of the cranium has a triangular or circular area of small white dots, usually distinctly contrasting with the nonpneumatized area.

H or 3 - **H**alf the skull pneumatized, between one-third and two-thirds complete. Typically, most of the rear half is complete, as well as part of the front, extending back to the eyes. The front is usually difficult to see, because of dense, short feathers.

G or 4 - **G**reater than two-thirds pneumatized, but at least a small area not complete, less than 95 percent complete.

A or 5 - **A**lmost complete pneumatization, between 95 percent and 99 percent complete. These birds show a tiny dull, pinkish area or "windows."

F or 6 - **F**ully complete pneumatization.

U - **U**nknown, skull examined, but extent of pneumatization not determinable.

Sex Determination

The best method for determining the sex of sexually monomorphic passerine birds during the breeding season is by the presence or absence of the cloacal protuberance in the male, and the brood patch, which primarily occurs in females. All North American landbirds develop at least one of these characteristics, at least partially, and most are reliably sexed by them during the late spring and summer months. Latin American birds are less well-known, but these guidelines should generally apply.

Cloacal Protuberance—In order to store sperm and to assist with copulation, external cloacal protuberances, or bulbs, are developed by male passerine birds during the breeding season. They usually begin to develop early in the spring and reach their peak size in 3-5 weeks. Depending on the species and the number of clutches attempted during the breeding season, cloacal protuberances will recede from mid to late summer.

Although the cloacal regions in females will sometimes swell slightly, or show a small protuberance, it rarely approaches the size of those in the males (the Wrentit appears to be an exception). If the swelling forms a gradual slope on the abdomen ending with the cloacal opening pointing towards the tail, then it is probably a female in breeding condition. When the female is most swollen in this area, she will usually also have a brood patch. A typical male protuberance essentially forms a right angle to the abdomen and is somewhat larger at the top than at the bottom.

To view the protuberance, blow the feathers apart in the region of the vent. The shape of the protuberance can be somewhat variable, and nonbreeding males may not always develop one. After a little experience with the shape of the cloacal region during the nesting season, biologists should have no problem separating breeding males from females.

We have categorized cloacal protuberances into four size categories *(fig. 6)*: none (**N** or 0), small (**S** or 1), medium (**M** or 2), and large (**L** or 3). As one becomes familiar with the various extents of protuberances, one can make a judgment on the relative size.

Brood Patch—Incubation or brood patches are developed by incubating birds as a means of transferring as much body heat as possible to eggs or young in the nest. In most landbirds, females perform all or most of the incubating, and develop more substantial brood patches. The presence of a distinct brood patch can thus be used to reliably sex breeding females of almost all passerine species.

The development of the brood patch begins with the loss of the feathers of the abdomen, about 3-5 days before the first eggs are laid (Blake 1963). Shortly thereafter, the blood vessels of the region begin to increase in size, and the skin becomes thicker and filled with an opaque, whitish fluid. *Figure 7a* illustrates a full brood patch as viewed by blowing

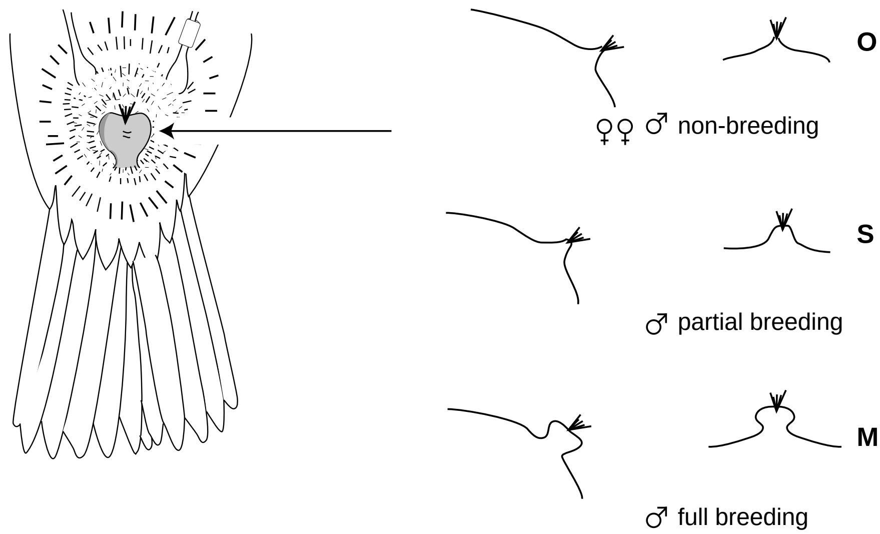


Figure 6—On the left, a cloacal protuberance at its peak in a male passerine. On the right a nonbreeding male (class = 0), a male beginning to be in breeding condition (class = S), and a male in full breeding condition (class = M). Class "L" would show a more prominent protuberance. Taken from Pyle and others (1987).

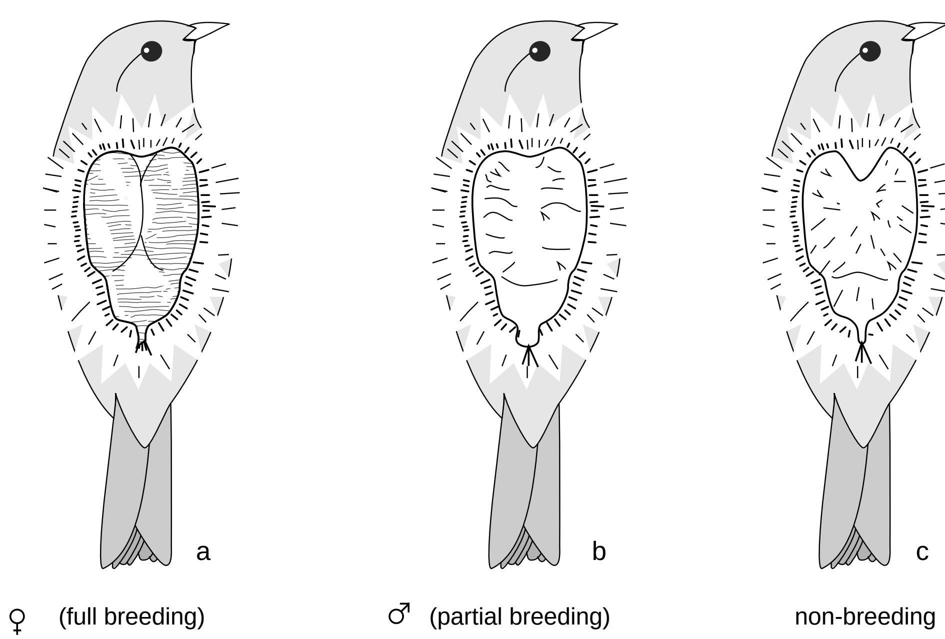


Figure 7—Brood patches in different stages of development. Taken from Pyle and others (1987).

the feathers of the breast aside. A few days after the fledglings leave the nest, the swelling and blood vascularization will begin to subside. If a second clutch of eggs is laid, the process (except for defeathering) will be repeated. A new set of feathers on the abdomen are usually not grown until the prebasic molt, after completion of breeding. Between the end of nesting and the onset of molt, the skin of the abdomen will often appear grayish and wrinkled. Many young, and especially juvenile, passerine birds have little or no down or feathers on the belly; therefore the belly of some young look much like that of an adult who is just beginning to develop a brood patch, but the area will be quite smooth and usually a pink or dark red.

In most North American passerine birds, the male does not develop a brood patch in the breeding season. Slightly fewer feathers may be present on the abdomen than are found in the winter, but the breast retains a feathered appearance. In a few groups, in North America, notably the mimids, vireos, *Myiarchis* flycatchers, and a few other species (see Pyle and others 1987), the male will assist with incubation and develop an incomplete brood patch. This will include partial or complete feather loss and slight to moderate vascularization and swelling, which rarely or never approaches the extent of development typically found in females of the same species. Only in the Wrentit and the woodpeckers does the male develop a full brood patch.

We suggest recording brood patch in the order of its development as follows:

N or 0 - **N**o brood patch present—Breast more or less feathered. Nonfeathered areas of the breast and abdomen smooth without evident vascularization. In some species such as hummingbirds, and in most young birds, the breast is normally not feathered.

S or 1 - **S**mooth skin—A loss of breast and some abdomen feathers, but most of the area is still rather smooth and dark red.

V or 2 - **V**ascularized—Abdominal skin thickened with increased fluid and vascularization. This is the peak of incubation.

W or 3 - **W**rinkled—Abdomen skin thinning, wrinkly, and scaly.

M or 4 - **M**olting—New pin feathers are coming in on the abdomen. Nesting is usually completely over by this point.

Measurements

The standard reference for measuring birds is Baldwin and others (1931), which outlines virtually every possible measurement. Although old, it is commonly listed as available in catalogs of used natural history books.

Size, as indicated by specific measurements such as wing, tail, or tarsus length, is often a useful characteristic for identifying, ageing, and especially, for sexing passerine birds in the hand. In almost all passerine species, the size of males of a given population will average larger than that of the females by about 5-10 percent. The extent to which the sexes overlap in size depends on both the species and the particular measurement being considered. Measurements also vary with age, but to a lesser extent than with sex. For example, juvenal primaries tend to be slightly (2-5 percent) shorter than adult primaries. Within each sex class, immature birds with juvenal primaries will have shorter wing lengths than adults. When coupled with weight and fat, size can also give a strong indication of the health of a bird.

When identifying, ageing, or sexing passerine birds it is important to use measuring techniques that are strictly standardized with those of published samples. In the following sections we recommend standardized methods for obtaining the measurements. All linear measurements should be recorded in millimeters (mm).

Wing Length—Although various methods of measuring wings are employed, we recommend that you measure the wing chord, because this is the length most frequently used and most widely published for North American birds, and is the most consistent between measurements. The wing chord is measured from the bend of the wing to the tip of the longest primary, across the natural arc of the primaries *(fig. 8)*. While taking the wing measurement, avoid the tendency to flatten the natural curve of the wing, thus getting a measurement that is 2-5 percent longer than proper.

To measure the wing chord it is best to have a thin ruler with a perpendicular stop at zero. Insert the ruler under the wing, and place the bend of the wing (carpal joint or “wrist”) snugly against the stop. To avoid differences due to carpal compression, we recommend that the bend of the wing be pushed against the stop with no more pressure than the wing itself applies when the ruler is moved up to the wing. Once the wing is in place, make sure that the line between the carpal joint and the tip of the longest primary is parallel with the edge of the ruler, gently lower its tip to the ruler so that it touches it, and read the wing chord length *(fig. 8)*.

When measuring the wing it is important to make sure that the longest primary is not broken, bent, or molting. Bent primary tips should be straightened. Older and more worn primaries will result in a shorter wing measurement and should be noted.

Weight—Because bird weight varies substantially with geographic population, condition of the individual, and season or period within the life cycle of each particular species, this measurement is not as useful for ageing, sexing, or identifying birds as is the wing chord. Weight, however, is an important indicator of the health of the bird, especially when coupled with wing length and fat content. It should always be recorded, when possible, to the nearest tenth of a gram.

Molt

Types of Molt—Relatively little is known about the timing, sequence, and extent of molt in many species, especially in Latin America. A proper understanding of molt can be extremely helpful in the accurate ageing and sexing of passerine birds in the hand. With a few known exceptions, molting is confined to two periods within the annual life cycle of North American passerine birds, just before and just after the breeding season.

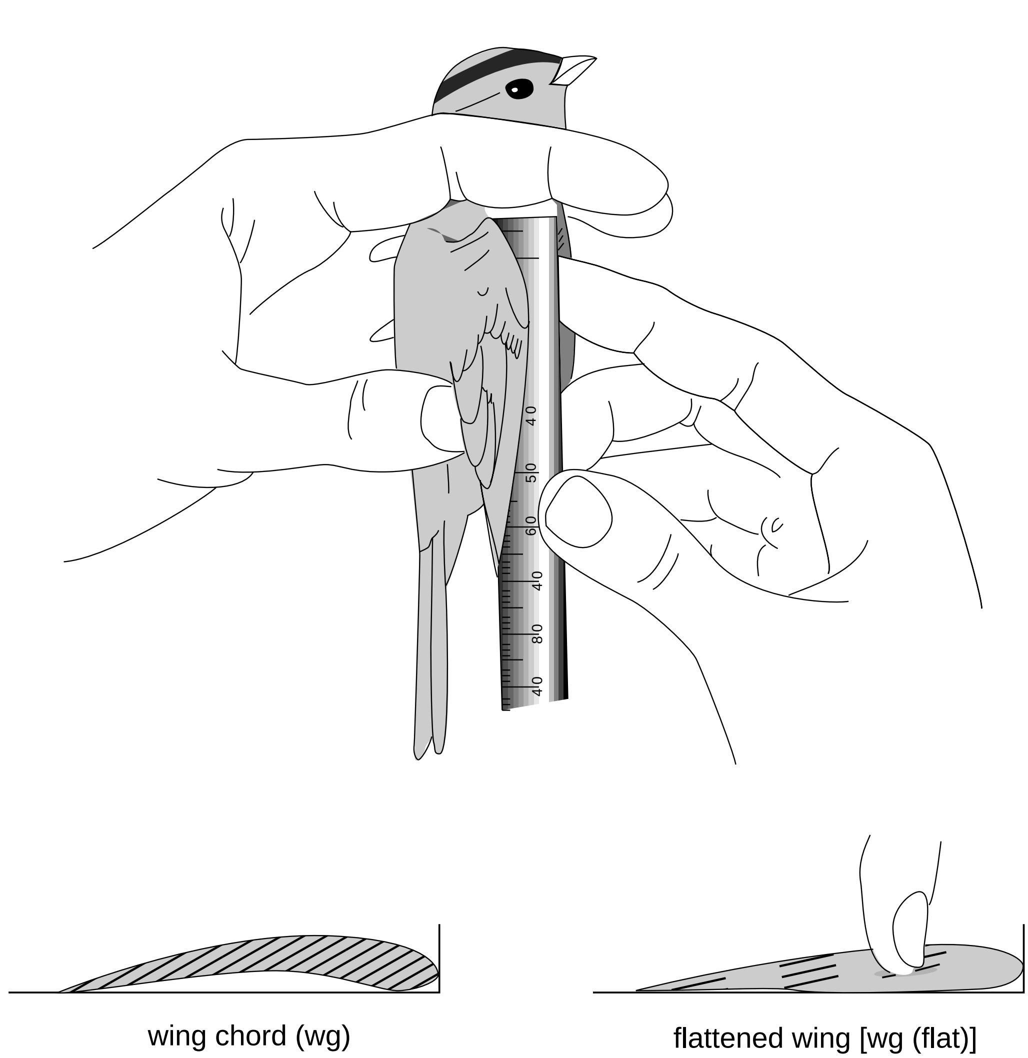


Figure 8—Above, a good hold for measuring the wing chord, and below, the measurement of the wing chord and flattened wing. The wing chord is preferred in North America. Taken from Pyle and others (1987).

Thus, most adult passerine birds display two plumages, the basic (winter) plumage and the alternate (summer or breeding) plumage. The molt that occurs just before the breeding season is called the prealternate molt; that occurring just after the breeding season is the prebasic molt. All North American passerine birds have a prebasic molt, and just over half (predominantly migratory species) have a prealternate molt.

The prebasic molt usually occurs from July to September on the breeding grounds and occurs in both recently fledged birds and adults that have completed nesting activities for the year. With one or two exceptions, the prebasic molt in adult passerine birds is "complete" *(fig. 9*; includes all body and flight feathers), whereas hatching year birds of most species typically replace the body feathers and some coverts, but not the primary coverts, and flight (wing and tail) feathers (except the central two tail feathers) during a "partial" first prebasic molt.

As you blow apart the feathers on the various areas of the body, you can easily determine which feathers are molting by the presence of a cylindrical sheath around the base of the molting feather. When the feather is fully grown, this sheath is preened off and the feather ceases its traffic with the body and is thus fully grown.

Birds have three types of flight feathers: the rectrices, or tail feathers, and the outer (primary) and inner (secondary) wing feathers. The rectrices are numbered in pairs, beginning with the central ones (the "decks") as #1, and proceeding outward in both directions usually to #5 or #6, depending upon the taxon. In some species the decks are sometimes molted by the young at the same time as their body feathers. The remaining rectrices molt in an ascendant sequence from #2 through #6.

The secondaries are long flight feathers attached to the skin at the ulna, the bone of forearm. These are numbered by all authors beginning at the bend of the wing and proceeding inward toward the body. This is the usual order of molt, except that the three innermost secondaries (tertials) molt like body feathers and may be molted by juveniles. They are also often molted concurrently with the longer secondaries.

The primaries are the long flight feathers attached to bones of the "hand." These are numbered in most of the North American literature from the wrist-joint (bend of the

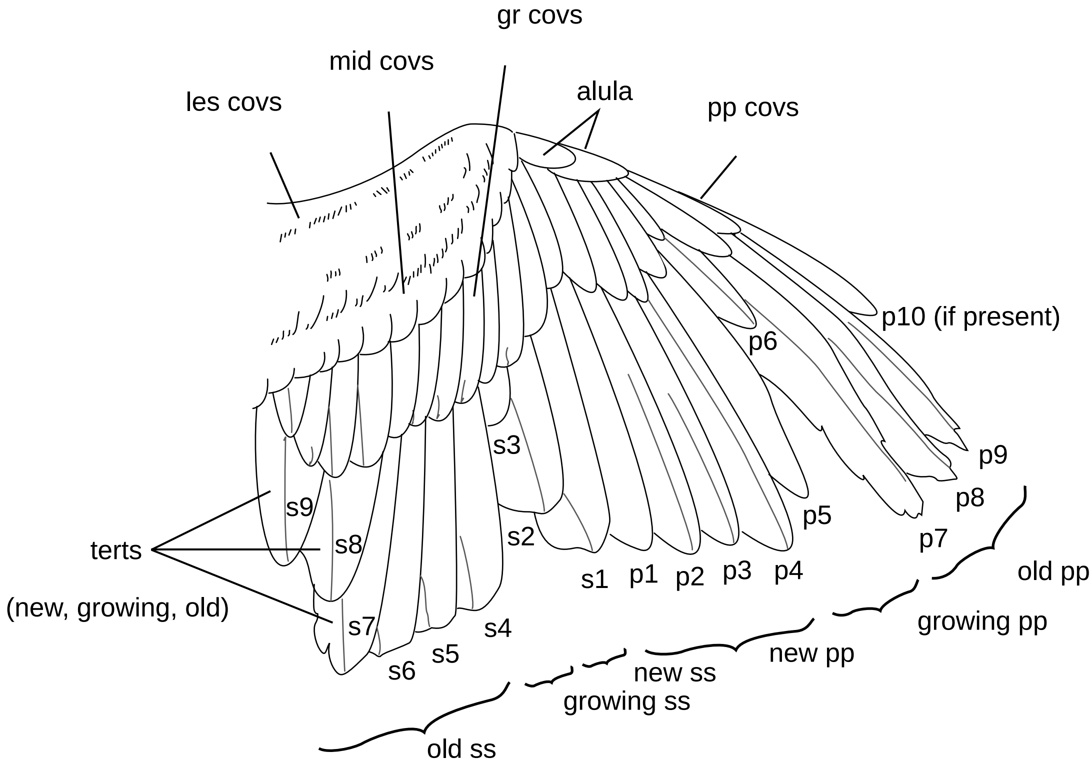


Figure 9—An example of a wing during complete molt of an adult. Notice the worn primaries 7-9 and secondary 7. Taken from Pyle and others (1987).

wing) outward, which is the sequence that nearly all birds molt these feathers.

Pyle and others (1987) have provided a complete enumeration of the numbers of flight feathers of passerine birds in North America.

Recording Molt—A basic system of recording molt in the flight feathers is to record presence or absence of molt in the primary feathers or the secondaries (except the innermost three). We suggest that the molt in the tail feathers not be recorded, except as a note. You should always check both wings, because birds often lose feathers accidentally ("adventitious molt"). Flight feather molt is "**S**" if **s**ymmetrical and normal, "**A**" if **a**dventitious, and "**N**" or "**0**" if **n**one.

More detailed recording of molt can be conducted using the British Trust for Ornithology's method (Ginn and Melville 1983).

Body molt can be recorded by a subjective determination of none (**N** or 0), trace (**T** or 1) (a few, perhaps adventitious molting feathers), light (**L** or 1) (involving more than one feather tract), medium (**M** or 2), or heavy (**H** or 3) molt.

Extent of Juvenal Plumage

We suggest that the extent of juvenal plumage be recorded, because it is a good indicator of the age of a young bird and the timing of breeding. Juvenal plumage can be coded in the following: **N** or 0 = no juvenal body plumage; **L** or 1 = **l**ess than half of juvenal plumage remains; **H** or 2 = more than **h**alf of the juvenal plumage remains, some first basic plumage is visible; **F** or 3 = **f**ull juvenal plumage, bird has not started first prebasic molt. For a more objective measure, the bander could estimate the percent of juvenal plumage.

Primary Feather Wear

Feather wear could be a useful indicator of age, because it seems likely that the juvenal generation of flight feathers may wear faster, and thus show more wear at any given time, than later, adult generations of feathers. Faster wear results from the rapid growth of juvenal feathers resulting in weaker feathers, and the protracted molt of adults. In some species during especially the early breeding season, adult flight feathers, molted after the previous breeding season, are much older than juvenal feathers and can help age birds.

Examine the outer four or five primaries to determine wear, and classify them according to the following scale: **N** or 0 = No wear, the feather edges are perfect, and the entire edge is light, including the tips; **S** or 1 = **S**light wear, the feather edges are slightly worn with no fraying or nicks, and the edge is often light-colored, except at the tips; **L** or 2 = **L**ight wear, the feathers are definitely worn, but with little fraying and few nicks; **M** or 3 = **M**oderate wear, considerable wear with definite fraying, and nicks and chips are obvious along the edges; **H** or 4 = **H**eavy wear, feathers very heavily worn and frayed, and the tips often worn completely off; and **X** or 5 = E**x**cessive wear, feathers are extremely ragged and torn, the shafts are usually exposed well beyond the vane, and all the tips are usually completely worn or broken off (one wonders how well the bird can fly).

Fat

The amount of fat on a bird may indicate periods of stress, low availability of food, low fledging weight, and other conditions that give insight into the viability of an individual. Especially as birds prepare for migration, subcutaneous fat is accumulated and is visible beneath the skin as white, yellow, or light orange areas easily seen in contrast to the red muscular areas. The fat can be most easily seen on the abdomen and the furculum. The furcular or interclavicular region is the depression formed between the attachments of the pectoralis muscles to the furculum (the "wish-bone") and coracoids, forming a "V" running toward the spinal cord and pectoral girdle, through which the neck protrudes. You can assign a fat class on the basis of how much fat you can find:

Fat Class	Furculum	Abdomen
N or 0	**N**o fat, the region is concave	No fat
T or 1	**T**race, deeply concave, scattered patches, less than 5 percent filled.	None, or a trace
L or 2	Thin **L**ayer, less than a third filled.	Trace or thin layer
H or 3	One-**H**alf filled in small patches covering some areas.	Small patches, not
F or 4	More than 2/3 **F**illed, level with clavicles	Covering pad, slightly mounded
B or 5	Slightly **B**ulging	Well mounded
G or 6	Bulging **G**reatly	Greatly distended mound
V or 7	**V**ery large fat pads of furculum and abdomen meet	

Data Entry

We include a standard data form *(fig. 10)* that we encourage you to use. Fill in all the information, and print neatly in soft, black pencil. For codes not shown, and for exact definitions, see CWS and USFWS (1991). Right justify data in appropriate fields. Do not use ditto marks. If data are repeated on the next line, use a slanting line in the field from upper left to lower right, or a vertical line in the center of each column. If data are not collected, leave the column blank, or enter 9's for numerical data. If a band is lost or destroyed, indicate this in the code column and also in the species column. On any one sheet place only the records for one band size or the recaptured birds. When starting a new series of bands, or a new calendar year, **always** start a new banding sheet. The sheet is broken into the following categories:

• Heading material: State code, region code, band size ("R" for recaptures, entered on a separate sheet), page number (for each band size), and year of banding or capture.

• Recorder and bander—Place the initials of the recorder and bander here, and their full names at the bottom of the page (these are not entered into the data base).

• Code—This column tells if it is a: new banding (**N**); recapture (**R**) (a bird previously banded); unbanded bird (**U**) (place 9's in the band number columns); destroyed band (**D**); lost band (**L**); or a changed band (**C**) (a band that replaced an old or worn band—make a note of the old band number).

• Band number—The full, right-aligned number of the first band on the first line. Thereafter, the final three digits of new bands only. Do not use dashes in this field to separate prefix; rather, right align all numbers. On recapture pages, the full band number should be entered each time.

• Species—An abbreviation of the species name (e.g., Bl-cap Chick, for Black-capped Chickadee). The abbreviation is not entered into the data base, but is a check against the error-prone species codes below, such as Barn Swallow (BARS) and Bank Swallow (BANS).

• Species Code—The four-letter code of species name (e.g., BCCH). The list of these for North America is in CWS and USFWS (1991). A Latin American version has not yet been prepared, but biologists can use the first two letters of the genus and the first two letters of the species names. This will suffice for many species.

• Age—The single letter or numeric codes as indicated above.

• How aged—Use the following codes: **A**, adult plumage; **B**, brood patch; **C**, cloacal protuberance; **E**, eye color; **F**, feather wear; **H**, hatching year (first winter) plumage; **I**, inside of mouth or any part of bill; **J**, juvenal plumage; **M**, molt; **P**, plumage in general; **S**, skull; **T**, tail length; **W**, wing length; or **O**, other (explain this code in the Notes section). Write the codes in their order of importance to your age determination.

• Sex—Use M for male, F for female, and U for unknown.

• How sexed—Use the codes as in "how aged."

• Skull—Record the code above that indicates the percent of skull pneumatized.

• Cloacal protuberance—Use the code described previously

• Brood patch—Use the code described previously.

• Fat—Use the codes described previously.

• Body molt—Use the codes described previously.

• Flight feather molt—Use the codes described previously.

• Flight feather wear—Use the codes described previously.

• Juvenal plumage—Record the extent of this plumage, using the codes described previously.

• Wing length—Record to the nearest millimeter.

• Weight—Record to the nearest tenth of a gram.

• Status—Among the most common are: 300, normal and released; 301, color-banded; and 615, injured and released. The full list of status codes is in CWS and USFWS (1991).

• Date—Month, day, and year, all in numbers.

• Capture time—Using the 24-hour clock, record to the nearest 10 minutes, e.g., 6:24 a.m. is 062, 4:48 p.m. is 165, etc.

• Station/location—Record an abbreviation using four letters for the station's name and two numbers for the net location; a total of six columns used.

• Notes—Record any useful additional data, such as: sequence of color bands, if present; suspected ages or sexes of birds coded "U"; information on unusual wing lengths; or why an "other" code was used for how aged. If additional data are taken, such as an unusual age category, they should be placed in the "Notes" columns, in order to keep primary data consistent.

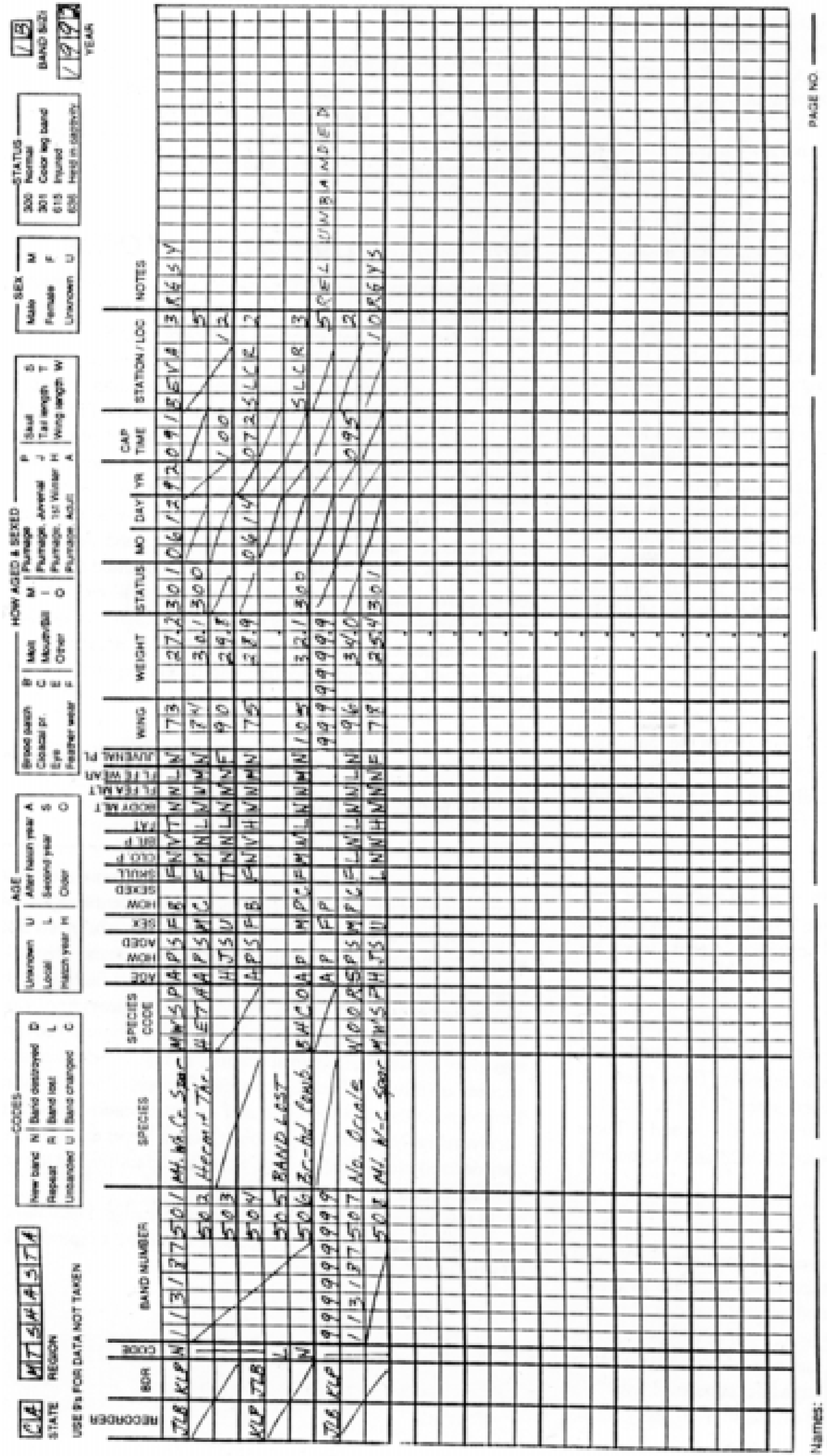


Figure 10—An example of a form for recording data from captures.

Sources of Equipment[1]

Advertisements for supplies and good articles on capture techniques can be found in the publication "North American Bird Bander." Persons doing mist netting or banding should join their regional Association and receive this, the joint publication of the Western Bird Banding Association (BBA), 1158 Beechwood St., Camarillo, CA 93010 (Colorado and west); Eastern BBA, R.D. #2, Box 436A, Hellertown, PA 18055 (Appalachians and east); or the Inland BBA, 81 Woodshire Drive, Ottawa, IA 52501.

Mist Nets

Nets can be purchased in the United States at the following:

Association of Field Ornithologists, c/o Manomet Bird Observatory, Box 936, Manomet, MA 02345 [telephone (508) 224-6521]. A wide assortment of nets.

Avinet, P.O. Box 1103, Dryden, NY 13053 [telephone and FAX: (607) 844-3277]. They have a wide selection of nets, banding tools, scales, poles, color bands, and other material.

Eastern Bird-Banding Association, Gale W. Smith, R.D. #2, Box 131, Kempton, PA 19529. An assortment of nets.

Color Bands

The only source of split-ring plastic color bands for landbirds that we have found is A.C. Hughes, Ltd., 1 High Street, Hampton Hill, Middlesex TW12 1NA, England. Avinet (see above) carries a limited supply of Hughes' bands.

The best bands for most species are the "Plastic Split Rings" in solid colors. We have found their five most visible and separable colors are Red, Yellow, Light Blue, Dark Blue, and Orange. If more colors are needed, some investigators have found White reasonably separable from the standard aluminum band, and the Black and the Dark Green separable from the Dark Blue. Hughes' sizes (and their Fish and Wildlife Service approximate equivalents) are: XF (0), XCS (1), XCL (1B), XB (1A), and X3 (2).

Optical Device for Skulling

An excellent one is OptiVisor, a binocular magnifier available in 2.5, 2.75 and 3.5 powers. Available from the manufacturer Donegan Optical Company Incorporated, P.O. Box 14308, Lenexa, Kansas 66285-4308, or call them at (913) 492-2500 for a distributor near you.

Wing Rulers

Rigid tempered steel rules with a stop at the end are very good for measuring wings. Sizes are 15 cm, 30 cm, and 60 cm. Available from Chris N. Rose, 98 Lopez Rd., Cedar Grove, NJ 07009.

[1]The use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service.

Banding Pliers

The best have holes in jaws to fit standard U.S. band sizes, with a split pin on top for even band opening. Three pliers are available: one will open all of band sizes 0, 1, 1B, and 1A; another for sizes 2 and 3; and one for sizes 3B, 3A, and 4. These are available from Roger N. MacDonald, 850 Main St., Lynnfield, MA 01940, (617) 334-3448.

Scales for Weighing

Electronic scales are widely available for under $300, and Pesola scales and a spring balance field scale are available through Avinet (see above). A good general purpose one has a capacity of 300 g and a readability of 0.1 g. The Ohaus C-Series costs under $200 and Acculab has one under $150. With a capacity for most birds, Acculab has a pocket balance with 80 g capacity for under $100. These are available from many scientific supply houses, such as Markson, P.O. Box 3944, Houston, Texas 77253 (800-528-5114).

Bags for Holding Birds

Washable bags can be made, or cotton mailing bags can be purchased. An ideal size for most small birds is 6 by 9 inches, or somewhat larger. U.S. Government agencies can purchase excellent cotton mailing bags from the General Services Administration.

Bird Banding Laboratory and Office

All capture work must be done under very strict regulations and permits. Permit applications in the United States can be obtained from the Bird Banding Laboratory, U.S. Fish and Wildlife Service, Laurel, Maryland 20708. In Canada, the address is Canadian Bird Banding Office, Canadian Wildlife Service, Environment Canada, Ottawa, Ontario K1A 0H3. Special permits are also needed from most states and provinces, and the above offices can supply information on them. Many Latin American countries also require permits.

The Bird Banding Laboratory and Office provide excellent support for all activities relating to capture, and permittees receive bands at no cost. However, they have limited resources for supporting banding work and cannot honor all requests for permits. Applicants for permits must show evidence of qualifications and must have a well-justified need to band. Permittees are expected to provide accurate and timely reports of birds banded.

Nest Searches

Nest searches provide the most direct measurement of nest success in specific habitats. They also allow identification of important habitat features associated with successful nests and insight into habitat requirements and species coexistence. Knowledge of the appropriate cues and techniques for finding nests allows large numbers to be found, thereby providing vital information about many species. Nest searches have an advantage over constant-effort mist netting, in that the measures of success are direct and habitat-specific. However, they are more limited as to the area surveyed and do not measure individual survivorship. Mist nets sample birds from a larger area, and the data derived may therefore have wider applicability, but are not habitat specific.

In this section we describe aids and standardized techniques for locating and monitoring success of nests, adapted from Martin and Geupel (in press).

Nest Sites

Nest finding is labor intensive (DeSante and Geupel 1987, Ricklefs and Bloom 1977), but most observers can improve their ability to locate nests in a matter of days with training and practice.

The behavioral observations and clues described below work effectively for a variety of species. However, our experience includes a small subset of species and habitats and, in particular, is largely restricted to forest and shrub habitats. Other methods may be more effective in other habitats. For example, cable-dragging (Higgins and others 1969) and rope-dragging (Labisky 1957) may be more effective for many grassland species. In particular, all species, and even some individuals, differ in nest placement and behaviors near the nest. The patience and alertness of observers, and their familiarity with the habitat and behavior of individual species, are the most important influences on effectively locating nests.

Nest finding can be a frustrating task; patience is an important asset. It is a good idea to set a goal of finding at least one nest daily. More than one nest will be found on many days, but if at least one nest can be consistently found every day, the numbers of nests over the season will rapidly accumulate.

Methods

The particulars of plot sizes and numbers will vary according to the purpose of the study or activity, the habitat involved, and the density of birds. As a general guideline, we recommend that two study plots be established for each person that searches for nests. The searchers should work alternating days on these two plots for the entire nesting season. This provides consistent monitoring and allows the person to become familiar with the plot. In general, eight plots, each 40-50 ha, would usually be necessary to be established in forest habitat to find sufficient numbers of nests (ca. 20 nests per species) for the range of species typically found in any given forest, but smaller plots (ca. 10 ha) can be established in areas with higher densities.

In general, one should try to develop as quickly as possible a search image for the nests of various species. T. Sherry (pers. comm.) notes that he routinely finds 25-50 percent of his nests by constantly scanning appropriate potential nest locations in the vicinity of an active female.

During Nest Construction

Ideally, nests should be located during construction to provide the best estimates of nest success. This is also usually the easiest time to find nests because of the high level of activity and, in some areas, forests are not leafed out, making the task of following the female much simpler (T. Sherry, pers. comm.). We advise biologists to spend the maximum amount of time early in the season when the finding rate is maximum. Nest building begins by May in most areas of North America, although permanent residents and some ground-nesting species will begin earlier. Only the female constructs the nest and incubates the eggs for most small terrestrial birds (Kendeigh 1952, Silver and others 1985). Exceptions include woodpeckers, vireos, and wrens. Thus, the most effective way of finding most nests is by locating and following females, although males may provide some cues. Some nests in the shrub layer can be found by random search. Ground nests in forests are usually the most difficult to find. It is best to watch the female as she is gathering nesting material without using binoculars, because when she flies, she can be followed more easily with the naked eye.

Females tend to be extremely furtive during nest building. A mated female can be recognized by copulations or by her movements around the territory unharassed by the male. Females should always be checked with binoculars, especially during and after long, direct flights, to determine whether nesting material is being carried. Many birds will carry very fine material, not obvious upon casual inspection, such as spider webbing and hair for lining nests.

Sitting near sources of nesting material (e.g., failed nests, thistles) or open areas with a good view of the territory can help detection of nest-building females. Observers should use different paths across plots to increase the probability of randomly encountering females near undiscovered nests.

Follow a bird with nesting material from a distance to avoid disturbance. Do not interrupt a long flight. If the bird disappears in a patch of vegetation, begin to scan for potential nest sites. Be patient and wait for another visit by the bird. If the area where the female disappears is near the nest, the female will spend time in the area. At the same time, be aware that the female may move out of the back side of the patch to another patch that contains the nest.

Some individuals tolerate nearby observers and behave normally, but most species are very wary of observers. If the observer is too close to the nest, the bird often will sit on a perch somewhere near the nest site until the observer leaves. Eventually the bird will drop the nesting material if the observer does not move away. Thus, such behavior is an indication that the observer is too near the nest and should move quickly away. Obtain a new position at some distance (ca. 15 m) hidden by vegetation. Observe the female arrive with nest material and leave without it from the same location several times. Be aware that a female can skulk into one patch of vegetation and leave unobserved to move to a different patch, then return the same way, to give the appearance of nesting in the first patch. Some species such as MacGillivray's Warbler, Hooded Warblers, and Sage Sparrows will walk on the ground for several meters to approach the nest secretly. Birds can often be detected by watching for movement of the vegetation where they are otherwise hidden. Where the vegetation stops moving is usually the nest site.

Mapping the male's position as he sings around the territory can often reveal a center of activity from which the male can often see the nest (T. Sherry, pers. comm.). The observer then can scan appropriate nest sites nearby, or at least increase the chance of catching a glimpse of a wary female.

Once the suspected nest site has been identified, back away quickly. Verify the status and location a few hours later, being careful that the female is absent. Do not approach the nest while the female is watching; disturbance at this early stage can cause abandonment. After quick verification, the area should be left and not visited for four days.

During Egg-Laying

This is the most difficult stage for finding nests because the female may visit the nest only when she lays an egg, and most species lay one egg per day. The female will sometimes sit on the nest during egg-laying when weather is particularly harsh. Nest visitation becomes more frequent with more eggs in the nest (Kendeigh 1952).

Behavioral cues are useful at this stage. When either parent gets near the nest, they will look at it. If an egg-laying female detects a predator in the area, such as an observer following her, she will sometimes check the nest. Another good cue is a female staying in an area without actively feeding. She will often look at the nest site repeatedly, aiding location of the nest.

Finally, copulatory behavior can be used during both nest-building and egg-laying. Copulation often occurs in the same tree above a nest, on the same branch, or in the next tree. Examine carefully the area immediately adjacent to copulatory activity.

During Incubation

The beginning of incubation can be estimated as when females suddenly "vanish," and males increase singing. Some behavioral cues can help locate nests. Females start foraging faste during the incubation and nestling stages, probably because their time is more limited. Females that are making rapid hops, quick short flights, and rapid wing flicks will probably return to the nest soon. On average, most passerine females are off the nest for 6-10 minutes and on for 20-30 minutes (e.g., Zerba and Morton 1983).

Observers can find females by alertly moving through the study plot, but sitting down in a spot for 20-30 minutes is also useful. A female leaving a nearby nest can thereby be detected. Females can also be detected by call notes, although species differ in the types of sounds. Females of many taxa (e.g., gnatcatchers, warblers, Emberizine finches) chip or call just before leaving, or just after leaving, the nest. This behavior seems to be a communication note to the mate. Females of other species use other vocal signals, e.g., thrushes give a chuck or mew sound; tanagers often give a characteristic sound near the nest or during copulation; and some taxa (e.g., Emberizine finches and icterines) have a nest departure call (McDonald and Greenberg 1991), often answered by the male. If you detect, follow, but then lose a vocalizing female, immediately return to the original location where she was detected, and you may often find her again before she returns to the nest.

Males can also be of some help. When the female is off the nest, some males quietly guard the nest or follow her (for example, the Gray Catbird) (Slack 1976). A quiet male may indicate presence of a foraging female or a nest nearby. In many species, especially cavity-nesters, males will feed incubating females (e.g., Lyon and Montgomerie 1987; Martin and Geupel, unpubl. data; Silver and others 1985). Males of some species (e.g., Chestnut-sided Warbler) use singing perches that are in direct view of the nest. Males sitting on a perch, looking towards the same spot, may indicate a nest.

Males can sing anywhere in the territory while a female is incubating, but he can become silent when the female is about to leave, or has left, the nest (T. Sherry, pers. comm.). When this occurs, he will often make a long flight over to where the female is starting to forage (and sometimes will incite her to leave the nest). Sherry suggests being alert to these flights because they provide valuable clues to where the nest vicinity is, and can also help the observer detect females, which are often difficult to find considering how long they stay motionless during incubation.

A female foraging off the nest is fairly tolerant of people, but observers should be inconspicuous. As she returns to the nest, she is more cautious. This can be used to an observer's advantage. First, a relatively long flight after foraging is probably a return to the nest, and is often along the same route. Quickly running in her direction for about 25 m may often result in a resighting, because the disturbance will keep her from returning to the nest, giving more time to relocate her. If she is near the nest, but cautious about approaching, she will bounce between a few branches, and may also forage rapidly. Eventually, she will start to move down toward the nest several times and then suddenly fly back up, apparently indecisive. If the observer is too close to the nest, the bird will continue to bounce, and will sometimes fly off, only to return within a few minutes. The observer should then back off and watch. If it is cold, do not keep her off the nest for too long. If the female has been followed for more than 30 minutes without results, then she probably is not on a nest, unless both sexes incubate.

If a female disappears into a tree or shrub, the nest is probably in or next to it. Memorize the area where the female disappeared and choose potential nesting sites before approaching. Moving quietly, begin tapping potential nest shrubs with a stick. Listen for the flush of the female off the nest. If unsuccessful, the site can be revisited for careful searches.

In many species, nest site preference seems to be an evolutionarily conservative trait (Martin 1992). Some birds greatly prefer their nest to be in or under certain plant species, or in particular patch types (Martin and Roper 1988, Martin unpubl. data). Describe and visit nest sites from previous years to aid new observers in finding nests.

During the Nestling Stage

Finding nests during the nestling period is the easiest, because both males and females commonly bring food and remove fecal sacs. Males are normally the easiest to follow, as they tend to be less cautious. Nests can usually be found from a distance using binoculars because of the constant activity of the parents.

In some species a singing male can indicate the nest location. He may sing, for example, less and less as he starts to gather food to carry to the nest, become silent when he is about to approach the nest, and then resume loud song immediately after leaving the nest (T. Sherry, pers. comm.). Additionally, Sherry notes that birds will often become reticent to go to a nest with a human nearby, so that if a bird becomes relatively inactive (hopping around, not taking long flights) in a particular area, or dropping prey, then the nest is probably nearby. In this case, the observer should either search intensively in the vicinity, if likely nest spots are nearby, or back away to give the bird a chance to become calm and go to the nest.

Knowledge of the nesting cycle allows an observer to anticipate when to start looking for a new nest. Most species will renest after a nesting failure, although this varies among and within species (Geupel and DeSante 1990a, Martin and Li 1992). Reconstruction usually begins within 10 days, and the earlier in the nesting cycle that failure occurred, the farther apart the nests are likely to be (citations in Martin 1992). Multi-brooded species may renest in as little as 8 days after fledging. Sometimes the female will begin nesting while the male is still tending the fledglings of the previous brood (Burley 1980).

Nest Monitoring

Each nest found needs to be checked every 3 to 4 days to determine its status. Careful attention to checking nests is critical for data quality, because the number of days that nests have eggs or young is used to calculate daily mortality rates, the most effective measure of nest success (Mayfield 1961, 1975). Nests should be checked from a distance the day before expected fledging, and every other day thereafter. A chart showing nests as they are found and the expected date of fledging is extremely helpful. If nestlings appear ready to fledge before the next scheduled visit, then the next visit should be sooner. Calculations of nest success should terminate with the last day that young were observed in the nest. Nests should also be checked more frequently about the time of hatching, if the length of the incubation period is desired.

With canopy nests, mirrors attached to telescoping aluminum poles can check contents of nests. These are available from stores stocking swimming pool supplies, and are commonly up to 4-5 m. A window-washing pole to 12 m is also available (Tucker Manufacturing Company, 613 Second Ave. S.E., Cedar Rapids, Iowa 52406; 319 363-3591). T. Sherry (pers. comm.) suggests a convex mirror to allow views from a variety of angles from the ground. Mounting a small flashlight next to the mirror can illuminate the nest contents in cloudy or rainy weather. Often binoculars must be used to view the nest in the mirror.

Careful and detailed observations should be recorded if a nest predation event is observed. If the nest appears inactive from a distance, it should be approached to verify. If the eggs or young appear to be gone, then check the nest structure and immediate area, perhaps up to 6-10 m (T. Sherry, pers. comm.) for evidence. Any evidence (e.g., shell fragments, hole in nest, nest torn up) should be fastidiously noted. When the young fledge, they commonly perch on the edge, flattening it, and leave fecal droppings in (or on the edge of) the nest. These would indicate possible successful fledging. Observers should try to verify success by seeing fledglings or by hearing adult alarm calls or begging calls of the young. Fledglings normally do not move very far in the first couple of days, although some, such as Rufous-sided Towhee, may move 100 m in a few hours. Some species or individuals may carry food up to 24 hours or longer after predation of their nest, including to unrelated fledglings from neighboring territories.

Nestlings may be banded when the primaries first break sheath. Banding may provide valuable information on juvenile survival and dispersal. Always have an assistant with you to record data, and be careful the nestlings do not jump out as you try to remove them (use two hands). Avoid banding in the morning or during cold or wet periods.

Filling Out the Forms

Two types of data sheets are used to record data about the nest site and nest activity. One set ("Nest Check Form"— *fig. 11)* is used in the field to record information when nests are checked. To prevent loss, and serve as a backup and summary record for each nest, the "Nest Record Form" *(fig. 12)* should be maintained at some permanent location. The Record Form should be updated daily, to prevent data loss.

All observations should be recorded on the Check Form and transferred to the Record Form, including visits with no activity. This is particularly critical for canopy or cavity-nests where nest contents cannot be viewed.

Nest Check Form

Data are collected in the field and are recorded on the Check Form. One to several nests can be recorded on a single form. When a new nest is found, its location is carefully noted at the bottom of the form, and the form may be needed in the field over the next few visits to relocate the nest. The data taken should include:

- State or province—The 2-column code for each.
- Region—An 8-column code, designated by the investigator. Often, the name of the USGS quad, a prominent landmark, or a nearby town will provide the best code name.
- Station—A 4-letter code for the station that contains the nest search plot.
- Year.
- Observer's initials.
- Nest number—A unique, identifying 2-column number for the nest site. We would expect that at each station, for each species, no more than 100 nests would be found.

NEST CHECK FORM

STATE	REGION	STATION	YEAR
CA	MTSHASTA	BEVA	1992

OBS.	NEST NUMBER	SPECIES	MO	DAY	YR	TIME	ADULT Build	ADULT On	ADULT Obs.	CONTENTS Number of Eggs	CONTENTS Number of Young	NOTES
JKL	4	MTCH	6	12	92	0725		X	X	3		Flushed off nest
	17	RSTO				0737			X		4	No adult seen
	8	MTCH				0750	X					described below
	6	MWSP	6	13	92	0655		X				Sat tight on nest

Nest site description(s):

#8 - MTCH 7 m due W of peg 23-D in 5 m Aspen — hole 2.3 m above ground

3/26/92

Figure 11—An example of a Nest Check Form for recording in the field the status of nests and information on where the nest is located.

NEST RECORD FORM

1.

STATE	REGION	STATION	SPECIES	YEAR	NEST NO.	ATTEMPT
CA	MTSHASTA	BEVA	MTCH	1992	4	2

2. NEST CHECKS

DATE Month	DATE Day	Build-ing	Adult on	Observed	CONTENTS Number of eggs	CONTENTS Number of young	COMMENTS
6	6	X					entering hole
6	9	X		X			3/4? built
6	12		X	X	3	0	flushed off nest
6	15			X	3	0	
6	18			X	0	0	empty

DATE Month	DATE Day	Build-ing	Adult on	Observed	CONTENTS Number of eggs	CONTENTS Number of young	COMMENTS

3. DATES and PERIOD

Month	Day		Contents / Number
6	6	Found	start of nest
6	9	1st egg	
6	12	Clutch completion	3 eggs
		Hatched	nestl.
		Fledged or failure	fledg.
6	15	Last date active	

Outcome: predation - jay?

Cause of failure: PE

Period	Number of days observed	Success
Egg laying	4	S
Incubation	3	D
Nestling	0	

4. NEST SITE Measurements in cm unless otherwise designated

Plant common name: Alder

Genus: ALNUS

Plant height	530	Nest height above ground	2.70
Plant dbh	45	Nest dist. from edge	32
Canopy cover (denso.)	60	Nest dist. from center/stem	0
Number support branches	0	Diameter support branches	
Concealment from above		from below	
Concealment from side N		S / E / W	
Compass direction		Total % cover nest substrate	

Band numbers of young

3/10/92

Figure 12—An example of a Nest Record Form that is kept at a permanent location for recording data from the Nest Check Form, as well as the nest site and characteristics data.

• Species name—The 4-letter code, based on CWS and USFWS (1991).

• Date—Month, Day, Year.

• Time—Use the 24-hour clock.

• The activity of an adult if either building ("build.") or incubating ("on"), by putting an "X" in the blank.

• The observer should record the contents of the nest whenever it is approached close enough for careful observation. If the contents are actually observed, this should be noted by an "X" in the observed box ("obs."). If the contents are counted accurately, the number of eggs, young, or both, are noted. Age of the nestlings should be estimated when possible because it can help determine the nest fate by providing information on length of time that nests were active. Age estimates should be recorded in Notes.

The form also includes space for a description of one or more nest sites that the observer finds on this day. The description should be sufficiently detailed to allow anyone to locate the nest. Take compass readings from a fixed point (e.g., a stake or grid point) to establish a reference location.

Nest Record Form

This form is filled out each day upon return from the field, and should contain the following data:

• Header data

State or Province

Region

Species code

Year

Nest number

The number of attempts at nesting that this record represents for that pair for that season.

• Nest Checks. These are the data transcribed from the Check Form, and are the same as for that form.

• Dates and Period

The following dates should be tabulated, as they become available: date of finding of nest (and contents when found), date of first egg laid, date of clutch completion (and number of eggs laid in final clutch), date of hatching of last egg (and number of nestlings produced), date of fledging (and the number of fledglings), or nest failure, and date when last active.

Outcome, a written description of the fate of the nest.

Cause of failure (codes: UN = unknown because not revisited; FY = **f**ledged, with at least one **y**oung seen leaving or in vicinity of nest; FP = **f**ledged young, as determined by **p**arents behaving as if dependent fledgling(s) nearby, FU = Suspected **f**ledging of at least one young, but **u**ncertain (e.g., no adult behavior observed); FC = **f**ledged at least one host young with **c**owbird parasitism; PO = **p**redation **o**bserved; PE = probable **p**redation, nest **e**mpty and intact; PD = **p**redation, **d**amage to nest structure; AB = nest **ab**andoned prior to eggs; DE = **de**serted with egg(s) or young; CO = failure due to **co**wbirds; WE = failure due to **we**ather; HA = failure due to **h**uman **a**ctivities; and OT = **ot**her).

Period = the number of days nest was observed for the following: days during the egg laying, incubation, and nestling period.

Success = for each period, based on the following codes: S = **S**uccessful, D = **D**epredated, N = status unknown/ nest **n**ot occupied, U = status **U**nknown/nest occupied fate unknown, M = **M**ortality other than predation, A = **A**bandoned, F = **F**emale died, Z = abandoned, no **(z**ero) eggs laid.

Predation Risk from Monitoring

Locating and monitoring nests have potential to increase predation (Major 1989, Picozzi 1975, Westmoreland and Best 1985). With proper precautions, such biases can be eliminated or minimized (Gottfried and Thompson 1978, Willis 1973). Finding the nest normally creates the most distress to adults and disturbance to the nest site because subsequent visits are brief. Some evidence suggests that predation rates are higher on the first or early visits than subsequent visits (Bart 1977, but see Bart and Robson 1982).

Therefore, we suggest the following when locating nests:

• Minimize distress calls by adults; never allow them to continue for more than five minutes;

• Do not approach a nest when any potential nest predators, particularly visually-oriented predators (e.g., corvids), are present;

• Minimize disturbance to the area around the nest; and

• Do not get close to nests during nest building, as birds will abandon if disturbed before egg-laying, particularly during the early part of a season.

To lower the probability of predation or brood parasitism from checks, we recommend that you

• Check from as great a distance as possible, using binoculars to look into the nest or climb up to look from above;

• Approach nests on different paths on subsequent visits, using paths that are quick, quiet, and that minimize vegetation disturbance;

• Never leave a dead-end trail to the nest, but continue walking in a different direction;

• If avian predators are common, check other bushes without nests, and always assume a predator is watching;

• Be quick and accurate during nest checks and nestling banding;

• Minimize the number of observers;

• Use a pen or stick to check nests to prevent human scent from being left on or near a nest.

Vegetation Measurement

We suggest two methods of vegetation measurement: (1) the nest and the plant containing it; and (2) the nest site and random points in the plot. The entire plot should be measured with a series of points, as outlined in the section "Methods of habitat assessment" below.

The Nest and Nest Plant

Measurement of the vegetation of the nest site is an important research tool and has some application to monitoring. If you wish to determine this aspect of habitat, we suggest that you measure the vegetation as soon as a nesting attempt terminates. Be careful at the beginning of the season, as an empty nest may not yet have eggs. Some species or individuals will delay laying as long as eight days after completing nests. Do not delay measuring the vegetation, because foliage density around the nest changes rapidly.

We suggest the following measurements *(fig. 12)*, of the plant containing the nest. All measurements should be in centimeters.

• Plant species common name.

• Plant species genus.

• Plant height.

• Nest height.

• Plant "dbh" (diameter at breast height), stem diameter of the nest substrate, usually measured at 0.25 m above the ground, because many nests are in substrates less than "breast height."

• Nest distance from edge—Distance from edge of plant, inward to the nest.

• Canopy cover—The canopy cover at chest height should be measured using a densiometer. This is a measure of the tree canopy, and should be measured as close to the nest as possible, but not under the canopy of the nest plant if it is a shrub.

• Nest distance from center/stem—Distance of the nest laterally from the main stem.

• Number of support branches—The number of branches actually supporting the nest.

• Diameter support branches—Average diameter of stems supporting the nest.

• Nest concealment—Measured by estimating percent of the nest concealed by foliage cover in a 25-cm circle centered on the nest from a distance of 1 m from above (overhead cover), from below, and from the side (side cover) in each of the four cardinal directions.

• Compass direction—Direction from the nest to the main stem of the substrate.

• Total percent cover nest substrate—The percent cover of the plant containing the nest, using the outer margin of the plant as the boundary. This is most useful in shrubs.

The Nest Site and Random Points

Vegetation in the patch surrounding the nest can provide information on differences in microhabitat choice among species.

We recommend using vegetation sampling methods based on a series of points, as outlined in the section "Methods of habitat assessment," below, or those described in Martin and Roper (1988) with some modifications (obtainable from Martin). The point method involves measuring habitat features in the nest patch in circular releves of 11.2-m radius centered on the nest, smaller than the 25- to 50-m releves for general habitat assessment, detailed below. In addition, non-use sites should be sampled with the same protocol at 35 m from the nest in a direction parallel to the contour of the plot (to stay within the same microhabitat type when possible). The sampling plot should be centered on the plant stem nearest to the 35-m point that is of the same species and size as that used for the nest. Random plots can also be established in a grid to obtain a stratified random sample of the vegetation. Comparisons of random versus nest plots can indicate choice of microhabitat types. Comparisons of nest versus non-use plots then provide information on choice of habitat patches within a microhabitat type. These sampling protocols keep the methods relatively compatible with other sampling schemes (e.g., James and Shugart 1970), but also allow tests of hypotheses about the interactions between choice of nest site and predation risk or habitats chosen for nesting.

Censusing

The assessment of population size should be an integral part of any monitoring program. Various methods have been employed and thoroughly tested (see Ralph and Scott 1981). Abundance of birds has long been used to measure habitat suitability but is often retrospective, giving trends without any possibility of determining causation, and can even be misleading (van Horne 1983).

It is desirable to use a method that allows the biologist to census as many points as possible in the time available, thus gaining as many independent data points as possible. That is, it is much better statistically to census five points in a 10-day interval, than to count at one point five times. The farther apart each of the five points, the more likely the data can be extrapolated to a larger region.

Below we outline four major methods. Two of these, the point counts and the spot mapping methods, are the most common ones used (for definitions see Ralph 1981b). The point count is probably the best for most surveys and has been adopted as the standard method for monitoring (Ralph and others, in press). The methods for both are taken in part from the excellent book by Koskimies and Vaisanen (1991). In addition, a strip transect count and an area search method are also presented. The latter is especially popular with volunteers.

General Considerations

Time of Day

The best time for censusing at most temperate latitudes during the breeding season is usually between 5 and 9 a.m. Under most circumstances, no counts should be done after 10 a.m. Exceptions could be in the non-breeding period. It is best to start within 15 minutes of local sunrise. Examining pilot data is the best way to determine when detection rates are the most stable. In general, the period between official sunrise and the ensuing 3-4 hours is usually relatively stable. For most species, during the period between dawn (first light) and sunrise, the number and rate of birds singing is somewhat higher than the rest of the morning. For maximum comparability in detection probabilities for species among points, it will be best to start at sunrise rather than at first light.

Census Period

Breeding season point counts should be run during the time of year when the detection rates of the species being studied are most stable. Within the breeding season, the months of May, June, and the first week in July are best for counting most passerines in North America. However, stable counting periods, when the rate of singing of the various species has stabilized, are as early as April in the Southeast and Southwest and may extend later in the boreal zones. In Latin America the breeding season will be longer, and censuses can profitably be conducted throughout the year.

Weather

Birds should not be surveyed when rain or wind interfere with the intensity or audibility of bird sounds, when fog or rain interfere with visibility, or when cold weather shuts down bird song activity.

Point Counts

We suggest two levels of point counts. **Extensive point counts** are intended for a series of points, placed at a minimum of 250 m apart, largely on roads or trails over an entire region. **Intensive point counts** are placed within a mist net or nest search plot.

The account below is based on Hilden and others (1991), and the standards are taken from Ralph and others (in press), as adopted by the Point Count Workshop of the Monitoring Group of the Neotropical Migratory Bird Conservation Program, held in Beltsville, Maryland, November 1991.

Background and Aims

In many countries point counts are the main method in monitoring the population changes of breeding landbirds. With the point count method it is possible to study the yearly changes of bird populations at fixed points, differences in species composition between habitats, and abundance patterns of species. The point count method is probably the most efficient and data-rich method of counting birds. It is the preferred method in forested habitats or difficult terrain. Point counts involve an observer standing in one spot and recording all the birds seen or heard at either a fixed distance, or unlimited distance. This method can be conducted one or many times at a given point. The North American Breeding Bird Survey of the U.S.D.I. Fish and Wildlife Service is such a method.

The point count method applied to landbirds does not provide reliable data on waterfowl; however, rails and waders are counted well. Some landbirds also pose problems as they are particularly quiet, loud, nocturnal, or flocking. If these species are of particular interest, the method may be modified to accommodate them.

Equipment and Time Needed

One should not start point counts without good identification skills, including a knowledge of the songs and calls of birds. Details on training for distance estimates are given in Kepler and Scott (1981). In the tropics, learning all the songs and calls of all species at all times of the year is difficult in practice. In many areas it takes an experienced observer 4-8 weeks to identify 80-90 percent of the species. In temperate zones, this can often be done in less than 2 weeks.

For the census one needs a map, a pencil, notebook, a watch that shows seconds, and binoculars. The route and the points are marked on a survey map and, if necessary, in the field with plastic tape or streamers to ensure that the same points are found in the following years. The observer may move from one point to another by foot or with a vehicle.

The time needed for censusing one point count route is usually no more than four morning hours, depending on the distance between the points and the method of travel.

Choosing a Counting Route for Extensive Point Counts

An extensive point count route should encompass all the habitats of a region, if possible. In addition, it should include any mist net or nest searching plots in the region. In choosing a route and laying out the points for census, use a systematic rather than random sampling design, either on roads or off roads. Systematic gridding of points is preferable to the random placement of points in most cases. Systematic placement can include placing points at designated distances along roads. Do not stratify by habitat, unless separate estimates for a habitat are required. If the goal is to estimate population trends for an entire management unit, then point counts should be spaced evenly throughout that unit, or along the road system in an area, without regard to current habitat configurations.

Observers should attempt to carry out censuses primarily on tertiary roads, then secondary roads, and should avoid wide, primary roads. Off-road censuses should be carried out on trails, if possible, in major habitats not covered by road systems. Using roads, travel time can be reduced to as little as 1-2 minutes between sampling points. Under optimal road conditions, up to 25 5-minute point counts can be conducted in one morning. In an off-road situation, the number of point counts one observer can conduct during a morning varies between 6 and 12. Roadside habitats usually do not sample all of the available habitats. In this situation, a collection of both on- and off-road surveys can be created that best fits local conditions. Although a road modifies the surrounding habitats, we feel that tertiary road systems (i.e., narrow dirt roads) allow for birds to be counted in approximately the same proportions as off-road surveys.

The minimum distance between point counts in wooded habitats is 250 m. Birds previously recorded at another sampling point should not be recorded again. In virtually all habitats, more than 99 percent of individuals are detected within 125 m of the observer. In open environments, this minimum distance should be increased because of the greater detectability of birds. Along roads, where travel by vehicle is possible, distances of 500 m or more should be used.

Choosing Points for Intensive Point Counts

The intensive point counts are conducted within a study plot for mist nets or nest searches. We suggest between 9 and 16 points in a grid of 3 by 3, 3 by 4, or 4 by 4 points. For most analyses, the birds counted from these points will be combined into a single mean. Therefore, the distance between points is less critical than for extensive point counts where each point is intended to be statistically independent. The points on an intensive census grid should be adjusted to fit within the netting array or nest search plot so as to fully census the area. It is very important not to include areas much beyond the array or plot boundaries. These are covered by the extensive point count censuses. For example, a census grid of nine points, 100 m apart, would cover 4 ha. Allowing for an effective radius of censusing of perhaps 50 m outside this grid, the area covered expands to about 9 ha. A grid of 12 points 150 m apart would have an effective area of about 22 ha. Thus a census grid should have points that are between 75 and 150 m apart, depending upon the area to be covered and the number of points to be included. Under most circumstances 9-12 points should be more than adequate.

Field Work

The censuser should approach the point with as little disturbance to the birds as possible. Counts should begin immediately when the observer reaches the census point. Time spent at each count point should be 5 minutes if travel time between counting points is less than 15 minutes (for greater efficiency) and 10 minutes if travel time is greater than 15 minutes. If a survey is primarily for inventory and few points will be surveyed, then 10 minutes is appropriate. Data should be separated into those individuals seen or heard during the first 3 minutes (for comparison with Breeding Bird Surveys) and those additional individuals heard in the remaining 2 and 8 minutes.

The details of each point are recorded: the reference number, name of the point, date, and the time. The species are written down in the order they are observed. For each species, the number of individuals is recorded separately for those within a circle of 50 m around the censuser and for all those outside the circle, out to an unlimited distance. In noisy environments, dense foliage, or in tropical forests, observers have found that 25 m was preferred. The distance is that at which the individual was first observed. For birds near the 50-m border, the category may be confirmed by measuring paces to the border when the counting is over. If a bird flees when the censuser arrives at the point, the bird should be included according to its take-off place. Birds that were detected flying over the point, rather than detected from within the vegetation, should be recorded separately.

Estimating distances requires experience, so a new censuser should measure the length of steps in different terrain, and then check the distance to several singing birds in order to make the estimating of distances routine. Estimating may be eased by either natural or artificial landmarks.

If there are several males of the same species around a point, one may sketch in the margin the directions and distances of each singing male with an arrow to ensure that they are not confused. Juvenile birds or birds that fledged during the current breeding season should be recorded separately.

A bird flushed within 50 m of a point's center as an observer approaches or leaves a point should be counted as being at the point if no other individual is seen during the count period. It is advisable that this be recorded separately.

If a flock is encountered during a census period, it may be followed after the end of the period to determine its composition and size. An observer should follow such a flock for no more than 10 minutes. This is especially useful during the winter. A bird giving an unknown song or call may be tracked down after the count period for confirmation of its identity.

No attracting devices or records should be used, except in counts for specialized groups of birds.

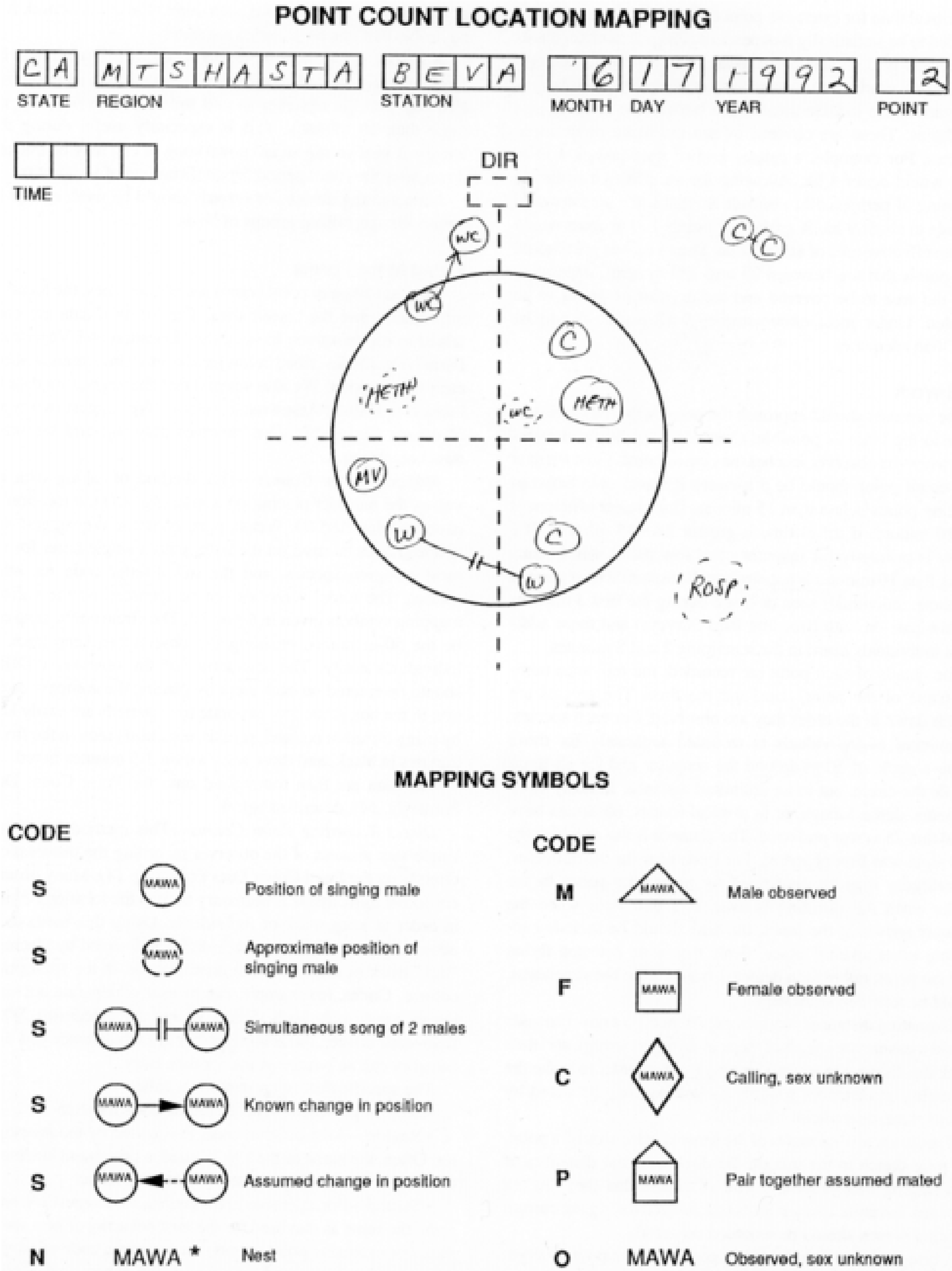
Filling in the Forms

The data taken at point counts are of two types, the location information and the census data. The location data are contained in the first three lines of the "Location and Vegetation Form" *(fig. 15,* described below) and contain information about each census point. We also suggest that the vegetation data be taken (see Habitat Assessment, below). We suggest two types of census data forms. One involves mapping and the other direct recording.

Mapping Point Counts—This method of taking data involves the recorder placing on a map *(fig. 13)* the location of each bird detected (D. Welsh, pers. comm.). We suggest that species codes be used on the map, with a single letter for the most common species, and the full 4-letter code for other species. The birds' activities can be recorded by the various mapping symbols given in *figure 13*. The circle on the map can be the 50-m radius, enabling the observer to keep track of individuals easily. The orientation of the observer ("DIR") should be entered on each form by placing the compass direction in the box at the top. Separate time periods are easily kept by using different colored pencils, e.g., birds seen in the first 3 minutes in black, and those seen within 3-5 minutes in red.

The data are then transcribed onto the Point Count Data Form *(fig. 14)*, described below.

Direct Recording Point Counts—This method involves a single-step process of the observer recording the observations directly on the Point Count Data Form *(fig. 14)*. Many observers do not think that it is necessary to map the location of birds in order to keep track of individuals. Using this method, an observer tallies in pencil each individual detected by placing a "tick" mark (a single line), or another code, in the appropriate column. Codes, for example, can be used to separate out singing vs. visual-only birds (S and V) and age categories. When field work is over, the actual number in each distance and time category can be written in ink for data entry.



POINT COUNT LOCATION MAPPING

STATE: CA | REGION: MTSHASTA | STATION: BEVA | MONTH: 6 | DAY: 17 | YEAR: 1992 | POINT: 2

TIME

DIR

MAPPING SYMBOLS

CODE		
S	MAWA	Position of singing male
S	MAWA	Approximate position of singing male
S	MAWA MAWA	Simultaneous song of 2 males
S	MAWA MAWA	Known change in position
S	MAWA MAWA	Assumed change in position
N	MAWA *	Nest

CODE		
M	MAWA	Male observed
F	MAWA	Female observed
C	MAWA	Calling, sex unknown
P	MAWA	Pair together assumed mated
O	MAWA	Observed, sex unknown

Figure 13—A recording form for mapping the location of birds during point counts with some mapping symbols. Taken from Welsh (pers. comm.)

Observer ____________________

POINT COUNT DATA FORM

STATE	REGION	STATION	MONTH	DAY	YEAR	VISIT NUMBER
CA	MTSHASTA	BEVA	6	17	1992	2

PT. NUMBER	TIME	SPECIES	0 - 3 MIN ≤ 50 M	0 - 3 MIN > 50 m	0 - 3 MIN fly -overs	3 - 5 MIN ≤ 50 M	3 - 5 MIN > 50 m	3 - 5 MIN fly -overs
1	0540	MTCH	'' 2	'' 2			'' 2	
		HETH	'' 2					
		MWSP	''' 3					
		ROSP				' 1	' 1	
		BEWR	'' 2					
2	0552	RTHA	''''' 5		' 1			' 1
		MTCH	'' 2			' 1	' 1	
		RCKI	''' 3			' 1		
		RECR		' 1				
		MWSP	' 1					
		FOSP				'' 2		
3	0559	HETH	''' 3					
		SSHA						' 1
		MWSP	'' 2				' 1	

4/17/92

Figure 14—An example of a data form for recording point count data. Birds are recorded separately within or outside a 50-m circle around the observer, and in the first three minutes or later in the census. The data are recorded as “tick” marks in each box; then later the actual numbers of birds, as derived from the data, are summarized and recorded.

LOCATION AND VEGETATION FORM

LOCATION

STATE	REGION	STATION	LOCATION / POINT	MONTH	DAY	YEAR
CA	MTSHASTA	BEVA	5	10	12	1992

LATITUDE 4063 LONGITUDE 12209

ELEVATION (M)	ASPECT	% SLOPE	WATER	PLOT RADIUS (M)	NOTES
2130	187	32	+	22	LARGE (5m) ROCK NEAR CENTER

VEGETATION

LAYER	TOT COV	HEIGHT (0.1 M) LOW	SPECIES	UPPER	SPECIES	DBH (CM) MIN	SPECIES	MAX	SPECIES	NUMBER SUBLAYERS
TREE	3	8.5	ALRU	12.0	TOLE	40	ALRU	150	TOLE	2
SHRUB	2	.5	PNKI	5.0	KSLO	20	PNKI	45	TOLE	1
HERB	4	.1	PSTL	.4	TOLE					1
MOSS	1	.	MOSS	.						1

SUBLAYER		COVER	SPECIES
T	1	1	TOLE
T	1	2	ALRU
T	2	2	TOLE
T	2	3	ALRU
T	2	1	PSTL
S	1	2	TOLE
S	1	+	ALRU
S	1	r	KSLO
H	1	1	PSTL
H	1	r	TOLE
M	1	+	MOSS

SUBLAYER	COVER	SPECIES

SUBLAYER	COVER	SPECIES

3/26/92

Figure 15—The Location and Vegetation Form. The upper portion should be filled out at all study locations. The bottom portion quantifies vegetation.

The specific data suggested are as follows:

• State or province—The 2-column code for each.

• Region—An 8-column code, designated by the investigator. Often, the name of the USGS quad, a prominent landmark, or a nearby town will provide the best code name.

• Station—For intensive point counts, we suggest a 4-letter code, the same as that used for the mist net array or nest search plot. For extensive point counts, we suggest a code relating to the general area or road. In general, we expect that a given station will have no more than 50 points.

• Month, day, and year.

• Observer

• Visit number—Indicate how many visits this year will have been made to these points at the end of this day's census.

• Point Number—The 2-column census point number.

• Time—Using the 24-hour clock.

• Species—The 4-letter species code.

• Tally of individuals—This is a series of five fields. The major subdivisions are those birds detected at less than, and more than, 50 m, and those birds flying over, but not landing within detection of, the observer. Within the two distance categories, observers can separate out those detected in the first three minutes, and the next two minutes. Observers wishing to separate out behavioral, age, or sex categories can note them with an appropriate letter code. Otherwise, "tick" marks (e.g., 3 = ///) can be used.

Repeating the Count

In general, a station should be sampled only once each season. Counts can be repeated if the goal is good estimates of the community at certain, specific points, such as a small area of rare wetland habitat.

The timing of the census of each route should be kept constant from year to year; it should not differ by more than seven days from the date of the first count. If the phenology of the spring differs, then the date can be changed. The start of the count should not differ by more than 30 minutes from that of the first year. If possible, the same observer should census the route every year.

Strip Transects

Strip transects are very similar to point counts, but the observer records all birds seen or heard while traversing each section of a trail. Each section is then the unit of measurement, and can be 100 m or 250 m long. This method is best used in very open terrain where the observer can devote his or her full attention to the birds, and not worry about footing.

In this method the observer should attempt to cover a given amount of trail in a fixed amount of time, e.g., 100 m in ten minutes.

Area Search

Background and Aims

The area search method has been adopted for a nation-wide survey, the Australian Bird Count (Ambrose 1989), and was chosen over several others because of its appeal to volunteers. It uses a method that, while quantitative, mimics the method that a birder would use while searching for birds in a given area. Essentially this is a series of three 20-minute point counts in which the observer can move around in a somewhat restricted area. In this way unfamiliar calls can be tracked down and quiet birds can be found.

Preparation

The observer should be reasonably familiar with most (if not all) bird species likely to be encountered at the plot. This method allows the observer to track down unfamiliar birds, but walking the plot before a survey with a person familiar with the birds allows the observer to be more efficient.

Choosing a Plot

The plot should allow relatively easy detection and identification of birds (by sight or calls) and allow the observer to move about freely. The plot should be sufficiently large to provide three separate search areas (or plots), each about 3 ha in forest or dense woodland, but larger areas of 10 ha or more can be used in more open habitats. In very dense forest, smaller areas of 1-2 ha can be used. The search areas can have adjoining boundaries or can be in completely separate regions of the plot. More than three search areas can be established within a plot, but the same search areas must be used on each visit.

Time of Day

Because of the intensive nature of this method, it can be carried out longer into the morning than other methods. However, it should continue no later than five hours after dawn.

Field Work

Walk throughout the plot for exactly 20 minutes in each search area, stopping or moving to investigate sightings or calls when appropriate. Record numbers of birds of each species seen, heard, or both seen and heard in the search area during this time. Record birds outside the search area separately, but concentrate on finding as many birds as possible within the plot. The observer may find it easier to tape record observations and then transfer results onto paper soon after the survey. An accompanying person can serve as a recorder. A single survey is completed after at least three areas have been searched at a plot.

Filling in the Form

A standard form is suggested, listing the species found and a running tally of the number of birds, both on and off the area. These tallies can be totaled on the right of each area for each species.

Spot Mapping

Background and Aims

The mapping method is based on the territorial behavior of birds. By marking the locations of observed birds on a detailed map during several visits within a breeding season, it is possible to count the number of territories in an area and estimate the density of birds. Spot mapping is not usually used as a general method for broad-scale monitoring of breeding landbirds, because it requires more time and field work than single-visit point counts and line transects. However, the method should be applied when fairly precise pair numbers and densities as well as the distribution of territories in small study areas or patchy habitats are to be studied. The standard mapping method is less suitable for species that live in colonies or loose groups, or species with large or no territories.

In general, one or two observers make repeated visits (a minimum of 8) to specific plots during the breeding season. Some habitat analysis is also required. Standard methodology as described by Robbins (I.B.C.C. 1970) is also used by The Cornell Laboratory of Ornithology's (CLO) resident bird counts. The latter program, known as the "Breeding Bird Census" (BBC), is a continent-wide program that welcomes contributors and publishes results of North American plots annually in the *Journal of Field Ornithology*. The CLO also encourages "Winter Bird Population Studies" (WBPS) on the same plot. For more information, write to: CLO, Resident Bird Counts, 159 Sapsucker Woods Road, Ithaca, NY 14850; Telephone (607) 254-2441. The basics of the method are contained in Koskimies and Vaisanen (1991). We present here enough information for a biologist to evaluate the technique. The methods of especially data recording, evaluation, and analysis are complex and detailed.

Equipment and Time Needed

One needs 30-40 copies of a very detailed map (preferably 1:2000, or, in open areas, 1:3000 may be acceptable), a compass, and flagging for marking the area.

The time needed depends on the size and terrain of the census area as well as on bird density, with higher densities requiring the mapping of more individuals. Usually about 10-30 hectares in a wooded area or 50-100 ha in an open area may be counted in one morning. Thus, in forest it takes 10 mornings to census 30 ha by the ordinary 10-visit version of the mapping method (about 50-60 hours of field work). In addition, it can take as many as 40 hours (4 hours per census morning) to prepare the species maps, and about 5-10 hours to analyze them. In total, one could spend as many as 100 hours censusing 30 ha of forest during one breeding season. Marking the 50- by 50-m plot in the field takes about 25 hours before the first census season.

Drawing a Map and Marking the Area

The census area should be as round or square as possible in order to minimize border length, because territories along edges are difficult to analyze. After the area has been chosen, a detailed map (known as a visit map) is drawn of it before the first census. The recommended scale for the map is 1:2000. A survey map (1:20,000) and field experience should be used in drawing. Boundaries of the area and landmarks such as edges between habitats, streams, roads, paths, buildings, big rocks, and trees are marked on the map. There should be enough landmarks on the map so that the observer can locate the positions of birds accurately on the map. One copy of the map is needed for each visit, and enough copies should be reserved for making the species maps. If there are only a few natural landmarks, a grid of 50-m squares can be established with the corners of the squares marked with plastic flagging with coordinates written on them.

Census Period and Number of Visits

Because of differences in phenology of arrival and nesting, the visits should cover a period long enough to ensure that each species is easily observable on at least three visits. There should be 10 visits in a standard mapping of forest birds. If the bird density is very high and the nesting period of the community is long, 12 visits are recommended. The visits ought to be evenly distributed over the census period. Fewer visits can suffice in open habitats, where bird densities are usually lower than in forests, or where the season is short (e.g., tundra or alpine grasslands).

Time of Day

The main census time is 5 a.m. to 10 a.m. when the birds sing most actively. After a very cold night counting can be delayed. During very warm weather it should be prolonged because of the lower activity of birds. Two visits should be made in the evening: the first in the beginning of the census period (especially for counting thrushes), the second about two or three weeks later (especially for counting nocturnal singers). If there are several nocturnal or dusk-active species breeding in the area, these two censuses should be added to the ordinary program of 10 morning visits, for a total of 12. In northern temperate zones, owls, woodpeckers, and crossbills breed early and should be censused by extra visits in March and April.

Field Work

A clean map is reserved for each visit. Each visit should cover the area as evenly as possible, and no place should be farther from the route than 25 m (dense vegetation or high density of birds), 50 m (sparse vegetation, few birds) or 100 m (open habitats). The route you follow through the plot should be on a grid twice the size of the distances above, for example, 50 m in dense habitat. Successive visits should be started at different points, especially if you think that a part of the area is getting attention at the expense of the rest. Simultaneous observations of two individuals of the same species singing or seen must always be recorded carefully so that birds can still be separated from their neighbors after they have moved, which frequently happens during a census visit.

Even while you are busy censusing, you should not walk very slowly, because then, for example, a bird uttering alarm calls may attract other birds to congregate nearby. Therefore, walk with moderate speed and record the birds all the time. Stop frequently to "hunt" for simultaneous observations of different individuals of the same species, to listen, and to mark the birds on the map. If you are not sure whether there is only one bird or two, you can return to the area censused already to make sure which is the case. In open areas it is often useful to search for the birds with binoculars.

The ordinary speed of censusing is 10-12 min/ha, or 5-6 ha/hour when the bird density is about 300-500 pairs/km^2. If the density is very high, the censusing speed slows down to 3-4 ha/hour (15-20 min/ha). When the density is very low or only some of the species are being censused early in the spring, one may walk a little more rapidly; however, at least eight minutes should be allowed for each hectare.

There are many advantages to slow and thorough censusing: (1) one can gather simultaneous observations effectively by following the movements of individual birds in different parts of their territories; (2) one can pay special attention to species difficult to detect; and (3) one can search for nests and check those found earlier. All observations are marked on a map using standard codes which are given in the detailed instructions in Koskimies and Vaisanen (1991). All observations are transferred from the field maps to exactly the same locations on the species-specific maps. There should be a separate map for each species.

Other Considerations

Color Banding Individuals

Observer variability can be a great problem in many of the censusing schemes described above (Verner and Milne 1989). The color banding of individuals allows field identification and survival estimates of individuals without recapture and can greatly enhance spot mapping efficiency, the ability to find nests, and basic life history information. Furthermore, it allows more detailed observation of behavior including breeding biology, survival, and foraging ecology. Color-banding and other auxiliary markers must be authorized by the Bird Banding Laboratory.

Methods of Habitat Assessment

Many applications of habitat analysis are in the literature (e.g., Verner and others 1986). It is not our intention to outline what analyses can be done, but to emphasize that, at the least, vegetation information should be taken at each of the stations. Objectives of vegetation assessment can be many, but among the most common are to relate, in one way or another, the changes in bird composition and abundance to differences in vegetation. These vegetation changes can be either changes over time, or differences between habitats. Two adequate, but relatively time-consuming, methods of habitat assessment are those of James and Shugart (1970), used primarily in forested habitats, and Noon (1981). An excellent and rapid method which could be substituted for the method of estimating stand characteristics below is that of MacArthur and MacArthur (1961) which involves estimating foliage density. The technique uses horizonal measurements to estimate density by relating the percentage of a board that is obscured by foliage. This method has been tested and found reliable by Conner and O'Halloran (1986) and Conner (1990).

If managers wish to characterize the interactions of birds and habitat in a region, then some kind of habitat classification with sampling in proportion to the relative abundance of habitat in that region is the optimal design. This sampling, stratified by habitat, should be done with the guidance of a biometrician.

We present two alternatives here. One is that used to type vegetation into broad habitat classifications, as the Constant Efforts Site vegetation assessment technique does, or a more specific one, involving estimation of stand characteristics. We strongly suggest the latter method, as being more useful for monitoring.

Broad Habitat Classification

Objectives—This method provides brief, overall classification of vegetation and a map that allows other investigators to evaluate the habitat of your station. These data should be the minimum collected on vegetation at any monitoring station. If more detailed vegetation data are collected, then this level need not be taken.

Considerations—The information collected should provide enough data to determine the vegetation types. The method will not provide quantitative information for correlative analyses and ordinations.

Procedures—It is best to make a map of the main areas of habitat within the station on a yearly basis, sometime in June. Prepare it on the scale of approximately 1:2000 (approximately 1 foot to a half mile [1 m to 2 km]). Include the major vegetation types, extending it at least 100 meters beyond the outermost net or capture location. Indicate on the map: trails, roads, ditches, streams, marshy areas, net or census points, open water, and broad habitat boundaries. Also on the map should be a reference point identifiable on a U.S. Geological Survey topographic map or equivalent.

Use colored lines to separate habitat types, and record the following on a form:

• Habitat type: broad category such as forest, brush, marsh, field, etc.

• Shrubby vegetation: list the shrub species comprising more than 10 percent cover in order of their percent cover in each type.

• Trees: list the tree species comprising more than 10 percent cover in order of their percent cover in each type.

• Height of vegetation: record the approximate average height of the canopy of forest or brush to the nearest meter.

• Ground layer: describe the vegetation of the ground layer in terms of the common name of the main species groups present, e.g., ungrazed grass, bare ground with nettle, rushes, etc.

• For wet areas: indicate the water depth in June, or for temporary ponds and streams, give the period that water was present.

Estimation of Stand Characteristics

Objectives—This is a system for assessing habitat characteristics in an efficient and timely fashion at vertebrate monitoring stations. It is taken from a method developed by Bruce Bingham and C.J. Ralph.

Considerations—The information collected will provide enough data to determine the vegetation formation, association, and major structural characteristics. The types of data are those which have some logical relationship with bird requirements for feeding or nesting. The method provides enough quantitative information for correlative analyses and ordinations. It is flexible so that it can be applied to any vegetation formation, including deserts, grasslands, and forests.

Procedures—Establish a releve, a variable radius plot centered, for example, on a census point. The size of the plot will vary, depending on the homogeneity of the vegetation composition, and the density of the vegetation. Generally, this would be a radius of less than 50 m, and often about 25 m. Walk around the point for no more than 5-10 minutes, or until you stop adding new species, whichever is less. Once the search is stopped, the distance from the stopping point, or the outermost boundary of vegetation that the observer can see from the point center, is the radius of the plot and is treated as a boundary for estimating relative abundance.

If the point has more than one vegetation type, then establish two releves. An example would be along a road, with a clear cut on one side, and a mature forest on the other. No more than two releves should be established at a point.

Determine the number of major layers of vegetation within your releve by their dominant growth form: tree layer (T), shrub layer (S), herb (H), and the ground cover (moss and lichen) layer (G).

In a forest with all layers, the tree layer is the uppermost stratum, dominated by mature trees. It may be a single layer, or consist of two or more sublayers recognizable by changes in density and canopy status (see below). The shrub layer is dominated by shrubs or small trees. The herb layer is dominated by low-growing plants, typically nonwoody, although seedlings and other reproduction of trees and shrubs may be present. The ground layer is dominated by such plants as mosses, lichens, and liverworts. Bare ground and litter are ignored for this classification scheme.

We recommend the use of the following height classes for each stratum, if they are appropriate, because they can make the process less subjective. For example, the tree layer could include any plants taller than 5 m (In shorter forests, this might be lowered to 3 or 4 m, as appropriate). The shrub layer could then be established at between 50 cm to 5 m. The herb layer includes any plants less than 50 cm tall. The moss/lichen layer refers to a ground-appressed, low carpet, less than 10 cm high.

For purposes of bird-habitat association, only species of trees and shrubs need be identified and recorded in the data below. For other plants, a common name such as FERN, HERB, MOSS, or LICH will suffice for most purposes. Plant ecologists have used some species in the herb or ground cover layers as indicative of a particular plant association. In this case, the species should be recorded.

Determine the average height of each major layer present and dominant plant species. It is desirable to have additional information on structure, such as the maximum and minimum d.b.h. of canopy trees and total percent cover value of each layer.

Determine relative importance of species in each layer present. Importance can be expressed as either abundance or cover. Percent cover is probably the most common, and we suggest using it.

Below is a detailed description of the data we suggest be taken and recorded as on *figure 15*. The data are separated into Location Data and Vegetation Data.

Location Data:

State or province—The 2-column code for each.

Region—An 8-column code, designated by the investigator. Often, the name of the USGS quad, a prominent landmark, or a nearby town will provide the best code name.

Site data.

• Latitude and longitude—For each point, latitude and longitude should be recorded as the southeast corner of the 1-minute block containing the point, as determined from accurate topographic maps. For example, 40°53’20"N, 124°08’45"W would be reduced to 4053-12408.

• Elevation to nearest meter, by using an altimeter.

• Aspect of the slope (the compass direction the observer faces when looking down hill) to the nearest degree, with a compass.

• Percent slope, with a clinometer.

• Presence (+) or absence (-) of water within the releve.

• Plot radius, distance from the center to the edge of the releve.

Vegetation Data:

Vegetation Structure and Composition

• Total cover—Estimate the cover of each of the four layers, according to the established scale such as Braun-Blanquet (Mueller-Dombois and Ellenberg 1974) or Daubenmire (1968). We recommend the Braun-Blanquet Cover Abundance Scale, which is: 5 = >75 percent cover; 4 = 50-75 percent cover; 3 = 25-50 percent cover; 2 = 5-25 percent cover; 1 = numerous, but less than 5 percent cover, or scattered, with cover up to 5 percent; + = few, with small cover; and r = rare, solitary, with small cover.

• Height—Record to the nearest decimeter (0.1 m) the *average* height of the lower and upper bounds of each of the four layers.

• Species—Record the species by a 4-letter code (using the first two letters of the genus and the first two of the species) with the greatest cover (foliage or crown cover) within each layer’s boundary.

• D.b.h.—For each layer where trees are present, record the diameter at breast height to the nearest centimeter of the largest tree in the layer and also for the smallest trees.

• Species—Record the species of trees used for minimum and maximum d.b.h. measurements

• Number of sublayers—Sublayers are useful to give the plant ecologist a quick overview of the structure of a layer, and are primarily relevant to the tree layer, although sometimes seen in the shrub layer. Record the number of sublayers visible in each primary layer. Record "1" if the layer is uniform and "2" or more if more than a single layer is divided into sublayers. In a primary layer, sublayers are sometimes obvious because of one or more species with shorter heights than the dominant species of the upper portion of the layer. In addition, sublayers are sometimes formed by cohorts of one or more size classes, possibly related to some event. For example, the tallest trees in a stand may form an open (low-density) layer of emergent individuals. Beneath that may be a denser layer of trees forming the main body of the tree layer. Below this denser layer may be another open or closed layer of trees that are intermediate to the main body of the canopy. This layer may consist of shade tolerant species or reproduction. Biologists should be cautioned that extreme precision is not required for this estimation, and unless sublayers are very obvious, they should not be recorded.

Species composition data

• Sublayer—For layers where sublayers have been recognized, record the sublayers with a letter designating the primary layer, followed by a number (e.g., T1, T2, T3, S1, etc.), indicating the sublayers by decreasing heights.

• Cover or cover abundance value, as above, using the Braun-Blanquet method—Because of the difficulty of determining crown covers independently for species of trees in a canopy, sometimes basal area cover of stems (trunks) has been used for tree layer species and crown cover for species in other layers. We suggest the cover abundance value for consistency.

• Species—Record the species' name for each plant species making up at least 10 percent of the cover.

Additional/optional information can be integrated into the method, if desired:

Snags: list layers with snags present; separate into those with a d.b.h. of less than 10 cm and those larger.

Logs: list those less than 10 cm diameter at large end by abundance or cover class, and those greater than 10 cm.

Comments—This type of vegetation assessment is limited by the size of the plot and the amount of estimation required. For example, a plot of even 50 m in radius obviously does not include all vegetation inhabited by birds heard or seen from a census point. This would require a plot of 200 m or more radius. However, most birds detected at a point are within 100 m, and many are within 50 m. Further, time limitations would require much more time spent monitoring vegetation than spent counting birds.

When observers are required to estimate, a substantial amount of error is introduced. What effect the degree of observer error likely with estimation would have on conclusions should be established. The principal source of error in this method of vegetation assessment is the determination of percent cover and heights. Intensive training can moderate this source of error, enabling each vegetation assessment to be placed into at least broad categories or plant associations.

Weather Monitoring

We suggest the following weather measurements three times per day, at the beginning, midpoint, and end of the census or capture period in a day. The maximum high and low temperature from each 24-hr period should also be recorded. Data from nearby weather stations may also be used. However, some measurements from the immediate area are more valuable.

• Weather—Use RAIN, DRIZZLE, SLEET, SNOW, or FOG. (If it is raining and foggy, put down RAIN.) If the above conditions do not apply, use: OVC (overcast), more than 90 percent cloud cover over entire sky; BRK (broken), 50-90 percent cloud cover; SCT (scattered), 10-50 percent cloud cover; or CLR (clear), less than 10 percent cloud cover.

• Wind Direction—Using an anemometer, stand facing into the wind and record the direction to the nearest 1/16th of the compass, i.e., N, NNE, NE, etc. If winds are variable, record predominate direction.

• Wind Speed—Record both the average and maximum speeds.

• Visibility—Estimate visibility to the nearest 250 m if less than 2 km, otherwise to the nearest kilometer.

• Barometric pressure.

• Temperature—Dry bulb temperature. Record to the nearest 1 degree centigrade.

• Relative humidity.

• Rain—Record from a rain gauge to nearest 0.1 mm.

We suggest a continuous strip chart recorder to measure temperature and a somewhat permanent station to measure rainfall.

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Exhibit 5. Mountain Plover Survey Guidelines, U.S. Fish and Wildlife Service, March 2002

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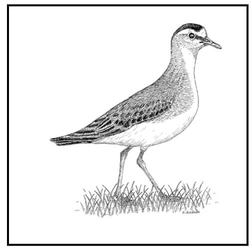
Appendix D

MOUNTAIN PLOVER SURVEY GUIDELINES

U.S. Fish and Wildlife Service, March 2002



The mountain plover (*Charadrius montanus*) is a small bird (17.5 cm, 7 in.) about the size of a killdeer (*C. vociferus*). It is light brown above with a lighter colored breast, but lacks the contrasting dark breast-belt common to many other plovers. During the breeding season it has a white forehead and a dark line between the beak and eye, which contrasts with the dark crown.

Mountain plover breeding habitat includes short-grass prairie and shrub-steppe landscapes; dry land, cultivated farms; and prairie dog towns. Plovers usually nest on sites where vegetation is sparse or absent, conditions that can be created by herbivores, including domestic livestock and prairie dogs. Vegetation at short grass prairie sites is typically less than 4 inches tall. Nest sites within the shrub-steppe landscape are also confined to areas of little to no vegetation, although surrounded by areas visually dominated by shrubs. Commonly, nest sites within shrub-steppe areas are on active prairie dog towns. Nests are commonly located near a manure pile or rock. In addition to disturbance by prairie dogs or livestock, nests have also been found on bare ground created by oil and gas development activities, and on dry land, cultivated agriculture in the southern part of their breeding range. Mountain plovers are rarely found near water. Positive indicators for mountain plovers therefore include level terrain, prairie dogs, bare ground, prickly pear cactus (*Opuntia sp)* pads, cattle, widely spaced plants, and horned larks. It would be unusual to find mountain plovers on sites characterized by irregular or rolling terrain, dense, matted vegetation, grass taller than 4 inches, wet soils, or the presence of killdeer.

Service biologists and Dr. Fritz Knopf, USGS-BRD developed these guidelines. Keep in mind these are guidelines - please call the local Fish and Wildlife Service, Ecological Services office, if you have any suggestions.

GENERAL GUIDELINES FOR SURVEYS

On February 16, 1999, the Service proposed the mountain plover for federal listing as threatened. Because listing of this species is proposed, the Service may recommend surveys for mountain plovers to better define nesting areas, and minimize potential negative impacts. The Service may recommend surveys for mountain plovers in all suitable habitat, as well as avoidance of nesting areas, to minimize impact to plovers in a site planned for development. While the Service believes that plover surveys, avoidance of nesting and brood rearing areas, and timing restrictions (avoidance of important areas during nesting) will lessen the chance of direct impacts to and mortality of individual mountain plovers in the area, these restrictions do nothing to mitigate indirect effects, including changes in habitat suitability and habitat loss. Surveys are, however, a necessary starting point. The Service has developed the following 3 survey guidelines, depending on whether the intent is to determine the presence or absence of plovers at a site during the nesting season for permanent and short-term projects, or to determine the density of nesting plovers at known nesting sites.

Survey Protocol

Surveys for mountain plovers are conducted during the period where the highest numbers of plovers are likely to be tending nests and territories, and therefore are most likely to be detected. Throughout their range, these dates are generally from May 01 through June 15. However, seasonal restrictions for ground disturbing activities in suitable mountain plover nesting habitats are usually longer than the survey dates. The longer seasonal restrictions allow for protection of early nesting birds, and very young chicks which tend to sit still to avoid detection during the first week post-hatch. Since specific nesting dates across the breeding range of the plover vary according to latitude and local weather, the project proponent or the land management agency should contact the local U.S. Fish and Wildlife Service Office to determine what seasonal restrictions apply for specific projects.

Two types of surveys may be conducted: 1) surveys to determine the presence/absence of breeding plovers (i.e., displaying males and foraging adults), or 2) surveys to determine nest density. The survey type chosen for a project and the extent of the survey area (i.e., beyond the edge of the construction or operational ROW) will depend on the type of project activity being analyzed (e.g., construction, operation) and the users intent. One methodology outlines a breeding survey that was used in northeastern Colorado to establish the density of occupied territories, based on displaying male plovers or foraging adults. The other was developed to only determine whether plovers occupy an area.

Techniques Common to Each Survey Method

- Conduct surveys during early courtship and territorial establishment. Throughout the breeding range, this period extends from approximately mid-April through early July. However, the specific breeding period, and therefore peak survey days, depends on latitude, elevation, and weather.
- Conduct surveys between local sunrise and 1000 and from 1730 to sunset (periods of horizontal light to facilitate spotting the white breast of the adult plovers).
- Drive transects within the project area to minimize early flushing. Flushing distances for mountain plovers may be within 3 meters for vehicles, but plovers often flush at 50 to 100 meters when approached by humans on foot.

- Use of a 4-wheel drive vehicle is preferable where allowed. Use of ATVs has proven highly successful in observing and recording displaying males. Always seek guidance from land management agencies regarding use of vehicles on public lands, and always obtain permission of private landowners before entering their lands.
- Stay in or close to the vehicle when scanning. Use binoculars to scan and spotting scopes to confirm sightings. Do not use scopes to scan.
- Do not conduct surveys in poor weather (i.e., high wind, precipitation, etc.).
- Surveys conducted during the courtship period should focus on identifying displaying or calling males, which would signify breeding territories.
- For all breeding birds observed, conduct additional surveys immediately prior to construction activities to search for active nest sites.
- If an active nest is located, an appropriate buffer area should be established to prevent direct loss of the nest or indirect impacts from human-related disturbance. The appropriate buffer distance will vary, depending on topography, type of activity proposed, and duration of disturbance. For disturbances including pedestrian foot traffic and continual equipment operations, a 1/4-mile buffer is recommended.

SURVEY TO DETERMINE PRESENCE/ABSENCE

Large scale/long term projects

1. Conduct the survey between May 1 and June 15, throughout the breeding range.

2. Visual observation of the area should be made within 1/4 mile of the proposed action to detect the presence of plovers. All plovers located should be observed long enough to determine if a nest is present. These observations should be made from within a stationary vehicle, as plovers do not appear to be wary of vehicles. Because this survey is to determine presence/absence only, and not calculate statistical confidence, there is no recommended distance interval for stopping the vehicle to scan for birds. Obviously numerous stops will be required to conduct a thorough survey, but number of stops should be determined on a project and site-specific basis.

3. If no visual observations are made from vehicles, the area should be surveyed on ATV's. Extreme care should be exercised in locating plovers due to their highly secretive and quiet nature. Surveys by foot are not recommended because plovers tend to flush at greater distances when approached using this method. Finding nests during foot surveys is more difficult because of the greater flushing distance.
4. A site must be surveyed 3 times during the survey window, with each survey separated by at least 14 days. The need for 3 surveys is to capture the entire nesting period, with the intent of reducing the risk of concluding the site is not nesting habitat by an absence of nesting birds during a single survey.

5. Initiation of the project should occur as near to completion of the survey as possible. For example, seismic exploration should begin within 2 days of survey completion. A 14-day period may be appropriate for other projects.

6. If an active nest is found in the survey area, the planned activity should be delayed 37 days, or seven days post-hatching. If a brood of flightless chicks is observed, activities should be delayed at least seven days.

<u>Short-term, linear projects</u>

The Service recognizes that many projects have minimal, if any impact on mountain plover nesting habitat, and that these projects may only be present in suitable habitat for a day or less. In order to address concerns from project proponents about delays associated with mountain plover surveys for these projects, the Service has developed the following guidelines. However, the Service encourages the project proponent to plan these projects so that all work occurs outside the plover-nesting season.

Short-term linear projects are defined as projects, which move through an area within the course of a day and result in no permanent habitat alteration (e.g., vegetative/topographic changes), and no permanent project-related above ground features. Short-term, linear projects may include activities such as pipelines (4 inch diameter or less), fiber optic cables, and seismic exploration. For these projects, all ROW surveying/staking activities should be completed before April 1 to avoid discouraging plovers from nesting in suitable habitat. If ROW surveying cannot be completed before April 1, surveyors will need to coordinate with the lead Federal agency before entering these areas, and a plover survey may be required prior to ROW demarcation. For these projects, the presence/absence guidelines above should adhere to the dates below.

1. **April 10 through July 10 -** a plover survey will need to be completed 1- 3 days prior to any construction activity, including initial brush clearing, to avoid direct take of mountain plovers. The survey should include the route and a 1/4-mile buffer on either of the project corridor. If there is a break in construction activity in these areas of more than 3 days (e.g., between pipe stringing, trenching, or welding), an additional plover survey is necessary before construction activity can resume after that break in activity. Generally, mountain plovers are either establishing territories or nests in April, and from late June to early July young chicks commonly freeze in place to avoid detection, increasing their vulnerability to direct take. After July 10, most mountain plover chicks are sufficiently mobile to reduce the risk of direct take.

2 If an active nest is found in the survey area, the planned activity should be delayed 37 days, or seven days post-hatching. If a brood of flightless chicks is observed, activities should be delayed at least seven days.

SURVEY TO DETERMINE DENSITY OF NESTING MOUNTAIN PLOVERS

We are assuming people will have received training on point counts in general before using this specialized point count technique adapted to mountain plovers.

Establishing Transects

1. Identify appropriate habitat and habitat of interest within geographic areas of interest.

2. Upon arriving in appropriate habitat, drive to a previously determined random starting point.

3. For subsequent points, drive a previously determined random distance of 0.3, 0.4 or 0.5 miles.

4. Each transect of point counts should contain a minimum of 20 points.

Conducting the Point Counts

1. Conduct counts between last weeks in June to July 4th at elevations equivalent to the eastern plains of Colorado (i.e., about 5,000 feet). Timing of counts at other elevations should be coordinated with the local FWS office.

2. Only 1 counter is used. Do not use a counter and recorder or other combinations of field help. Drivers are okay as long as they don't help spot plovers.

3. If an adult mountain plover is observed, plot occupied territories on a minimum of 1:24,000 scale map and on a ROW diagram or site grid (see attached). The ROW diagram will be at a greater level of detail, depicting the location of breeding birds (and possible nest sites) relative to ROW centerline, construction boundary, and applicable access roads.

4. Estimate or measure distances (in meters) to all mountain plovers. Method used should be noted, e.g., estimates w/distance training, estimates w/o distance training, rangefinder or measured with tape measure, etc.

5. Record "fly-overs" as "FO" in the distance column of the data sheet.

6. If you disturb a mountain plover while approaching the point, estimate the distance from point-center to the spot from which the bird was flushed.

7. Conduct counts for 5 minutes with a 3-minute sub sample to standardize with BBS.

8. Stay close to your vehicle while scanning.

Recording Data

Record the following information AT EVERY POINT, EVERY DAY.

- Start time
- Unique point code (don't duplicate within a field crew or across dates)
- Number of mountain plovers and distance to each
- Land use and/or habitat type (e.g., fallow wheat, plowed, short grass)
- Temperature, Beaufort wind, and sky conditions (clear, partly cloudy, overcast)
- Information on the data sheet somewhere.
- Your name and address
- Record date for each point at some point during the census.
- Detailed location description of each point count including road number, distance to important intersections.
- Record transects and point locations on USGS county maps.
- Universal Transverse Mercator from maps or GPS are useful.

GENERAL HABITAT INDICATORS

Positive habitat images

Stock tank (non-leaking, leaking tanks often attract killdeer)
Flat (level or "tilted") terrain
Burned field/prairie/pasture
Bare ground (minimum of 30 percent)
"Spaced" grass plants
Prairie dog colonies
Horned larks
Cattle
Heavily grazed pastures
Opuntia pads visible

Negative habitat images

Killdeer present (indicating less than optimal habitat)
Hillsides or steep slope
Prominent, obvious low ridge
Leaky stock tanks
Vegetation greater than 4 inches in height in short-grass prairie habitat
Increasing presence of tall shrubs
Matted grass (i.e., minimal bare ground)

Lark buntings

Mountain Plover Transect Field Data Form

Part 1. Transect Information

Route Name	GPS File Name	Date	Tape Used?	Observer(s)	Affiliation	Employed By	Project(s)

Time Start	Time Stop	Temp Start (°F)	Temp Stop (°F)	Wind Start (Beaufort Scale)	Wind Stop (Beaufort Scale)	Sky Start (Weather Bureau Codes)	Sky Stop (Weather Bureau Codes)

Part 2. Survey Data

Survey Point Number	Time	Survey Point Northing	Survey Point Easting	# Adult Plover	# Juvenile Plover	# Nests	Distance And Direction To Birds/Nests	Bird/Nest Northing	Bird/Nest Easting	How Observed	Evidence of Breeding	WGFD Animal Activity Code	Behavior Notes	WGFD Habitat Type	Habitat Notes

Wind Speed Codes:

Beaufort Scale	Wind Speed Indicators
0	Smoke rises vertically (<1 mph, <2Kph)
1	Wind direction shown by smoke drift (1-3 mph, 2-5 Kph)
2	Wind felt on face; leaves rustle (4-7 mph, 6-12 Kph)
3	Leaves, small twigs in constant motion (8-12 mph, 13-19 Kph)
4	Dust rises; small branches move (13-18 mph, 20-29 Kph)
5	Small trees in leaf begin to sway (19-24 mph, 30-38 Kph)

Sky Condition Codes:

Weather Bureau Codes	Sky Condition Indicators
0	Clear or few clouds
1	Partly cloudy (scattered) or variable sky
2	Cloudy (broken) or overcast
4	Fog or smoke
5	Drizzle
7	Snow
8	Showers

WGFD Animal Activity Codes:

Activity Code	Animal Activity
0	Undetermined
01	Courtship
02	Reproductive (i.e., breeding, nesting, etc.)
03	Loafing, roosting, resting, etc.
04	Migration
05	Feeding
06	Disturbed
07	Damage
08	Sign (tracks, scat, etc.)
09	Watering
10	Escape (direct flight)
11	Territorial behavior
12	Predation
13	Standing
14	Walking
15	Running
16	Hiding
17	Flying
18	Swimming
19	Entrapped (trapped in fence, etc.)

Habitat Indicators:

Positive	Negative
Stock tank (nonleaking)	Leaky stock tanks
Flat terrain (level or "tilted"	Hillsides or steep slopes
Burned field/prairie/pasture	Prominent, obvious low ridge
Bare ground (minimum 30%)	Vegetation greater than 4 inches in height
"Spaced" grass plants	Increasing presence of tall shrubs
Prairie dog colonies	Matted grass (minimal bare ground)
Horned larks	Killdeer, lark buntings present
Cattle	
Heavily grazed pastures	
Opuntia pads visible	

WGFD Habitat Type Codes (southern Wyoming wildlands):

Basin – prairie shrub – shrub steppe

Sagebrush – grassland (04.10)	
04.11	Basin big sagebrush
04.12	Wyoming big sagebrush
04.13	Mountain big sagebrush
04.14	Black sagebrush
04.15	Silver sagebrush
04.16	Threetip sagebrush
04.17	Low sagebrush (Art. arbascula)
04.18	Sand sagebrush (Art. filafolia)
04.19	Other or mixed sagebrush or sagewort
Greasewood (04.20)	
04.21	Greasewood – sagebrush
04.22	Greasewood – saltbush
Rabbitbrush (04.30)	
04.31	Green rabbitbrush
04.32	Rubber rabbitbrush
04.33	Rabbitbrush – sagebrush – mixed shrub
Saltbush (04.40)	
04.41	Gardner saltbush
04.42	Fourwing saltbush
04.43	Shadscale
04.44	Saltbush – sagebrush – mixed shrub
Winterfat (04.50)	
Woody aster (alkali aster) Xylorhiza (04.60)	

Mountain – foothills shrub – shrub steppe

Sagebrush – grassland (05.10)	
05.11	Basin big sagebrush
05.12	Wyoming big sagebrush
05.13	Mountain big sagebrush
05.14	Black sagebrush
05.15	Silver sagebrush
05.16	Threetip sagebrush
05.17	Low sagebrush (Art. arbascula)
05.18	Sand sagebrush (Art. filafolia)
05.19	Other or mixed sagebrush or sagewort
Rabbitbrush (05.20)	
05.21	Green rabbitbrush
05.22	Rubber rabbitbrush
05.23	Rabbitbrush – sagebrush – mixed shrub

Grasslands

Eastern great plains area grasslands (07.10)	
07.11	Shortgrass (Blue grama – Buffalo grass)
07.12	Midgrass (Blue grama – Needlegrass – Western wheatgrass)
07.13	Draws (Bluebunch wheatgrass – Needlegrass – Wildrye)
07.14	Sandy (Muhly – Sand dropseed – Prairie sandreed)
07.17	Annual forb
Great Basin – foothills grassland (07.20)	
07.21	Bluebunch wheatgrass – Bluegrass
07.22	Thickspike, Western wheatgrass – Nealeandthread – Bluegrass – Blue grama
07.23	Annual forb
Mountain – foothills grasslands (07.30)	
07.31	Bluebunch wheatgrass – Idaho fescue – Bluegrass - Needlegrass
Kentucky bluegrass grasslands (07.70)	
Annual grasslands (07.80)	

Exhibit 6. Surveying for Pygmy Rabbits (*Brachylagus idahoensis*), Interagency Pygmy Rabbit Working Group, February 2008 Version

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Surveying for Pygmy Rabbits
(*Brachylagus idahoensis*)

Photo by Rita Dixon and Helen Ulmschneider

Interagency Pygmy Rabbit Working Group

February 2008 Version

9/9/2010

TABLE OF CONTENTS

SURVEYING FOR PYGMY RABBITS (Brachylagus idahoensis*)*
February 2008

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***Marcy Haworth** (FWS, Reno, NV)*
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Introduction

Pygmy rabbits are a BLM Sensitive Species which occur through most of the Great Basin. Although it has been petitioned for listing under the Endangered Species Act, its distribution and population trends are largely unknown. In recent years, biologists in most of the western states have surveyed for and found populations of this rabbit, although there is still much area to inventory. On February 26, 2003, biologists from various federal and state agencies and universities met in Reno to discuss the current state of knowledge and future work needed for pygmy rabbits. Development of a consistent method for surveying for pygmy rabbits across their range was identified as a high priority. A west-wide survey subgroup was formed which helped develop this current paper, based largely on a previous effort by the Idaho BLM pygmy rabbit survey committee.

The intended audience for this paper is biologists who will be surveying for pygmy rabbits. Our purpose is to help you find pygmy rabbits, by using a standardized but flexible and realistic approach. The information presented is a collation of field knowledge gained by biologists who have surveyed for pygmy rabbits in Idaho, Nevada, Utah, Wyoming, Washington, Oregon, and California. This paper describes pygmy rabbit habitat, how to recognize and evaluate rabbit sign, an approach for organizing and conducting broad-scale surveys, and how to record data. It also includes discussion of some other survey techniques. It includes photos of habitat and burrows. This is a work in progress and may be modified as we learn more about the variety of habitats used by pygmy rabbits, pygmy rabbit sign, and about surveying for these rabbits. A few additions and edits were added in 2008 to the June 2004 version, by Helen Ulmschneider. These include: photos of sandy Wyoming habitat near Kemmerer, a discussion of burrowing by the desert cottontail, and a map of vegetation types with pygmy rabbit locations for the Bruneau Field Office, Idaho BLM.

The goal of the broad scale survey described here is primarily to find populations of the rabbit. However, by conducting surveys and recording data in the manner described, locations and a measure of burrow density and "occupancy status" can be obtained at the same time, which can provide a baseline index for population monitoring, and a way to coarsely compare different areas. These surveys will document not only where the rabbits are but also where they are not, which is useful information for refining habitat models, and for land managers.

We recommend that biologists surveying or studying pygmy rabbits across the range of the species will use the included form to gather the basic population data identified (burrow locations and status), although they may add or delete other data to suit their specific needs. This way, it will be easier to compare population indices across the west and across the years.

Field Training

A key piece of advice: The rabbits themselves are secretive and difficult to see; thus it is being familiar with their habitat and sign that is the key to finding populations. Before surveying, look at pygmy rabbit habitat, burrows and pellets with an experienced person in the field. If possible, also look at badger and ground squirrel diggings, to help you learn to distinguish the differences between their burrows and those of pygmy rabbits. Descriptions and pictures are helpful, but there's no substitute for seeing it in the field. Biologists from different states with experience in surveying for pygmy rabbits are listed in Appendix A.

Habitat

There are two main features of pygmy rabbit habitat: relatively taller and denser big sagebrush (*Artemisia tridentata)* (but see below) and deep soils.

Sagebrush

Usually burrows are found in the taller and denser big sagebrush in an area. The height of the sagebrush can vary enormously, from about 1 ½ to 7 feet. Density can also vary, but commonly the sagebrush is so dense right at burrows that it is difficult to walk through. This means > 30% cover. Various subspecies of sagebrush are used, including Wyoming (*A. t. wyomingensis*), mountain (*A. t. vaseyana*), and Great Basin (*A. t. tridentata*). Other shrub species may be present, including bitterbrush (*Purshia tridentata),* rabbitbrush (*Chrysothamnus* spp.*),* greasewood (*Sarcobatus vermiculatus),* snowberry (*Symphoricarpos* spp.*),* and juniper (*Juniperus* spp.).

In some habitats used by pygmy rabbit in Oregon and Nevada, rabbitbrush is dominant or co-dominant with sagebrush, and burrows occasionally or commonly occur under large dense rabbitbrush (T. Forbes, OR; E. Sequin, NV, pers. comm.) and greasewood (J. Himes, NV, pers. comm.). The burrows are so hidden under the canopy that they are often only found by lifting the vegetation.

Pygmy rabbits also may occupy habitat that does not appear ideal: with short sagebrush and "bad" soil. In east-central Idaho, pygmy rabbits occupy "mima mounds" (mounds of soil several feet high and approximately 20-30 feet in diameter) with taller and denser sage, which are dotted in a landscape of shorter and thinner sagebrush (Roberts 2001). Katzner and Kozlowski (pers. comm.)

both emphasize that it is important to keep an open mind, and not develop set ideas about what comprises pygmy rabbit habitat too early, or you may overlook inhabited areas. In Wyoming, Katzner (pers. comm.) has seen pygmy rabbits in areas that he initially would not have thought were habitat. In Montana, the average sagebrush height in occupied sites was only about 15 inches. There, Rauscher (pers. comm.) has often found them in areas where the sagebrush is not very dense and only knee-high or less, especially in mountain bowls and where sagebrush has been manipulated. In Utah, pygmy rabbits have been found to occupy 12 to 120-inch tall sagebrush. Regardless of the absolute height of the vegetation, the rabbits will almost always burrow in the tallest and densest sagebrush on the landscape.

Soils

Generally, pygmy rabbits burrow in loamy soils deeper than 20 inches. Soil composition needs to be able to support a burrow system with numerous entrances, but also must be soft enough for digging. A habitat model from the Univ. of Idaho (Rachlow and Svancara 2003) used a clay content of 13 to 30%, but models from Idaho State Univ. (Simons and Laundre 2001) used <13.5 % clay. In central Washington, pygmy rabbits are found only in areas with deep loamy soils. In southwest Idaho, they occur in areas with soils classified as stony sandy loam, and sandy loam over sandy clay and clay loam. In east-central Idaho, soils are gravelly outwash plains with lime-coated rocks. On the lava plains of southeast Idaho, rabbits will often burrow between or under lava boulders. In Nevada, soils are light-colored and friable. In the Moxa Arch of Wyoming, burrows are found in stabilized sand dunes.

At the Landscape Scale

Pygmy rabbits are found in alluvial fans, swales in a rolling landscape, large flat valleys, at the foot of mountains, along creek and drainage bottoms, in basins in the mountains, or other landscape features where soil may have accumulated to greater depths. They are generally on flatter ground, sometimes on moderate slopes, and not on steep ground.

At the Patch Scale

Look for relatively taller, denser big sagebrush (not low sage) and areas where there appears to be a non-uniform distribution of sage, in other words, where the texture of the sagebrush stand is uneven, or "lumpy", in both height and density. When scanning across a valley these clumps stand out as taller, or as having a different color. It is fairly effective to go directly to these areas to begin a search. Also look for signs of digging, and for soil surface that is not flat and level. The rabbits tend to mound up the soil where they have been burrowing over the years. Drainage bottoms and sagebrush draws with a relatively uniform coverage of sagebrush are also often used by pygmy rabbits.

Habitat Descriptions by State

Idaho: Areas with mounded topography – 'mima mounds' – are prime areas to target for surveys. In the Salmon, Idaho area, alluvial plains where rabbits are found are dotted with mounds about 20-30 ft in diameter, 1-2 ft tall, several hundred feet or yards apart, where the sagebrush is taller than in the surrounding intermound spaces. On 1:24,000 aerial photos, these mounds can be seen as a pattern of darker dots, extending over many miles of landscape (Photo 1); and from the ground, the mounds appear as lenses of darker and taller sage. The mounds are where the pygmy rabbits burrow.

In southwest Idaho, a similar habitat is big sagebrush islands intermingled with low sagebrush (*Artemisia arbuscula)* (Photos 2 and 3). These kinds of areas are also visible on aerial photos).

In the mahogany (*Cercocarpus ledifolius)* savannah in the Owyhee Mountains of southwest Idaho, the rabbits are found in swales of taller sagebrush (Photos 4 and 5) Mounding of the soil is present, but does not form distinctive mima mounds. A dotted pattern is usually not visible on 1:24,000 aerial photographs, although careful examination can show subtle and dim dotting. The soil does end up mounded where the pygmy rabbits have been digging their burrows and maintaining them over time.

Another major habitat in the Bruneau plateau country is the bottoms and lower slopes of small drainages where the sagebrush is denser and taller, indicating deeper soils (Photos 6 and 7).

Oregon: Habitats in Oregon are very similar to those in Idaho. Most habitat is comprised of areas where big sagebrush inclusions are mixed with low sagebrush, rabbit brush, or shorter stature big sagebrush. Mounding similar to 'mima mounding' occurs in most of these sites (Photos 8, 9, 10, 11). Sagebrush on the mounds is usually 1-3 feet taller than that of the surrounding area. These mounds or clumps of big sagebrush can be spaced from a few feet to hundreds of feet apart.

The second most common type of habitat in Oregon is small draw bottoms where deeper soils have collected. Most of these sites are vegetated with basin big sagebrush in the drainage bottom, surrounded by Wyoming big sagebrush, low sagebrush, or mountain big sagebrush in the surrounding uplands. Some mounding can occur in these areas, but it is absent or very subtle. Burrows in these areas seem to be restricted to the very bottom of the drainages or the lower inside slopes of the drainage itself. Some areas with rabbits are dominated by rabbitbrush (Photo 12).

Nevada: In Nevada pygmy rabbits are found in broad valley floors, drainage bottoms, alluvial fans, and other areas with friable soils. Burrows can be located in mounds (either natural or human caused) when they are available in these types of soils. Pygmy rabbit burrows are easiest to find in light colored, friable soils. These soils are usually found in valley bottoms and can be associated with rabbitbrush / sagebrush vegetation. The understory of grasses and forbs can vary from almost none (as in the Reese River Valley) to dense (as in the Sheldon Range). When there are a lot of rabbits present in a valley they are generally distributed throughout the area. However, when there are only a few individuals, they are generally located in the largest, most dense clumps of vegetation (as in the White River Valley).

Montana: Pygmy rabbits are found in habitats similar to those in Idaho and Oregon: large intermountain valley bottoms, alluvial fans, mountain valleys and bowls, drainage bottoms, plateaus, rolling sagebrush plains and isolated patches of sagebrush in grasslands. Preferred habitat in Montana appears to be gently sloping or nearly level floodplains where adequate sagebrush and appropriate soils exist. However, many occupied sites have marginal sagebrush cover and shallower soils. Areas that contain mima-like mounds are good areas to investigate. If pygmy rabbits are found in these areas, they generally occur throughout the continuous sagebrush coverage at varying densities and up into sagebrush drainages.

Utah: The site characteristics of areas inhabited by pygmy rabbits in Utah vary considerably, because they occupy three different ecoregions (U.S. EPA): Central Basin and Range, Wyoming Basin, and the Wasatch and Uintah Mountain. These regions vary significantly in latitude, elevation, precipitation, and geologic history. Pygmy rabbits are found throughout the western half of the state in habitat ranging from 4800 to 7800 feet in elevation and 0° to 20° slopes. Some evidence suggests that Pleistocene Lake Bonneville has excluded the rabbits from the lowest elevations of the Great Basin. Rabbits occur both in alluvial deposits and in favorable microsites on bench tops. Habitat in Utah's northern or high elevation sites is characterized by Wyoming, mountain, and Basin big sagebrush, with bitterbrush and snowberry present at the highest elevations. (Photos 13 and 14). Burrow habitat in southern, low elevation sites is often limited to the bottom of gentle drainages supporting Wyoming sagebrush amid a black sage, shadscale, and gray molly community of minimal height (28 cm). Understory condition is variable: many sites have grasses and forbs in excellent condition, but some of the most numerous pygmy rabbit populations discovered are in chronically grazed areas (sheep and cattle) being targeted for rehabilitation. In all parts of its Utah range, burrowing by the pygmy rabbit appears to be part of a positive feedback system: the rabbits choose the tallest, densest sagebrush, and their burrowing and the mounding it causes appears to help taller, denser sagebrush to grow. Especially in the lowest elevations, raised mounds provide relief from shallow water tables and alkali soil chemistry allowing growth of better cover and forage species.

California: Northeastern California has historical records of pygmy rabbits but has not been surveyed recently. Recent surveys have documented rabbits in the Mono Lake area. Pygmy rabbit habitat in Northeastern California is very similar to adjacent Nevada habitat. Two habitat types occur in the Mono area (Photos 15 and 16). Near Mono Lake, pygmy rabbits occur in islands of big sagebrush and loamy soils, similar to areas in Nevada, but with sandier soils. Burrows tend to be in sandy loam soils, which are often surrounded by very sandy soils. The second area, near Bodie, has shorter, more uniform sagebrush, often less than 3 ft tall, with less clumping of the sagebrush. The elevation at this site is 8400 ft, one of the highest known populations.

Wyoming: Pygmy rabbits occur in swales of taller, denser sagebrush in a setting of hillsides with thinly distributed, shorter sage. Although there have been no quantitative studies comparing pygmy rabbit habitats in different areas, the habitat in Wyoming appears different from that in Washington, Oregon, Nevada, and western Idaho (Katzner, pers. comm.). The overall impression from observation is that the sagebrush in Wyoming is denser and often less heavily grazed, with more standing dead sagebrush, and more Great Basin big sage. The general areas used by pygmy rabbits have evenly distributed, taller, and more structurally diverse sagebrush with a dense canopy. Three subspecies of big sagebrush can be present, Great Basin, Wyoming, and mountain. Surrounding unused areas have fewer, shorter, shrubs with less vegetative cover. In the Moxa Arch of the Kemmerer Field Office, BLM, pygmy rabbits occur in very sandy soils with Indian ricegrass and greasewood (Photos 17 to 21).

Pygmy Rabbit Sign

Burrows *(Photos 21 to 25)*

- Burrow entrances range from 4-10 inches across, usually fairly round but may be slightly wider than tall. The size of pygmy rabbit burrows usually surprises biologists the first time they see them because the holes are larger than they would have thought; many would have identified them as badger burrows. The older a burrow, the more the entrance seems to get enlarged, possibly from predators digging.

- Burrows are most often placed right at the base of a sagebrush, or occasionally another shrub species. Sometimes an entrance will be more in the open, but the majority of entrances will be underneath sage.
- At burrows, usually you will find the sagebrush so dense that walking is difficult, and you have to thread your way through it (which means >30% canopy cover). In more open sagebrush where you can walk more freely, you will probably not find burrows.
- The opening of the burrow usually flares out, and there may be a large pile of dirt outside the entrance, 1 to 3 feet in diameter.
- Usually, there will be more than one entrance in a burrow system; 2-4 is most common, with a maximum of up to 12, and occasionally there is only one.
- The burrow can slope down very steeply or moderately, and the burrow often narrows down from the flared entrance to about 4-5 inches in diameter.
- At currently used burrows, there will often be a lot of fresh dirt piled outside the entrances. Key your search on piles of fresh dirt to find burrows.
- Burrow systems will rarely be isolated; there will be a number of them in a habitat area. Isolated burrows without pellets are difficult to identify with certainty.
- A key feature of pygmy rabbit burrow systems is that they show evidence of having been built up and used over many years, unlike ground squirrel or badger diggings, which are generally a one-time affair. Pygmy rabbits remodel in the same spot year after year, creating mounded areas with taller, denser sagebrush growing on the old dirt piles, and evidence of burying the lower stem of nearby sagebrush over time. The undisturbed areas between these mounded areas will have a fairly level ground surface (observation from Dana Quinney, expert on badger and ground squirrel diggings, Idaho Army National Guard).
- Sagebrush grows taller and denser on the mounded dirt. As pygmy rabbits ‘remodel’ over the years, filling in one tunnel and digging new ones within the same burrow system, they create overlapping mounds of varying ages in one area. The resulting complex of mounded area may be 15 to 30 ft in diameter. Thus, pygmy rabbit burrow areas have old mounding with plants and shrubs growing on them in addition to the current fresh dirt piles.

It is common to find many old burrows, with no fresh pellets, while surveying. In general, unoccupied old burrows appear to last some years. However, in Nevada, Sequin (pers. comm.) has observed extensive burrow systems “melt” completely into non-existence over the course of two to four weeks of wet weather in certain soils. All evidence of burrows was erased. Some of these burrows had been associated with very high pygmy rabbit activity just a few weeks prior. Later, the rabbits appear to return and dig burrows again.

Pellets *(Photos 26 to 27)*

Rabbit pellets are distinctive: round, without dents or points, different from those of any other group of animals. Pygmy rabbit pellets are the smallest of the rabbit pellets, averaging 4-6 mm in diameter. However, the size can vary. Pregnant females produce bigger pellets, as large as cottontails, and up to 11 mm in diameter! (Dave Hays, pers. comm.). Young cottontails can produce very small pellets. Usually the size of pellets is uniform within a pellet group.

- Pellets are in little groupings near the burrow entrance and under sagebrush nearby. At an active burrow, there will often be a carpet of evenly-sized small pellets. Large quantities of uniformly small pellets around a burrow entrance are diagnostic of pygmy rabbits.
- Mountain cottontail pellets average 6-10 mm, but can be smaller. It appears that younger, smaller cottontails produce smaller pellets. Thus, they can overlap in size with pygmy rabbit pellets, creating potential for confusion. Be cautious: in Washington, genetic testing of pellets thought to be pygmy rabbit revealed they were from cottontails (Dave Hays, pers. comm.).
- Cottontails may use some of the same areas as pygmy rabbits, and may use their burrows. Beware particularly if there are rocky outcrops nearby. This is less of an issue in some places such as the Lemhi Valley, where the two do not commonly coexist. It can be more of a problem in smaller pygmy rabbit habitat patches intermixed with rock outcrops, such as in the Owyhee uplands. However, in Lakeview, Oregon, a telemetry study showed cottontails using the same habitats and some of the same burrows as the pygmy rabbits, though there are no rock outcrops for miles.
- Full-grown whitetail jackrabbit scat is 11-12 mm in diameter; blacktail jackrabbit pellets are about 9-10 mm in diameter.
- Rodents, including ground squirrels, have oblong droppings.
- Recent rabbit pellets are usually a dark to medium brown to greenish or blackish color. Very fresh pellets have sheen or appear somewhat glossy. Older pellets appear somewhat dull and eventually weather to gray. If the rabbits have been eating a lot of dry grass, fresh pellets may be more tan, the color of dry grass, and a little larger. If rabbits have been eating green wet vegetation in the spring, the pellets can be almost black on the outside, green on the inside, and may be more elongated and have little pinched ends, being softer when they were deposited.
- It is not known how long pellets last or how long they take to turn grey. Weather conditions affect how fast they turn grey; dry pellets will stay brown, wet pellets will turn grey faster. Pellets under winter snow may stay very fresh looking until uncovered the next spring. In an experiment at 6000 ft in southwest Idaho, pellets gathered fresh in April and placed under a sagebrush were still brown in December. By the next April, they were grey, probably from the wet of winter snows and spring rains followed by exposure to sunlight.
- Some ants collect the pellets, so if you find burrows and no pellets, it may be due to ants. Look for pellets on the conical ant piles.
- Rabbits sometimes eat their own pellets (coprophagy), apparently mostly during the night (Dave Hays, pers. comm.).

Other Burrows *(photos 28 to31)*

- A key difference between pygmy rabbit and badger or ground squirrel burrows is that badger and ground squirrel burrows generally do not create large complex mounds of overlapping dirt piles where sage has regrown.
- Richardson's ground squirrels make smaller holes the size of the diameter of their bodies (approximately 2 -3 inches), and which do not usually have a flared entrance or a sizable pile of dirt. They usually dig holes in the open, overall occupy more open areas, and are often associated with a wet area of some kind. Belding's ground squirrel burrows are similar, but are in dry areas, and can be found under sagebrush as well as in the open. Pygmy rabbit and

ground squirrel burrows may be mingled in the same area. Any ground squirrel may use pygmy rabbit burrows, or may dig their smaller burrows off of pygmy rabbit tunnels (Dana Quinney, Idaho National Guard, pers. comm.).

- Piute (Townsend's) ground squirrels also have small burrows with little dirt around them, and may be both under bushes or out in the open, but not particularly near water.
- Antelope ground squirrels have many small entrance holes placed in a mound of dirt 5 -10 ft across and a foot or so high. Kangaroo rat burrows are similar. Both tend to be in sandier soils than pygmy rabbit burrows.
- Desert cottontails can dig burrows. Generally, they dig simple natal burrows, and do not live in burrow systems.
- Badger diggings are typically bigger than those of pygmy rabbits, 12-18 inches across and very round. Where there are ground squirrels, badger diggings may be numerous. Typically, however, you will see large, badger-dug holes located next to small ground squirrel holes, at least while ground squirrels are active. So instead of several moderate-sized burrow entrances near each other, like a pygmy rabbit burrow system, there will be big and small burrows together. Additionally, badger hunting burrows are one-time affairs, and even their natal burrows are only used briefly during one year.
- Where badgers have dug out pygmy rabbit burrows, which is common in some areas, the entrance will be enlarged to 12 to 18 inches, and very round, with a large pile of dirt. You probably will find both badger-dug and regular pygmy rabbit burrows in the area.
- Coyote and fox burrows are bigger, and more in the open, not under the sage. There will be only one burrow system in an area, not a number of them.
- Chipmunks, pocket mice, and deer mice all have burrows that are tiny (1 inch in diameter or so) and no or little loose dirt outside.
- Pocket gophers produce a mound of dirt about a foot in diameter, approximately 4-6 inches high, and the entrance hole, approximately 2-3 inches in diameter, is hidden under the mound of dirt. There will be a number of mounds in an area, and they are usually more in the open, between the bushes. In winter, pocket gophers tunnel under snow and fill the tunnels with soil; these will produce ropes of soil after the snow melts. They move through the landscape as they burrow, rather than maintaining a stationary burrow system.

Are Burrows from Pygmy Rabbit?

The combination of all factors must be considered in deciding whether burrows are from pygmy rabbits: the habitat, the burrow itself, pellets, and the pattern of burrows on the landscape. No other animal digs burrows with the combination of features of those of the pygmy rabbit: in taller dense sagebrush habitat, burrow entrance 5-7 inches average diameter, located under sagebrush, small round pellets, and a number of burrow systems in an area. A burrow system with a carpet of small rabbit pellets around it is diagnostic of pygmy rabbits.

- First, you need to find both burrows and pellets together.
- For burrows that appear characteristic of pygmy rabbits but have no pellets, search further in the area, and/or look at another time of year. If you find other burrows with pygmy rabbit pellets in the area, then you can conclude that other, similar burrows without pellets are also from pygmy rabbits. Old burrows may tell us something about changes in population extent or density (although we're not sure how to interpret it yet!), and are also important to map.
- If you find small rabbit pellets but no burrows in the area, they are probably from mountain cottontails, especially near rocks. Burrows are an essential piece of evidence, because the

pygmy rabbit seldom ventures far from them. (However, see the section on seasonal considerations.). There should be a number of burrow systems in an area, within a habitat patch.

- Is it the right habitat – big sagebrush and deep soils?
- Are the burrows placed underneath sage? Are they the right size and shape?
- What other animals are around? Be aware there may be cottontails and perhaps young jackrabbits producing small pellets similar in size to pygmy rabbit pellets, or ground squirrels, badgers, or other burrowers to sort out.
- Cottontails and ground squirrels may use burrows originally dug by pygmy rabbits, and further confuse the issue. However, of the rabbits, only pygmy rabbits dig large burrow systems as a matter of course. In captivity, desert cottontails have dug burrows with one or two entrances, and dig natal burrows in the wild (Fred Knowlton, Utah State Univ., pers. com).
- Finally, you can use other methods (discussed at the end of this paper) to confirm presence of pygmy rabbits.

Sign in Snow

During winter, pygmy rabbit tracks and pellets in the snow can be more obvious than other times of the year. Pygmy rabbit tracks can generally be distinguished from other rabbits by the size of the hind foot (Table 1). During winter, juvenile cottontails are nearly the same size as adults, which should minimize overlap in track size between the species.

Table 1. Rabbit track sizes, from information in Forrest 1988, Green and Flinders 1980, and Katzner 1994.

	Pygmy Rabbit		**Cottontail**		**Jackrabbit**	
Back foot length	1.8-2.5 in	46-71 mm	3-3.5 in	77-90 mm	3.5 -4 in	90-103 mm
One track set (prints of all 4 feet)	6-8 in		6.5-11 in		10-30 in	
Between track sets	6-16 in		8-22 in		10-60 in	

Both Rauscher and Katzner (pers. comm.) have observed that pygmy rabbits traveling in fresh snow will re-use the same tracks, leaping from spot to spot a few inches apart (launching-and-landing sites), and leaving a diagnostic pattern. This keeps the rabbits relatively clear of snow and means that they can move much more easily in new snow than if they had to break trail every time they moved. As the rabbits use those sites for several days, the launching-and-landing sites get larger and larger and eventually become a continuous trail. Other rabbit species do not create this initial stage of re-used launching-and-landing sites. Over time, in older snow, pygmy rabbits create a complex maze of continuous trails between burrows (Ulmschneider, pers. obs.).

It can be quite effective and efficient to drive two-track roads in sagebrush areas a day or two after a light snow, looking for launching and landing sites, measuring rabbit tracks, and following weasel or other predator tracks to locate pygmy rabbits (Rauscher, Katzner pers. comm.). To find burrows, it can also be useful to look where snow on a sagebrush forms an umbrella with a cave underneath. Rabbits often use these areas and pellets and tracks will be found underneath (Sequin, pers. comm.) In the snow, active burrows will be obvious with tracks leading into and out from the entrances.

Janet Rachlow has had success searching from a fixed-wing airplane for pygmy rabbit track patterns in the snow, followed by ground surveys of likely looking areas (cooperative study with Shoshone, Idaho BLM).

Snow tracking is also an excellent way to obtain detailed habitat use data. In Utah, intensive snow tracking was conducted in 2003-2004 on a high elevation (7400 ft) site that had been thoroughly surveyed during the preceding spring and summer. Six to ten hours after a fresh snow, tracks of pygmy rabbits were followed by an observer with a GPS unit. Burrow clusters were considered the sample unit as it was too difficult to distinguish individuals. When overlaid on 1 m resolution imagery, GPS-mapped snow tracks illuminate social interactions between rabbits from different burrow clusters (gene flow), and maximum travel distances from burrows. Uninterrupted tracks extended for several kilometers, creating meta-burrow complexes. Most importantly, habitat parameters being measured are representative of the rabbits' foraging and social behaviors, not just their burrow locations. It was generally agreed among participating researchers that radio telemetry could not have provided an equivalent level of resolution without disturbing the rabbit.

Organizing and Conducting Surveys

Targeting habitat

Pygmy rabbits are not randomly distributed within the sagebrush landscape, they are patchily distributed, because they choose particular soils and sagebrush habitats, and they do not appear to be abundant in many situations. Additionally, we cannot yet accurately predict with models where they might occur. With a patchy distribution, random survey methods that might work well for a more evenly distributed animal would be ineffective and inefficient. It is necessary to first target habitat as best you can, that is, to identify the most likely habitat. We describe below a several-stage approach to doing this, using aerial photos, soil and vegetation maps, Geographic Information Systems (GIS, if available), and field knowledge, and then driving and walking in the field as the final step to target areas to survey for pygmy rabbits.

Landscape Scale: The most basic components to use in a GIS model or other map are sagebrush types overlaid on soils (composition and depth). One kind of area to target for surveys is regions where big and low sagebrush are intermingled (Figure 32). Some models have added slope, aspect, fire history, and elevation, but these would be secondary parameters after first delineating sagebrush types and soils.

Fire history can be relevant but you need to know whether sagebrush has come back in or not. The timescale for this will vary enormously depending on whether its mountain sagebrush (maybe 15 years) or Wyoming sagebrush (maybe 100 years or never). So you must include this difference in a model. Aspect may be relevant if windblown soils are being deposited on the lee sides of hills, as in Gabler's model for the Idaho National Engineering and Environmental Laboratory, and Himes' model for east-central Nevada. Slope and elevation may be somewhat useful, after first delineating potential habitat using sagebrush types and soils.

For examples of GIS models from Idaho, see Rachlow and Svancara 2003, or Gabler et al 2000. John Himes (Texas Parks and Wildlife Dept.) has developed one for east-central Nevada, currently

in review for publication.   Be cautious with GIS models – we don't have successful ones yet. The Idaho models need refinement. The data used for both models did not distinguish between low sagebrush and big sagebrush. This resulted in the models rating as habitat large homogenous expanses of low sage with very rocky shallow soils, where no pygmy rabbits are found. At the same time, areas where pygmy rabbits were subsequently found in southwest Idaho were not targeted, consisting of prime habitat with intermingled big and low sagebrush.
The lessons from these efforts are that better habitat models are needed, as well as finer-scale, more accurate soil and sagebrush data. Additionally, there is no substitute for knowing what to look for from field experience, and going in the field and looking.

Mid-scale: Examine aerial photos, topographic maps, and use local knowledge to add or delete areas from your initial map. It is usually possible to distinguish dense sagebrush or to see mounds of taller, denser sagebrush as a dotted or mottled pattern on aerial photos. Local knowledge will help to eliminate burned areas that haven't regrown to sagebrush- e.g. some large old fires in the very southwest corner of Idaho are still vegetated with grass, but are included in the 2003 GIS model because they burned more than 15 years ago (the parameter used in the model). In Oregon, biologists have had success with flying over sagebrush landscapes and identifying dense areas of sagebrush for future ground surveys. You could combine surveys for sage grouse or big game with surveys for pygmy rabbit habitat.

Rank the areas you identified at the large scale, and start surveys in the most likely areas. These would be the largest blocks on the sagebrush and soils map which weren't eliminated by your refinements, areas surrounding past records, areas where aerial photos show mounds of sagebrush as a dotted pattern (see photo 1), where big and low sagebrush are interspersed, and where there are swales of deep soils and tall dense sage.

Fine scale: You will probably have to make the final choice of where to walk a survey route while you are in the field, because the available data are not at a fine enough scale to do this from a distance. While you are driving to or in a chosen area, look for dense tall sage, especially with a "lumpy" or uneven texture, as well as for signs of digging. Sometimes, particularly where soils are light-colored or contain white, lime-covered rocks thrown out by digging, the mounds of freshly dug soil or white rocks are visible from the road. However, in darker soils this is not true, and you have to walk to see burrows. When a suitable area is spotted, stop and walk a survey route.

Your sampling scheme will be dictated by your particular circumstances, both by how the potential habitat is distributed and by your available field staff. Your planned survey intensity for each area will vary with its priority, the size of the area you want to survey, and the people available to do it. Depending on travel time and whether you are finding burrows, (which will slow you down), you might expect to complete about 3 to 7 miles of walking transects in a day. Conduct the greatest amount of sampling in high priority areas, less sampling in lower priority areas. Portion your survey efforts among your highest priorities, with some sampling in lower priority habitat also, as a check on your ability to target habitat.

In snow: Areas where pygmy rabbits are concentrated will attract predators: coyote, badger, bobcat, and weasel. You can use their tracks to help guide you to pygmy rabbit areas, and even to burrows.

Patch scale: While you are walking a survey route you should target the tallest, densest patches of sage. These patches look like islands that stand out above the rest. It is a key part of this method to target appropriate patches; otherwise, you will miss the burrows in the area.

Survey Routes

The goal of a survey route is to check enough habitat in an efficient manner to determine whether pygmy rabbits are present or not, and secondarily to get an index of density of burrows. The goal is not to map out the total patch of habitat or to map every burrow within the habitat. Therefore you will not be trying to walk the perimeter of the population to map its extent, or to completely inventory the habitat, because this can be very time-consuming. Mapping a polygon requires a lot of walking to determine, first, whether rabbits are there, and their extent, and then walk the whole perimeter to map it with a GPS unit. It is simpler and faster to walk a meandering line through a habitat patch, targeting the most likely looking places (instead of the edge), and then continue on to the next swale or habitat patch, or loop back the other side of the valley. If you map your route and record results well, especially if you use a GPS unit, your survey route will be repeatable.

There are several advantages of recording burrow system locations with a GPS unit as you walk a survey route, as opposed to just tallying them. If you use the "repeat" feature (which fills out each new feature with the data from the previous one, so you only have to change a few things), it only takes a few seconds to record a burrow system as a point using a GPS unit, and will not appreciably increase your survey time. The advantages to having the data in this electronic form are many. You can directly download the points to a GIS map and see the pattern of distribution and density on the large scale. If you only record your survey route, and not the burrow points, you will not be able to easily see this pattern. Being able to see the points displayed on a GIS map is useful for refining your understanding of small-to-large scale distribution and habitat. Displaying the points on a background of orthophotoquads will help you with interpreting habitat from aerial photos, and will help you draw the extent of habitat patches on a topographic map or aerial photo.

Recording burrow system locations is a more complete record for those who come after you and want to repeat your work to determine changes over time – they will know exactly what you found where. For example, on a 2-mile long survey route, you may have found clusters of burrows in only a couple places. You can create a baseline for long-term monitoring at the same time as doing an initial survey, because you have a repeatable survey line along with very site-specific results. By recording burrow points along your survey line you can determine whether the distribution of burrow complexes changes over time, which will help us understand how to interpret old burrow complexes.

If you are alone, walk in a loop or triangle, targeting patches of taller, denser sage, looking for pygmy rabbit burrows and pellets. The goal of a looping or triangular route is to survey during all your walking time, and to avoid walking without actually surveying. You may walk through some unsuitable-looking sagebrush, but these data will be useful for helping distinguish where the rabbits do not occur, and will function as a check on your ability to target habitat. Using a topo map, you should be able to design a route that takes you up one swale and down another, or up and down two sides of a valley. In patchy habitat and where patches are small and follow the contours of the land, following the landforms and targeting the taller sagebrush clumps will be most effective. This means your survey line will be meandering, not straight.

If the habitat is uniform or on extensive flats, as in Nevada, straight transect lines arranged in a triangle, or a spiral pattern may be appropriate. For a spiral transect, walk directly to the center of a large, dense sagebrush patch, and then spiral your way out, gradually increasing the diameter of your circle until the habitat is no longer appropriate. It often takes about one hour of survey time to fully check out a potential site (Eveline Sequin, pers. comm.)

Transect length should be dictated by the extent of the habitat patch, road distribution, and the amount of overall habitat you have identified to cover. Surveys in Idaho have shown that you will likely need to walk at least ½ mile to check an area for presence of pygmy rabbits with any degree of confidence, because of the distances between burrow systems, unless you find burrows immediately.

With two people working together, walking one-way linear transects may be possible, by "leapfrogging": one person is dropped off to begin a survey route, the second drives ahead and starts another survey route; the first person ends up at the truck and drives ahead to pick up the second person. If two people walk a survey route in tandem, the width each can cover will be determined by the habitat, but may be on the order of 100 ft., or 50 ft to each side. When two people are surveying together, each can simultaneously sample opposite sides of the road when the road bisects suitable habitat.

When you drive through unsuitable looking habitat within a generally potential habitat area, stop occasionally and walk a short survey route, as a check on your judgment of habitat, and record your transect walked. Take notes on why the habitat looks unsuitable. Remember that 'zeroes' are as important to record as finding pygmy rabbit sign. These data will be used to refine habitat models, and will let us know where to and where not to focus management for pygmy rabbits.

Dogs and horses may be useful during surveys, if available. Dogs can let you know when a burrow is inhabited (though not what animal it is), and may flush rabbits. Horses can be used to survey more quickly than on foot.

Area search

When you find several current burrows and you are inventorying a new area, (or if you have not yet seen a pygmy rabbit in the area) take about a half hour to search the area looking for pygmy rabbits. This will help confirm whether you have pygmy rabbits, and will help you gain confidence in your ability to distinguish pygmy rabbit sign. So far you have had the search image for a burrow, and have been looking down. Now, switch, get the search image for movement and rabbits, and walk slowly, in widening circles around the active sites, looking ahead. Rabbits will often slip quietly into the burrow as you approach, and you have to be alert for the slight movement. Once you learn how to look for the actual animal, you will begin to see them more often (Dave Hays, pers com.).

Pygmy rabbits are easy to distinguish from mountain cottontails. When running away, the white of a mountain cottontail tail is usually visible. Pygmy rabbits do not have any white on their tail. Also, pygmy rabbits seldom run as far as mountain cottontails. Pygmy rabbits will scamper a short distance and stop, often under sagebrush plant or near a burrow entrance.

Seasonal Considerations

Surveys in Washington, Idaho, Nevada, and Oregon have shown considerable variation in the amount of fresh sign at burrows over the course of a year. During late summer and early fall pellets can be scarce at burrows. Burrow complexes that had lots of sign in winter or spring may appear almost deserted in late summer, with few pellets present, and then appear repopulated later.

Pygmy rabbits may use burrows less in summer and fall. In the fall, in SW Idaho, Ulmschneider found many burrows in big sagebrush islands on a valley bottom, with a mix of old and a few brown pellets. Several hundred yards away, under very dense tall sagebrush and bitterbrush on a rocky side slope, lots of fresh small pellets and a pygmy rabbit were observed, although no burrows were found right there. Rachlow (pers. comm.) found a similar situation in the summer in Montana, where there were lots of small pellets but no burrows in very tall sagebrush, and lots of burrows with few pellets in a nearby area. Apparently pygmy rabbits may abandon their burrows at that time of year in favor of dense cover, perhaps due to parasites. Himes (pers. comm.) also observed pygmy rabbit pellets without burrows in dense sage in Nevada in late summer.

In Nevada, Sequin (pers. comm.) has observed pygmy rabbits using certain areas dominated by rabbitbrush only during the dryer part of the year, late spring through fall. These areas have “loamier” soils that are much wetter in winter. Burrows in these areas often disintegrate during the winter, and there is no evidence of rabbits remaining in the area, by tracks, photo monitoring, or sightings. New burrows are then excavated in this habitat in spring. However, during all seasons, rabbits were still found in the adjacent sagebrush-dominated areas.

Winter may be a better time of year to confirm rabbit presence than the summer and fall. After a fresh light snow, fresh tracks and fresh pellets are obvious. Also, rabbits clean out burrow entrances after a snow, which helps identify occupied burrows. Pygmy tracks can often be followed to a burrow entrance. The logistics of surveying in winter can become difficult, though, as snow deepens. Additionally, rabbits begin to burrow under the snow as it deepens, and you may not see much sign on the surface.

When initial surveys are conducted in the summer, and if you find possible or “old” pygmy rabbit sign, plan to return in late fall or winter and check again. For monitoring known populations, the time of the year should be consistent.

In the spring, rabbits appear to be active at their burrows; however, pellets can be more confusing because pregnant females make larger pellets that can be confused with cottontail.

Recording data

The basics to record are where and when you surveyed, whether you found burrows and pellets or not, and burrow locations and status. If you did find pygmy rabbit burrows, categorize, count them, and map them and your survey route.

Classify the status of each pygmy rabbit burrow system (not each entrance) according to the following system:

- **Used burrow plus fresh pellets (B+FP):** brown pellets near a burrow, at least one entrance open, without cobwebs or debris that shows lack of use, usually shows a trail. In snow, tracks and/or pellets visible.
- **Unused burrow plus fresh pellet (UB+FP):** burrow entrances have cobwebs, grass seeds, or other debris in entrance, but with brown pellets. May show transitory use.
- **Burrow plus old pellets (B+OP):** only grey pellets at a burrow, entrances may show signs of non-use.
- **Burrow, no pellets (B):** burrow entrance is not collapsed but no pellets found. Also use this category for burrows in snow where no tracks or pellets are visible.
- **Collapsed burrow (Col):** No pellets
- **Pellets only (P):** No burrows found, but pellets appear right for pygmy rabbit. (Collect and label for DNA analysis or later comparison with known pellets.)
- **Fresh digging at a burrow but no pellets (B+dig):** Digging may have been by a predator such as coyote or badger. If it was a predator, it was most likely digging after prey, and the prey may have been pygmy rabbit.
- **Possible PR burrow (Poss):** Burrow seems right for pygmy rabbit, but there are confusing pellets or no pellets, or it is not in association with other pygmy rabbit burrows (identified by pellets or sightings).

There are several options for recording data, depending on the equipment available: electronically with GPS units, paper data forms, topographic maps, and aerial photos. With GPS units, one might think that it would be easy to map a polygon delineating a pygmy rabbit population, as opposed to walking a meandering line and mapping burrows. However, in the field one soon finds that mapping polygons is difficult and complicated, unless they are very small, and generally requires much more wandering about than walking a transect through a habitat patch, as you try to determine the extent of an often complicated population, exactly where the burrows stop, and then try to walk the perimeter. Additionally, a transect with burrow points added up along it will give you an index of burrow density that can be measured in future years (most GPS units are accurate within about 2 meters), which a polygon will not give you. If you try to do both, you will greatly lose efficiency! The simplest way to delineate the habitat is to draw the approximate extent of the habitat on a topographic map or aerial photo, after you finish your transect.

1. GPS unit with a data dictionary (e.g., GeoExplorer 3):
(A "data dictionary" is an electronic data form that can be filled out directly into the GPS unit, and later downloaded directly to a computer. It can be created to match the paper data form given at the end of this paper.)

- *Note your projection on a data sheet e.g., NAD 83.* Record your survey route (where you walked) using a line feature. You can interrupt the line where you record a pygmy rabbit point (i.e., a burrow system), and then resume it afterwards. Using 'Resume' creates one line feature for each transect, instead of creating many line features, one for each segment between burrows, which just complicates your data set.
- Record each pygmy rabbit burrow system (not individual openings) as a point feature, using a pygmy rabbit data dictionary that includes the essential information on the data form at the end of this paper. Use the "repeat' feature, and when you become skilled, it will only take about 30 seconds to record a burrow. Burrow systems may be about 15 ft across. In areas with dense burrows, it may be difficult to decide when to record a new burrow system. One

rule of thumb is to record a new burrow system at least 30 ft apart (however they can be much denser than that; in Montana, Rauscher [1997] found an area with 8 burrow systems within 30 m).

- Take daily field notes of where you surveyed for the day, habitat, numbers of burrows in each status category, extent of habitat, why you thought they were or weren't from pygmy rabbits, general findings (no sign, old sign, lots of current sign, other critters), any other notes that would help someone else determine where you looked, what you found, and the validity of what you found. Remember that it is possible to lose GPS data, and that general notes are often extremely useful in interpreting the data! Remember zeroes are important to record and discuss!
- Map your survey areas on a topographic map or aerial photo, with date, your name, and a key to any symbols used.
- When finding pygmy rabbit sign in a new area, take samples of droppings and label each container with date, location, and your name (film canisters work well, or plastic zip bags).
- Take photos of burrows, landscape setting, and any other sign (tracks, trails, bones, pellets). Label your photos with date, location (Township, Range, Section and ¼ sections), your name, and what it shows.
- Also mark your driving routes on the maps, when you are within a search area and looking for target habitat to do foot surveys.

2. GPS unit without a data dictionary:

- Record your survey route using a line feature and pygmy rabbit burrow systems using a point feature, as above.
- Use the paper data form to record the necessary information.
- Collect pellets and take photos as above.
- Mark your survey areas on a topographic map or aerial photos, with date, your name, and general findings.
- Also mark your driving routes on the maps.

3. No GPS unit (or GPS unit with a dead battery!)

- Use aerial photos and/or topographic maps to record locations of any burrow systems found and of your survey route. Label each map and photo with "Pygmy Rabbit Survey," dates, your name, and a key to burrow classification and survey routes.
- Alternatively, if burrows are too dense or difficult to map separately, map out your survey route and the area where burrows are found.
- Keep a tally of burrow systems in each category as you walk a meandering line within the area delineated (see data sheet). Also mark your driving routes on the maps.

Other Methods

Traps

Trapping is not effective for general surveys. It may be useful once you know where you have pygmy rabbits for further study. Even in areas with known dense populations of pygmy rabbits, and putting traps right in the entrances of burrows that show fresh activity, trapping success rates are low

(0-4%). Burrows are always there and usually distinctive, and therefore are more useful for general surveys.

Camera with automatic trigger *(from Eveline Sequin)*
Cameras can be used to determine if pygmy rabbits are currently active in an area. Photographs provide direct and convincing evidence that rabbits are present and provide a permanent record. Once burrows are located, or unconfirmed sightings are reported, cameras can be left at the site with minimal human attention to collect the required data. Cameras are able to visually detect pygmy rabbits at locations where other survey methods do not detect them, and may be especially helpful in the spring when the potential presence of other young rabbits may confuse pellet surveys.

An “active” camera set-up consists of a camera connected to an infrared beam unit (sender and receiver) that triggers the camera when the beam is interrupted. These infrared units are sold as burglar alarms for modest prices at electronic stores such as Radio Shack . “Passive” camera setups are triggered by a motion or heat sensor. Active infrared cameras have proven to be more cost effective than passive cameras because they can easily be set in vegetated areas without being triggered by the surrounding moving vegetation.

First a site inspection should be conducted by walking around the area looking for burrowing activity, animals and fresh pellets. Next, set up one active infrared-triggered camera in a central location (near burrows if they have been located). Cameras can be set either across the entrance of an active burrow, or across an open area nearby. The receiver should be set to trigger the camera if the infrared beam is blocked for 0.5 seconds (1 infrared pulse, or the minimum amount of pulses the unit will allow). To make the camera units even more sensitive, reduce the width of the infrared lens to 1 mm with black electrical tape. This combination of settings is responsive enough to capture full body images of rabbits even when they are surprised by the flash or noise. Set the transmitter about 2-4m from the receiver and camera allowing plenty of area for rabbits to travel between the two units. The beam should be set at a height of approximately 5 cm. Set a camera delay of 1 or 2 minutes so that one animal will not use up the entire roll of film. Use 100 or 200 ASA film, and set the cameras to be active 24 hours a day. In locations where pygmy rabbits are known to be active, it was shown that cameras were usually able to record their presence over the course of one week. Depending on the site and the season, the roll of film will be used up in a few days or over the span of a week. In winter, snow may trigger the camera and use all film in an hour.

It is possible to distinguish pygmy rabbits from other rabbits (juvenile jackrabbits, cottontails) using this method. Adult pygmy rabbits can be distinguished reliably by their tails, heads, ear shape, and size in relation to camera equipment. Juvenile cottontails and jackrabbits can be distinguished by tails, head and ear shape, and coloration. Individual rabbits are generally photographed multiple times at one camera location. Therefore, even if not every photograph is entirely conclusive, the multiple angles of single individuals allow for conclusive evidence. If for some reason only one questionable photograph is received, the camera can always be set out for another week. Comparison photos of rabbit species by Eveline Sequin may be viewed at www.wildlife.utah.gov/habitat.

Spotlighting
It is possible to see pygmy rabbits by spotlighting at night; however, it is not as effective or efficient as looking for burrows. Burrows are permanent and easy to spot once you know what to look for,

and you can look for them in the day. Spotlighting may be useful for confirming presence by seeing a rabbit once you find an area with burrows, however, the daytime area searches described above are probably more practical. Rauscher reports, “I attempted to spotlight pygmy rabbits in an area I knew to have a relatively high density of rabbits. I only saw 2 pygmy rabbits. This method is not very effective.”

Peeper Probe
This is a flexible cable with an infrared camera on the end, allowing you to look down a burrow. It may be useful, once you have found burrows, in spotting a rabbit or helping to identify what species dug a burrow in questionable cases. Rauscher in Montana has used these probes in known occupied sites, and was able to see pygmy rabbits; however, he thinks that it is probably not too useful or effective for general surveys. The peeper probe may be useful for some aspects of demographic studies, such as looking into natal burrows (J. Rachlow, pers. comm.) Females dig single, simple burrows for giving birth, and fill the entrance with dirt, so these burrows may be hard to find.

Inquire of Locals; Check Hunting Records
Ask hunters or ranchers who have bagged or claim to have seen pygmy rabbits. On all state-owned Wildlife Management Areas that permit hunting, hunters are required to fill out and submit a card afterwards that indicates their kill to the respective state wildlife agency, which would be an additional way of determining potential sites to survey for pygmy rabbits

Track Plots
To determine presence of pygmy rabbits near a burrow, lay aluminum tracking sheets on the ground or make cleared track plots, and cover them with a thin layer of fine dust to record tracks.

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Pygmy Rabbit Survey Form

Observer(s): ______ Affiliation: ______
Field Office: ______ Survey Acres: ______
Address: ______ Phone: ______
Observation Date: ______ Site Name: ______ Co.: ______ State: ______ Site #: ______
Township: ______ Range: ______ Meridian: ______ Section: ______ Quarter/Quarter: ______ of Quarter: ______
Project / Transect ID #: ______ Field Map ID: ______
Survey Method: ______ Search Time: Start: ______ Stop: ______

GPS Data

Projection: Decimal Degrees ☐ Decimal Minutes ☐ Degrees/Minutes/Seconds ☐ UTM Zone: 12 ☐ 13 ☐
Datum: NAD27 ☐ NAD83 ☐ WGS84 ☐
Coordinates:
Starting point Easting ______ Northing ______ Elevation ______
Accuracy: PDOP ______ FOM ______ +/- ______ Feet ☐ Meters ☐

Land Ownership: State ☐ BLM ☐ USFS ☐ USFWS ☐ Private* ☐ (state below)
Tribal ☐ Military ☐ Nat. Park ☐ Other: ______
*Private landowner / Address / Phone: ______

Potential Threats to Area: Agriculture☐ Fire☐ Development ☐ Grazing ☐ OHV ☐ None Other: ______

Summary of Results for Survey Route Pellets collected? Yes ☐ No ☐
Pygmy rabbit observed? Yes☐ No ☐ Pygmy Rabbit sign observed? Yes ☐ No ☐ Possible burrows ☐ Possible Pellets ☐
Summary of numbers of burrows B+FP: _ B+OP: B: _ _ UB+FP: Col: _ _ B+dig:__ FP alone: _ ____
Length of survey route Miles: Feet: Meters:
Predators (T- tracks, S–scat, V-visual) Coyote T S V Fox T S V Badger T S V Weasel T S V Bobcat T S V
Raptor T S V Other

Notes. *Provide directions, describe landscape setting, note other animals, explain why if no pygmy rabbits were found, describe behavior of any pygmy rabbits seen, etc.*

CODES FOR DATA

Burrow Status	**B+FP –** used burrow plus brown, green, or black pellets	**B+OP –** burrow plus grey pellets	**B –** open burrow, no pellets	**UB +FP** Unused burrow, fresh pellets	**Col –** collapsed burrow	**B+dig –** burrow, fresh digging, no pellets	**FP –** fresh pellets alone	**Poss** Possible PR burrow
Burrow Details	**T** –Clean trail **O** – Open **Col** – Collapsed **Deb-** Debris filled **Dig** - Fresh digging **TS** – tracks in snow **US** – Untracked snow **B** - At base of bush **R** - At base of rock **E**– Enlarged by predator							
Pellet Quantity	**H –** high**,** lots, a carpet **M –** moderate **F-** few							
Soil	**L** - Loam **S** - sand **C** - Clay **G -** Gravelly **R** - Rocky							
Canopy Cover (20 ft radius)	**S** – shrubs **F -** Forbs **G** – grass **B** - bare ground **0** –(0 – Trace) **1** - (1-10%) **2 -** (11-25%) **3** - (26-50%) **4** - (51-75%) **5** – (76-100%							
Grazing use level	**0** - None **1** - slight **2** - light **3** - moderate **4** - heavy **5** – severe *Use descriptions from BLM's Landscape Appearance Method*							

Burrow #	UTM Easting	UTM Northing	Status	Burrow details	Pellets	Soil	Canopy Cover				Grass Use	PygRab seen	# of entrances	Comments
							Shrub	Grass	Forbs	Bare				

BLM's Landscape Appearance Method for Classifying Grazing Use Level

1. **None** (0-5 %). The rangeland shows no evidence of grazing use; or the rangeland has the appearance of negligible grazing.
2. **Slight** (6-20%). The rangeland has the appearance of very light grazing. The key herbaceous forage plants may be topped or slightly used. Current seedstalks and young plants of key herbaceous species are little disturbed.
3. **Light** (21-40%). The rangeland may be topped, skimmed, or grazed in patches. The low-value herbaceous plants are ungrazed and 60 to 80 % of the number of current seedstalks of key herbaceous plants remains intact. Most ground plants are undamaged.
4. **Moderate** (41-60%). The rangeland appears entirely covered as uniformly as natural features and facilities will allow. Fifteen to 20 % of the number of current seedstalks of key herbaceous species remains intact. No more than 10 % of the number of low-value herbaceous forage plants are utilized. (Moderate use does not imply proper use.)
5. **Heavy** (61-80%). The rangeland has the appearance of complete search. Key herbaceous species are almost completely utilized with less than 10 % of the current seedstalks remaining. Shoots of rhizomatous grasses are missing. More than 10 % of the number of low-value herbaceous forage plants have been utilized.
6. **Severe** (81-100%). The rangeland has a mown appearance and there are indications of repeated coverage. There is no evidence of reproduction or current seedstalks of key herbaceous species. Key herbaceous forage species are completely utilized. The remaining stubble of preferred grasses is grazed to the soil surface.

Pygmy Rabbit Identification Summary Sheet

Burrows

- 5-10 inches in diameter
- Placed under sagebrush
- In relatively tall dense sage

Pellets

Pygmy Rabbit	**Cottontail**	**Jackrabbit**
4-6 mm – in carpets near burrow is diagnostic	6-10 mm	9-12 mm

Tracks – length of hind foot

Pygmy Rabbit	**Cottontail**	**Jackrabbit**
46-71 mm (1.8-2.5 in)	77-90 mm (2.5-3 in)	90-103 mm (3.5-4 in)

Visual

Pygmy Rabbit	**Cottontail**	**Jackrabbit**
Brown tail	White tail, obvious from rear	Black-tipped tail (blacktail) or whitish tail (whitetail)
Ears 2 1/4 – 2 1/2 in, about length of head	Ears 2 1/5 – 2 3/5 in, about length of head	Ears 5-7 in, way longer than head, and black tipped
Won’t run far, zigzags, often stops at sagebrush or burrow	Bolts fast and far	Bolts fast and far
Small – 8 1/2-11 in	Medium – 12-14 in	Large – 17-21 in Blacktail; 18-22 in Whitetail.

Photos

Photo 1 - Aerial photo (1:24,000) of pygmy rabbit habitat near Leadore in the upper Lemhi River valley, east-central Idaho. The dark dots on the outwash plain are mima mounds with taller sagebrush, where the rabbits burrow. Both the large and very tiny dark dots are habitat. This area has a particularly dense population of rabbits, currently being studied by students of Janet Rachlow, Univ. of Idaho. Agriculture in photo shows common pattern: areas with soil suitable for pygmy rabbits are also often suitable for agriculture.

Photo 2. Bruneau Field Office, BLM, Owyhee County, Idaho. Pygmy rabbit habitat in a big sage patch in a matrix of low sage. Photo by Helen Ulmschneider.

Photo 3. Bruneau Field Office, BLM, Owyhee County, Idaho. Pygmy rabbit burrow system was located in the taller sage, between the people. Photo by Helen Ulmschneider.

Photo 4. Bruneau Field Office, BLM, Owyhee County, Idaho. View from a helicopter of pygmy rabbit habitat in the mahogany savannah. The darkest patches are mountain mahogany, the greenest areas are low sage, and the greyest areas are the swales of big sage where the pygmy rabbits are found. Photo by Helen Ulmschneider.

Photo 5. Bruneau Field Office, BLM, Owyhee County, Idaho. Closer view of swale habitat in the mahogany savannah. Most of the burrows were found to the right of the road near the top of the photo. Photo by Helen Ulmschneider.

Photo 6. Bruneau Field Office, BLM, Owyhee County, Idaho. Draw with big sage, cutting into plateau of low sage. Burrows were mostly in the slightly taller sage below the rocks. Photo by Helen Ulmschneider.

Photo 7. Bruneau Field Office, BLM, Owyhee County, Idaho. Burrows were located in the small strip of taller sage just below the rocks. Photo by Helen Ulmschneider.

Photo 8. Dixon, Oregon. Pygmy rabbit on lower left, in big sage island in matrix of low sage. Photo by Todd Forbes.

Photo 9. Lakeview, Oregon. Big sage island; burrows located where person is pointing. Photo by Todd Forbes.

Photo 10. Dixon, Oregon. View of big sage islands which are where burrows are found: visible as the subtle, narrow lines of taller sage. Photo by Todd Forbes.

Photo 11. Dixon, Oregon. Pygmy rabbit near burrows. Photo by Todd Forbes.

Photo 12. Dixon, Oregon. Pygmy rabbit habitat with large component of rabbitbrush. Photo by Todd Forbes.

Photo 13. Duck Cr. Utah. Pygmy rabbit habitat in foreground and in swale bottom in background. Note large component of rabbitbrush. Photo by Kozlowski.

Photo 14. Northern Utah. Pygmy rabbit habitat in big sage with rabbitbrush. Photo by Kozlowski

Photo 15. Mono Lake, Bodie, California. Pygmy rabbit habitat in islands of taller sage. Photo by Evelyn Sequin.

Photo 16. Mono Lake, California. Pygmy rabbit habitat in tall sage on valley floor. Photo by Evelyn Sequin.

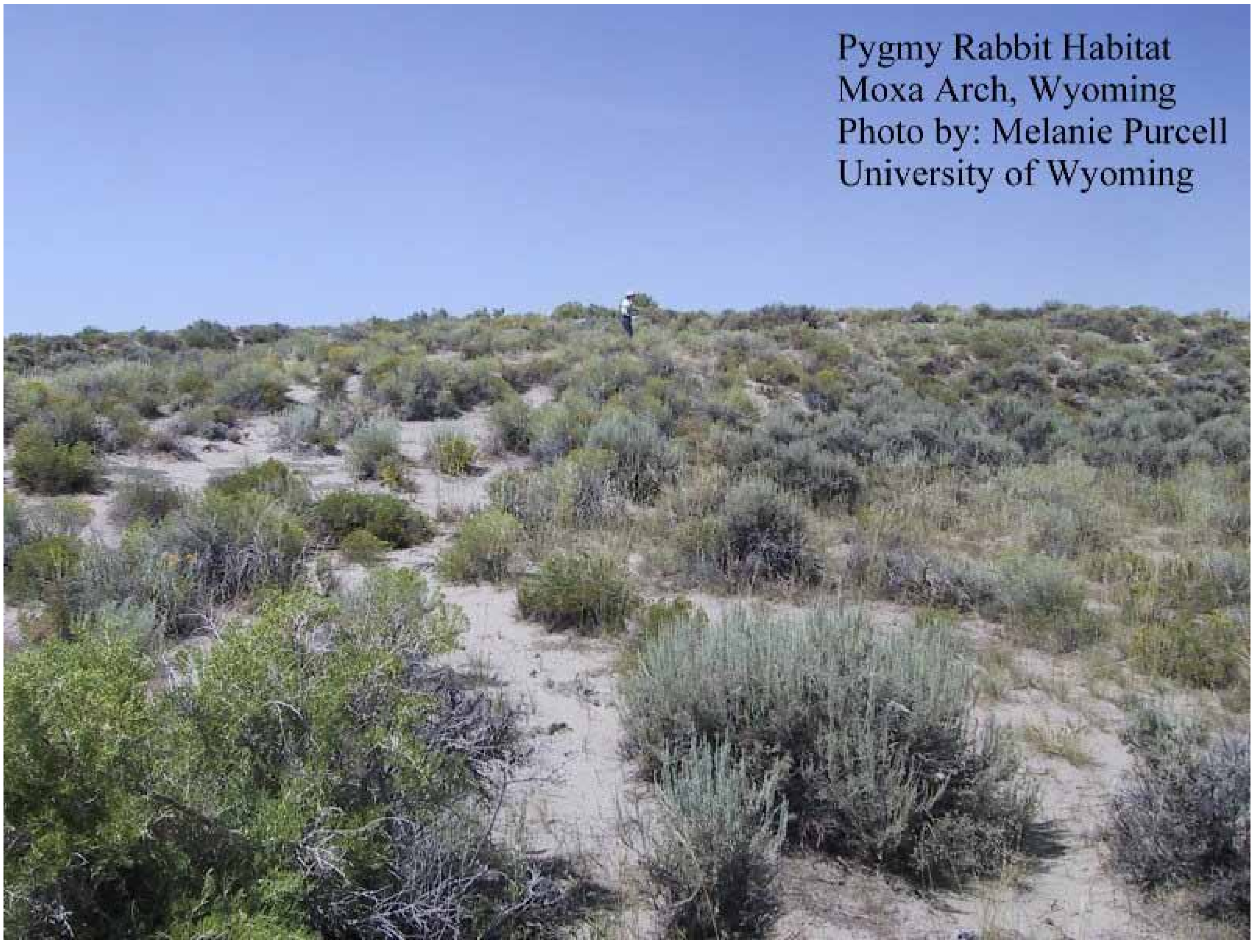

Photo 17. Moxa Arch, Kemmerer Field Office, BLM, Wyoming. Pygmy Rabbit habitat in sandy soils. Note greasewood, lower left.

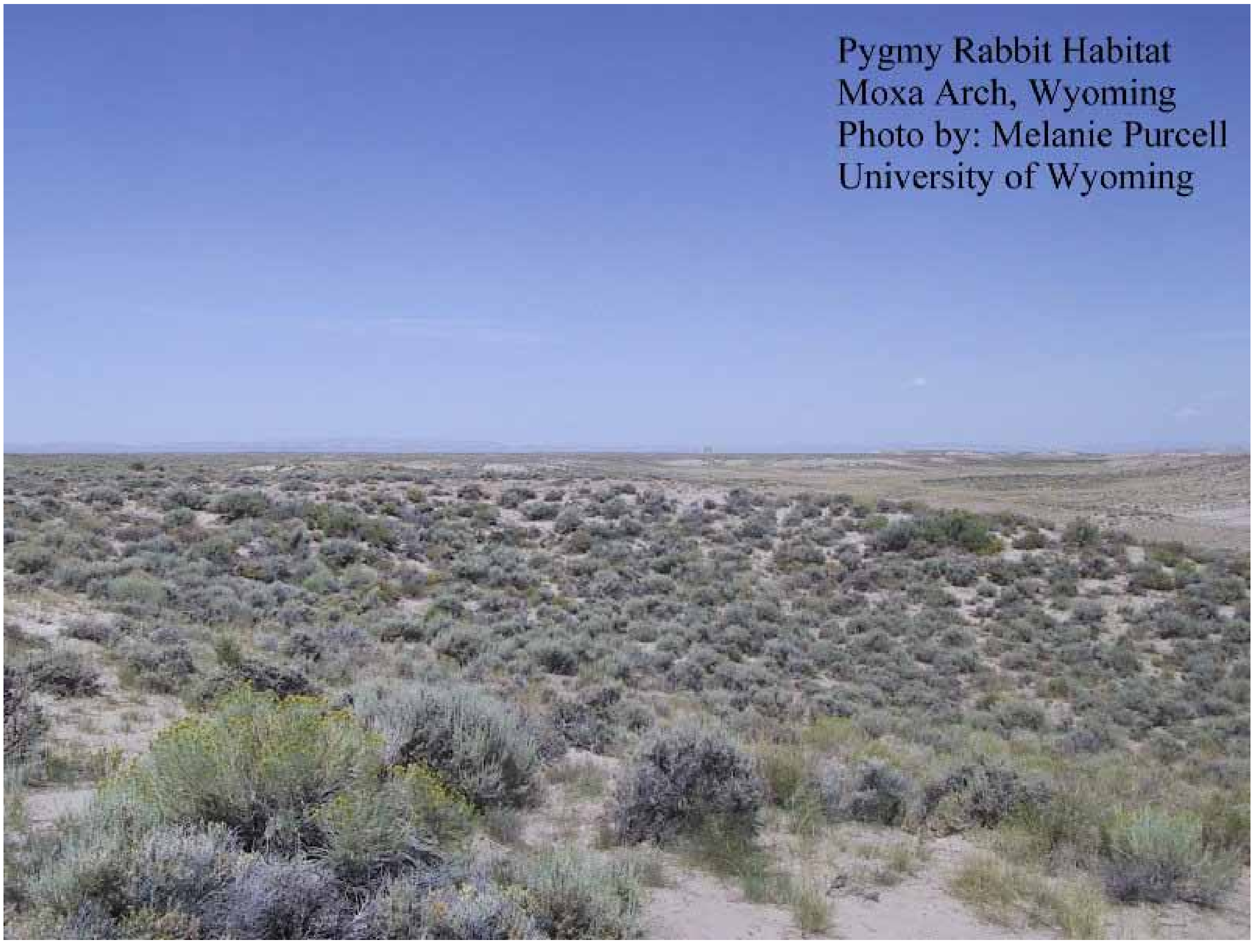

Photo 18. Moxa Arch, Kemmerer Field Office, BLM, Wyoming. High desert pygmy rabbit habitat.

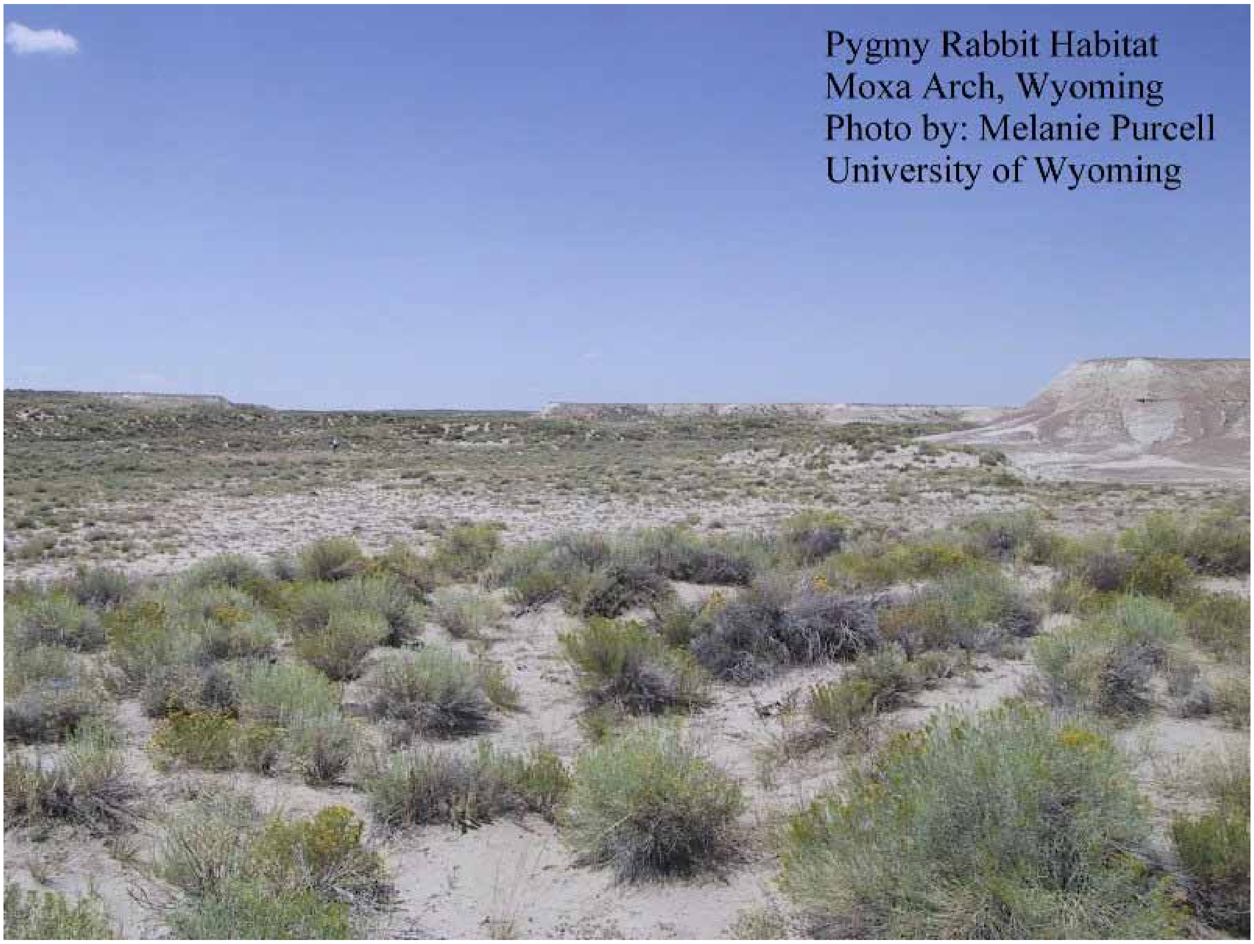

Photo 19. Moxa Arch, Kemmerer Field Office, Wyoming. Pygmy rabbit habitat: this habitat looks very atypical to biologists from other areas, with very sandy soils and lack of herbaceous vegetation between shrubs.

Photo 20. Moxa Arch, Kemmerer Field Office, BLM, Wyoming. Pygmy rabbit habitat and oil field development.

Photo 21. Moxa Arch, Kemmerer Field Office, BLM, Wyoming. Pygmy rabbit burrow in sandy soils. Note Indian ricegrass and rabbitbrush.

Photo 22. Leadore, Idaho. Pygmy rabbit near burrow entrance. Burrow position is further from base of sage than usual, which is why it can even be seen in a photo. Burrow also appears enlarged by badger digging. Most burrows are difficult to photograph because they look like a shadow under the sage. Photo by J. Witham.

Photo 23. Bruneau Field Office, BLM, Owyhee County, Idaho. Pygmy rabbit burrow entrance about 7-8 inches across. Photo by Helen Ulmschneider.

Photo 24. Owyhee County, Idaho. Pygmy rabbit burrow in center of photo. Photo by Helen Ulmschneider.

Photo 25. Owyhee County, Idaho. Badger tracks and digging at pygmy rabbit burrow in fresh snow. Photo by Helen Ulmschneider.

Photo 26. Three sizes of rabbit pellets: large-whitetail jackrabbit, medium-mountain cottontail, and smallest-pygmy rabbit. Photo by Helen Ulmschneider.

Photo 27. Pygmy Rabbit pellets (tiny) on ground with jackrabbit pellets, Oregon. Photo by Todd Forbes.

Photo 28. Paiute Ground Squirrel burrow, SW Idaho. Photo by Helen Ulmschneider.

Photo 29. Richardson's ground squirrel burrow, SW Idaho. Photo by Helen Ulmschneider.

Photo 30. Badger hunting burrow (>12 inches across) in Paiute ground squirrel area. Note how round it is, the large pile of fresh dirt, and how far into the burrow you can see. Usually you cannot see more than a few inches into a pygmy rabbit burrow without bending right down to the burrow. Photo by Helen Ulmschneider.

Photo 31. Badger hunting burrow into Paiute ground squirrel burrows, large and small entrances next to each other, large piles of dirt. Photo by Helen Ulmschneider.

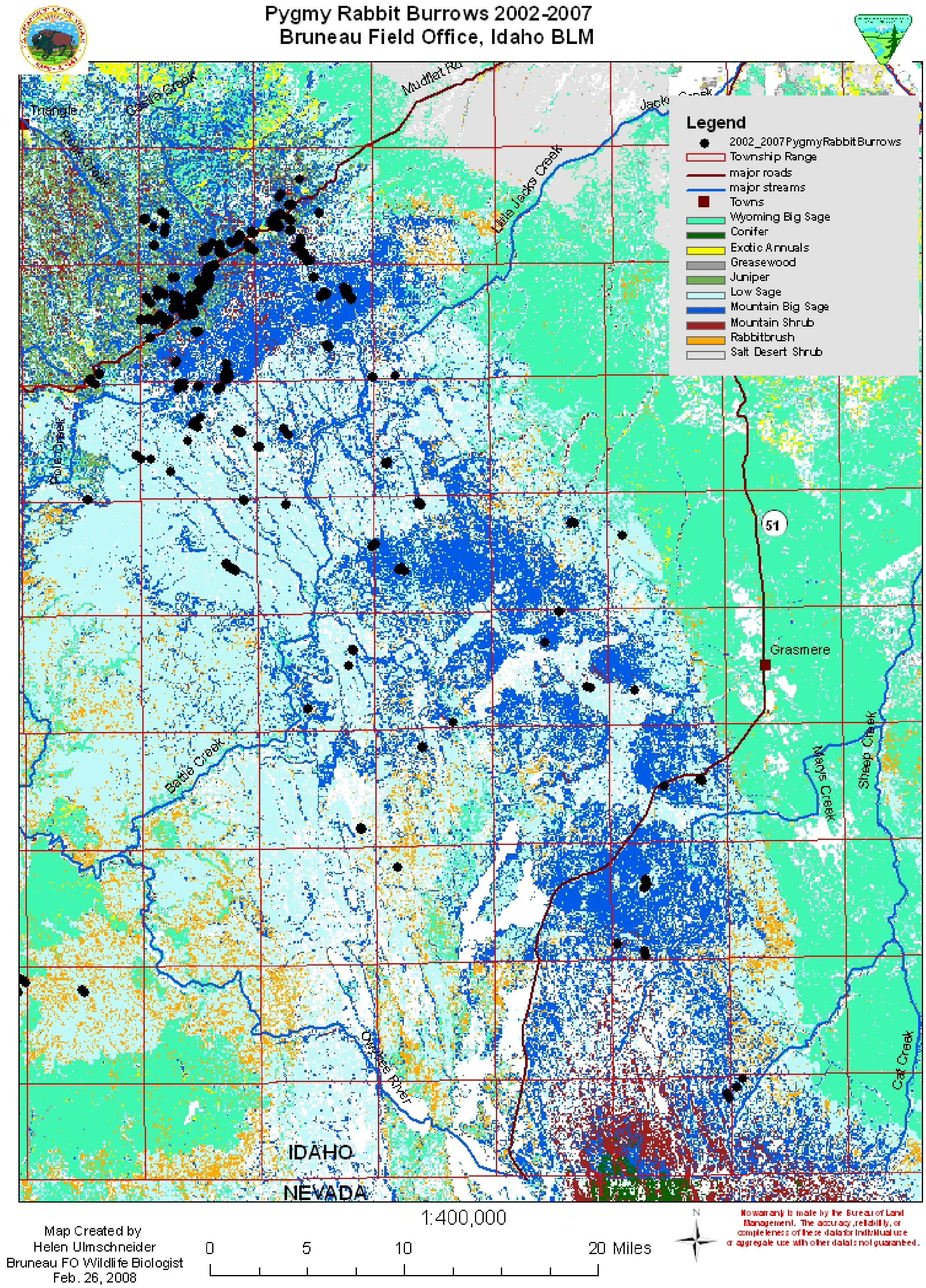

Figure 32. Vegetation map showing Wyoming, low, and mountain big sagebrush and pygmy rabbit burrow locations. In this region, pygmy rabbits are in the mountain big sage in a mosaic with low sage. Elevation at the Wyoming-mountain sage boundary is 5400 feet.

Exhibit 7. Wildlife Survey Protocols
Pinedale Field Office, Version 2.3, January 2011

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Wildlife Survey Protocols
Pinedale Field Office

Version 2.3
January 2011

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WHITE-TAILED PRAIRIE DOG SURVEY PROTOCOL

These survey procedures and data standards may be changed at any time at the discretion of the BLM.

Delineation of Survey Areas

Until the time that the Service, States, and other Federal agencies are able to identify reintroduction areas and to classify other areas as being free of ferrets, surveys for black-footed ferrets will usually be recommended. During this interim period the following approach is recommended to determine where surveys are needed. A white-tailed prairie dog (*Cynomys leucurus*) town or complex of less than 200 acres having no neighboring prairie dog towns may be cleared without a ferret survey. White-tailed prairie dog towns or complexes greater than 200 acres but less than 1,000 acres, may be cleared after completion of a survey for black-footed ferrets provided that no ferrets or their sign were found during the survey. Before any federally funded or permitted activities are conducted on black-tailed or white-tailed prairie dog towns or complexes greater than 1,000 acres, the appropriate Service office should be contacted to determine the status of the area for future black-footed ferret reintroductions. That office also will determine whether a survey for black-footed ferrets should be completed.

Defining a Prairie Dog Town

For the purpose of this document a prairie dog town is defined as a group of prairie dog holes whose density meets or exceeds 20 burrows per hectare (8 burrows/acre), unless otherwise specified by the BLM. Prairie dog holes need not be active to be counted but they should be recognizable and intact; i.e., not caved in or filled with debris

SURVEY METHODS:

1. The entire survey area is searched from ATV, or on foot where necessary, to locate prairie dog colonies using visually overlapping transects.
2. Transect spacing will range from 50-100 m to enable a thorough search of the survey area.
3. Map each colony by GPS-ing the location of a burrow on the edge of a colony, and then searching the area within 30 meters of this burrow for the next burrow occurring along the colony edge.
4. If another burrow is located within 30 meters, the location is collected as a polygon vertex. This technique is repeated until the colony edge is defined by the points (i.e., vertices) located along the perimeter and the biologist returns to the starting burrow, closing the polygon and providing accurate delineation of the colony.
5. Collapsed burrows are not considered the edge of a prairie dog colony. Open but unoccupied burrows are considered the edge of a colony.
6. Based on the assumptions underlying this methodology, prairie dog colonies delineated in this fashion should yield at least 8 burrows per acre, which compiles with the definition of a prairie dog town (Biggins et al. 1988).

Prairie Dog Town/Complex Acreage Determination (Biggins et al. 1988)

To determine the acreage that a prairie dog town or complex of towns occupy, several steps are required. A diagrammatic (spatial) example of a simulated complex is presented here. Before starting this exercise, those prairie dog towns that will be affected by the action and those in the surrounding area should be identified on a map having a scale of 1:24,000. Once this has been done, the following procedures should be followed:

1) Determine the northernmost prairie dog town on the map. Start at the northernmost point of the northernmost town of the complex being considered.
2) Pivot a 7-km (4.34 mile) line segment clockwise from due north until it touches a point on a town (see example). The line between the initial point and the second point forms the first segment of the polygon.
3) From the second point, pivot the 7-km line clockwise from alignment with the first segment until it touches a third point on a town. This forms the second segment of the polygon.
4) If a convex town perimeter prevents "pivoting" the 7-km line to another point, move clockwise around that perimeter until Step 3 can be accomplished. The convex perimeter of a town can thus become a segment of the boundary of the complex.
5) Continue pivoting the line from town to town until the polygon becomes closed.
6) In rare circumstances, a complex may contain one or more large prairie dog free spaces (diameter = 7 km). Delete this space from the area of the complex, circumscribing it as follows.
7) Start at the southernmost point of the northernmost town in the prairie dog free space.
8) Pivot a 7-km long line counter-clockwise from due south until it touches a point on a town.
9) If a concave town perimeter prevents the "pivoting" 7-km line from contacting another point, move counter-clockwise around that perimeter until (b) can be accomplished.
10) Repeat step (b) until the polygon becomes closed.

REFERENCES

Biggins, D., B. Houston, B. Miller, B. Oakleaf, T. Clark and A. Dood. 1988. A system for evaluating black-footed ferret habitat. U.S. Fish and Wildlife Service Draft Report, 40 p. plus appendix.

White-tailed Prairie Dog Survey Summary Form

Observers: ____

Affiliation: __________________________ Data Correction: ______________________

Location or Identifier	Township, Range, Section, ¼, and Shapefile ID	Date (mo/day/yr)	Activity (Y, N, U)	Size (acres) all mounds	Density (L, M, H)
1.					
Comments:					
2.					
Comments:					
3.					
Comments:					
4.					
Comments:					
5.					
Comments:					
6.					
Comments:					

SAMPLE

Survey Type
Project Name
Legal Location
Operator

Consultant Name
Contact
Address
City, State Zip

Date

1. Introduction
2. Methods
3. Results
4. Discussion
5. Maps
6. Data sheets
7. Photos (if taken)

Exhibit 8. Raptor Nest Survey Protocol

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RAPTOR NEST SURVEY PROTOCOL

1 INTRODUCTION

The survey area for nesting raptors will include the entire transmission line presence/absence survey area; new, improved, or overland access routes; and a survey buffer ranging from 0.25 mile to 1 mile surrounding these areas. Surveys for raptor species that may occur within the Project segments where construction is planned are generally required from February 1 to August 15, depending on the species, and will follow the survey protocol described in Annex A: *Nesting Habitats and Surveying Techniques for Common Western Raptors* (Call 1978). Table 1, Seasonal and Spatial Restrictions for Breeding Raptors, lists by species the relevant survey period and survey buffer.

2 QUALIFICATIONS

Raptor nest surveyors must meet the educational requirements (or possess a combination of education and experience) for Wildlife Biology Occupational Series 0486 and be preapproved by the Bureau of Land Management (BLM). Surveyors should have experience in raptor behavior, as well as excellent raptor-identification skills. Raptor surveyors should be able to identify raptor species visually and be familiar with the calls of those raptors expected to be in the Project area and any similar sounds that they could be confused with.

3 METHODS

For the purpose of this survey plan, raptor nests are defined using the Romin and Muck (2002) definition, which includes both occupied and unoccupied nests:

- *Occupied nests* are defined as those nests which are repaired or tended in the current year by a pair of raptors. Presence of raptors (adults, eggs, or young), evidence of nest repair or nest marking, freshly molted feathers or plucked down, or current year's mute remains (whitewash) suggest site occupancy. Additionally, all nest sites in a nesting territory are deemed occupied while raptors are demonstrating pair bonding activities and developing an affinity to a given area. If this culminates in an individual nest being selected for use by a breeding pair, then the other nests in the nesting territory will no longer be considered occupied for the current breeding season. A nest site remains occupied throughout the periods of initial courtship and pair bonding, egg laying, incubation, brooding, fledging, and post-fledging dependency of the young.

- *Unoccupied nests* are defined as those nests not selected by raptors for use in the current year. Nests would also be considered unoccupied for the non-breeding period of the year. The exact point in time when a nest becomes unoccupied should be determined by a qualified wildlife biologist based upon knowledge that the breeding season has advanced such that nesting is not expected. Inactivity at a nest site or territory does not necessarily indicate permanent abandonment.

Avian biologists conducting pedestrian raptor nest surveys will attempt to investigate the most likely substrates capable of hosting raptor nests. Raptors detected during pedestrian surveys should be observed for up to 20 minutes because these sightings often can lead surveyors to raptor nests.

Surveys will be conducted during favorable weather conditions and during hours when raptors are most likely to be active, generally at first light or before dark. The use of both a high-powered telescope and binoculars will be used to enable avian biologists to make observations far enough away from nests to minimize stress and avoid eliciting a sustained territorial behavior from raptors.

Avian biologists will conduct both aerial and pedestrian surveys. Aerial surveys are most appropriate for documenting the locations of nests on a broad scale; however, due to variability in raptor species territory establishment and nest building, surveyors should exercise caution when making occupancy and species determinations during aerial surveys alone. Supplemental pedestrian surveys are necessary whenever a conclusive occupancy determination cannot be established or when repeated visits to individual nests during the early breeding season would be necessary in order to determine nest occupancy.

Surveys begin with an examination of maps and aerial photographs to determine potential nesting sites based on each species' nesting requirements. Existing raptor nest data will also be reviewed prior to aerial and ground surveys. Aerial and ground surveys will be planned for times when target species are likely to be one-half to three-fourths of the way through the nesting season, which varies by species and location but generally occurs between April and June.

Aerial surveys will be conducted via helicopter over potential nesting sites identified during desktop mapping. During flights, all nest locations and areas of suitable habitat will be noted on a map. Aerial photographs will be taken of nests when possible but especially where raptors are using unusual topographic features as nesting sites.

Following the aerial surveys, all identified nests and areas of potentially suitable habitat will be surveyed from the ground using the best access routes observed from the air. All nests will be examined to determine the nesting species of raptors present. Pedestrian surveys are most appropriate for detecting ground-nesting raptors, which commonly nest in thick vegetative cover. Therefore, pedestrian surveys will be performed in areas likely to be selected for nesting by species that nest at or near ground level or species that nest in thick vegetative cover, as well as in situations in which a nest needs to be visited several times.

Data relative to the raptor species, number of eggs or young, type of nest and habitat being used, and maps and photographs of the nest will be recorded on a raptor inventory sheet. All old nests will be recorded because they may be alternate nest sites for active pairs or may be used by other species in subsequent years. All previously documented nests will use the same unique identifier (Nest No.), if available from the BLM field office. All new nests (not previously known) will be assigned a new unique identifier. All data related to the nest (i.e., species, phenology, dates, times, behavior, geographical positioning system coordinates, and number of eggs or nestlings) will be recorded. Specific data schema usage requested from the BLM field offices can be implemented upon request from those field offices.

3.1 Burrowing Owl

Survey methodology for burrowing owls is based on Phase II burrow surveys identified in the *Burrowing Owl Survey Protocol and Mitigation Guidelines* (California Burrowing Owl Consortium 1993). Surveyors will perform meandering transects through suitable habitat searching for burrows with any burrowing owl sign (tracks, feathers, pellets, prey remains, and scat). Burrows occupied by burrowing owls will be identified and photographed. Locations of occupied burrows will be recorded using GPS equipment. Observations of burrowing owls, owl sign (tracks, feathers, pellets, prey remains, and scat), and notes on the number and behavior of owls will be recorded.

Table 1. Seasonal and Spatial Restrictions for Breeding Raptors

Raptors	Spatial Buffer (miles)	Seasonal Restriction
American kestrel	0.25	February 1 to August 15
Bald eagle	0.50	November 15 to August 15
Burrowing owl	0.50	February 1 to August 15
Common barn owl	0.25	February 1 to August 15
Cooper's hawk	0.50	February 1 to August 15
Eastern screech-owl	0.25	February 1 to August 15
Ferruginous hawk	1.00	February 1 to August 15
Flammulated owl	0.25	February 1 to August 15
Golden eagle	0.50	February 1 to August 15
Great horned owl	0.25	February 1 to August 15
Long-eared owl	0.50	February 1 to August 15
Merlin	0.25	February 1 to August 15
Northern harrier	0.50	February 1 to August 15
Northern pygmy-owl	0.50	February 1 to August 15
Northern saw-whet owl	0.50	February 1 to August 15
Osprey	0.50	February 1 to August 31
Peregrine falcon	0.50	February 1 to August 15
Prairie falcon	0.50	February 1 to August 15
Red-tailed hawk	0.50	February 1 to August 15
Sharp-shinned hawk	0.50	February 1 to August 15
Short-eared owl	0.25	February 1 to August 15
Swainson's hawk	0.25	February 1 to August 15
Turkey vulture	0.25	February 1 to August 15
Western screech-owl	0.25	February 1 to August 15

Seasonal and spatial buffers were determined in accordance with the *Little Snake Field Office Record of Decision and Approved Resource Management Plan* (BLM 2011) and the *White River Record of Decision and Approved Resource Management Plan* (BLM 1997).

4 LITERATURE CITED

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Annex A. Nesting Habitats and Surveying Techniques for Common Western Raptors

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Form 1220-5

Filing Code 6611

Date Issued May 1978

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

TECHNICAL NOTE TN-316

U.S. DEPARTMENT OF THE INTERIOR – BUREAU OF LAND MANAGEMENT

NESTING HABITATS AND SURVEYING TECHNIQUES FOR COMMON WESTERN RAPTORS

by Mayo W. Call

Bureau of Land Management, Denver Service Center

…tional copies of Technical Notes are available from DSC, Federal Center Building 50, Denver, Colo., 80225

NESTING HABITATS AND SURVEYING TECHNIQUES FOR COMMON WESTERN RAPTORS

BY

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Photograph and Illustration credits

The author is grateful to all those persons who granted permission to use their drawings or photographs in this Technical Note. These illustrations make it much easier to quickly identify both the birds and their nest and/or their respective nesting habitats.

Alberta Recreation, Parks, and Wildlife: Figs. 1, 6, 26A, 32, 35, 39, 42, 45, 49, 52, 65A, 73, 80, 89, 99, 110, 117.

Allen, David: Fig. 90 (upper).

Call, Mayo W. : Figs. 7, 8, 9, 10 (all), 11 (all), 12, 14, 17, 18, 22 (upper), 25, 27 (all), 28 (middle & lower), 30, 31, 36, 37, 38, 40 (upper right & lower), 43, 44, 46, 51, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 66, 67, 68, 69, 70, 71, 74, 75, 76, 77, 85, 90 (lower), 91, 95, 98 (both), 101, 102, 103, 112, 113, 116, 120, 122, 123.

Colcord, Diane: Cover Drawing, Figs. 2, 3, 15.

Craighead, Frank: Figs. 23, 108.

Dunder, James: Fig. 90 (middle).

Erwin, Robert: Fig. 41.

Grubb, Teryl: Fig. 4.

Jurs, Lou: Fig. 22 (lower), 34.

Kochert, Mike: Figs. 28 (top), 96.

Millsap, Brian: Figs. 82, 111, 114, 121.

Mires, Jerry: Fig. 106.

Murphy, Joseph: Fig. 13.

Neitro, William: Figs. 104, 105, 107.

Oftedahl, Larry: Fig. 99.

Olendorff, Richard: Fig. 78.

Oregon Department of Fish and Wildlife: Fig. 109.

Paul, Don: Fig. 46.

Platt, Joseph: Fig. 48.

Schwarz, John: Fig. 93.

Scott, Virgil: Fig. 119.

Sibley, Fred: Figs. 92, 94.

Snyder, Noel & Helen: Figs. 26, 40 (center), 47, 48, 50, 72, 83, 84, 86, 88, 118.

U. S. Forest Service: Figs. 5, 16, 19, 20, 97.

U. S. Fish and Wildlife Service: Fig. 21.

Warburton, Joshua: Fig. 65.

Whaley, Wayne: Fig. 87.

White, Clayton: Fig. 24, 29, 32A, 81.

Woffinden, Neil: Fig. 79.

TABLE OF CONTENTS

Page

Page

Whose Nests Are These?

NESTING HABITATS AND SURVEYING TECHNIQUES FOR COMMON WESTERN RAPTORS

INTRODUCTION

For many years the birds of prey, known as raptors, were considered by many to be the villains of the sky. Occasionally, an eagle would be observed stooping from the sky to kill a sage grouse for breakfast or a "chicken hawk" would send a farmer's barnyard fowl scurrying. Likewise, Golden Eagles will sometimes kill newborn lambs, an event that does little to endear them to ranchers who consider this to be equivalent to a $30. theft of personal property. In the eyes of the observer, too often such aerial predators would be considered to be in competition with the hunting sportsman or endangering the economy of the small farmer.

However, in recent years a large segment of the American public has become aware of the ecological role of all predators and are not only accepting them as a vital part of the environment but are becoming increasingly interested in them because of their esthetic, economic, and scientific qualities. Raptors, as all animals, must eat to live and are a dynamic part of the flow of energy through many terrestrial and aquatic ecosystems.

Being high on the food chain, raptors may be used as environmental barometers. Because they feed largely on the primary consumers, the next lower rung on the food chain, they pick up residual toxins that have built up in the tissues of such animals as fish, jackrabbits, ground squirrels, and other small animals. By monitoring the amounts of toxins in raptors, scientists can help us better realize what is happening to our environment. In addition, preying on large numbers of small rangeland rodents and rabbits may dampen the damage to range plants by these animals when their populations are at high levels. The jackrabbit is known to be the major prey item for Golden Eagles, Ferruginous Hawks, Red-tailed Hawks, and Great Horned Owls in many parts of the West.

Because of the recognition of the many values of raptors, they are now totally protected by Federal Law and by most states. In order to protect key areas of their habitat from modification or complete destruction by man, it is imperative that we learn to identify their crucial habitats. The passage of the Endangered Species Act of 1973 (P.L. 93-205) and the Federal Land Policy and Management Act of 1976 (P.L. 94-579) makes it imperative that a determination be made of the species of birds using public lands and what the impacts on various birds might be with different types of land use activities.

This Technical Note provides a description of the nesting habitats of most of the common western raptors and describes survey methods that may be used for locating the specific nesting sites of these birds.

BACKGROUND INFORMATION

Need for Raptor Nest Site and Other Habitat Use Data. Basically, raptor habitat use information is needed by land managers for the following reasons:

1. To be knowledgeable on important nesting, feeding, wintering, and roosting areas in order to give adequate consideration to these areas in land management decisions.

2. In order to be able to determine and monitor the effects of man's activities on nesting or other life phases of raptors.

3. In order to ascertain general trends in raptor populations and productivity, by species, and the probable reasons for those trends.

General Considerations. A great variety of birds of prey, both diurnal and nocturnal, use the public lands during some part of their annual activities, either for nesting, feeding, or roosting. Because of wide differences in their inherent behavior patterns, it is easy to understand why a wide spectrum of nesting sites and habitats are utilized.

Some species of raptors will accept a *wide variety* of nesting sites, while *others show very little flexibility, or adaptability,* in utilizing a diversity of nesting sites or habitats. For example, the Prairie Falcon exhibits little ability to nest anywhere except in cavities or on ledges in relatively sheer cliffs or rock formations, whereas Ferruginous Hawks *in some states* may nest either on the ground, in trees, or on practically any elevated natural or man-made structure.

In commencing to conduct surveys for the various raptors that may be found in an area, the biologist should realize that, aside from a few areas that are fairly desolate in terms of prey or vegetation, most habitat on public lands *may be suitable for nesting by one species of raptor, or another.* Of course, prey abundance and an appropriate nesting site are both key factors in determining the *suitability* of an area for nesting by any particular species of bird of prey. Even then, far-ranging raptors, such as Golden Eagles and the larger falcons, may search wide reaches of their feeding range for prey during the nesting season, *even where prey is sparse. The general disturbance caused by many of man's activities may also be sufficient to discourage many species from nesting in an area, even though other key factors are suitable.* Such disturbance may gradually reduce the number of total sites available to easily disturbed birds, such as Golden Eagles and Prairie Falcons. On the other hand, Marsh Hawks (Harriers) and Short-eared Owls *might* be found nesting almost anywhere on public land ranges in grassland, sagebrush-grassland, or marshy areas.

The *bulk of the population of nesting raptors of any species* will be found in certain habitat types that we have come to recognize as their predominant nesting sites. As the reader reviews the remainder of this document, he should keep in mind that both the text and photographs relate to the *predominant* nesting sites of the species discussed. For example, trees will not be discussed as nesting sites for Prairie Falcons, even though the author is aware of *one nest* of this species where young were successfully fledged from an old Ferruginous Hawk nest in a tree. Similarly, *one pair* of Swainson's Hawks successfully fledged young from a ground nest on a rocky hill-side, *but both situations were the result of either excessive disturbance or destruction of their first nesting attempt during that year.*

Distribution of Nesting Raptors. States in which the various raptors are known to nest are shown in Appendix 1. Certain raptors nest in only a few states, while others are widely distributed. Some raptors will nest predominantly, or entirely, in certain parts of a state by virtue of topographic features, prey abundance, or other special features that meet some particular need for the bird's survival.

Preferred Nesting Habitats. Predominant nesting habitats used by the different raptors (cliffs, ground, trees, etc.) are presented in Appendix 2. Many raptors nest predominantly in one type of habitat, such as Prairie Falcons in cliffs, while others, e.g., the Red-Tailed Hawk, nest on ledges of cliffs or in a wide variety of types of trees. Ferruginous Hawks will nest in a wide variety of sites, including flat ground, pinnacles, low rocky outcroppings, on sharp ridges or points of ridges in the desert, in trees of virtually any height, and on a variety of man-made structures, such as windmills, rock monuments, stone chimneys, and many others. While Appendix 2 presents the predominant nesting habitats, or substrates, for the different species, keep in mind that unusual happenings are to be expected in Nature.

Raptor Nesting Phenology. Common dates for the various phases in the nesting sequence are presented in Appendix 4. These average dates will serve most purposes, but the biologist should be aware that variations will occur from year to year depending on climatic conditions and also with latitude and elevation. As a general rule, birds in southern latitudes will begin nesting before the birds in the northern latitudes, and birds at lower elevations before birds at higher elevations. Some raptors commonly have more than one clutch per year, e.g., Harris Hawk, Barn Owl, etc., so second nestings will obviously be later than dates indicated in the table. Also, some raptors will re-cycle and make a second nesting attempt if the first one is unsuccessful.

Raptor Feeding Ranges During Nesting Period. General activity and feeding ranges for nesting raptors are presented in Appendix 3. It must be recognized that feeding ranges, as well as defended territories will vary according to prey abundance, terrain, raptor population density, and other factors. Disturbance by man within these indicated ranges *may* cause adverse impacts on the nesting birds, *especially if such disturbance is within their primary feeding area.*

Competition for Nesting Sites. Many species of birds of prey will utilize nests constructed by other species. For example, Great Horned Owls and Long-eared Owls commonly nest in Buteo and Accipiter nests. Long-eared Owls, Merlins, and even Kestrels may utilize Magpie nests. Red-tailed Hawks, Swainson's Hawks, and Ferruginous Hawks will use each other's old nests, or even Golden Eagle nests, and Prairie Falcons sometimes use old Golden Eagle, Red-tailed Hawk, or Raven nests that are constructed on cliffs. Because of this somewhat common interchange of nests, some competition results for the nest sites between the various species, especially where trees or cliffs are scarce. Normally, the first pair of birds that assumes possession of an old nest will assert the necessary defense to maintain their possession, but not always. Also, differences in nesting phenology may permit utilization of the same nest by two different species during the same year, e.g., Great Horned Owls may rear a brood of young and leave a nest site about the time that Swainson's Hawks or Cooper's Hawks begin to nest. In such cases, these birds may utilize the abandoned owl nest. Aggressive interactions between Prairie Falcons and Great Horned Owls are known to have caused the abandonment of nest sites by Great Horned Owls. The Prairie Falcons then nested at the sites. *In general,* none of the owls construct any type of stick nest. Instead, they utilize other birds' nests or else nest directly on the dirt in natural rock cavities (or sometimes on pack rat nests) or on the debris of tree cavities. In a very few instances, owls have been reported to partially reconstruct deteriorating stick nests prior to laying eggs.

Information Sources. Much of the information included in this Technical Note is based on the author's experience and his conversations with others who have been involved in raptor surveys. The reader should not be disturbed if he observes birds of prey nesting in situations not described in this Technical Note, especially with regard to species of trees used for nesting, since raptors will use trees of suitable height, foilage density, etc., that are available in the locality in which they are living. In addition, information on some species was gleaned from the following publications: *Raptors of Utah, Wyoming Hawks, Life Histories of North American Birds of Prey (Bent), Water, Prey and Game Birds of North America, American Peregrine Falcon Recovery Plan* (Rocky Mountain and Southwest Populations), and the BLM Endangered Species Technical Note series. References are given as numbers in parentheses ( ) which are keyed to the Literature Cited section.

PROCEDURES FOR CONDUCTING RAPTOR NESTING SURVEYS

Locating and Examining Nesting Habitats

1. Map and Photo Studies.

   A. Determine the potential nesting sites (clumps of trees, cliffs, suitable ground vegetation, etc.) for the various species of raptors by examining appropriate maps and aerial photographs. Some knowledge of raptor nesting requirements is essential before this evaluation can be made.

   B. Plan aerial and/or ground survey routes to the potential raptor nesting areas.

2. Aerial Surveys.

   A. Make flights over areas delineated on a map as being potential raptor nesting sites and note locations on map of all nests observed and suitable habitat that should be examined from the ground.

   B. Where special or unique topographic features are being used as raptor nesting sites, obtain aerial photographs of the site for the raptor nesting file.

   C. Plan a flight to re-visit the active nests at a time when the young will be in the nest. This may be determined fairly well from the phenology table in the appendix of this Technical Note. Specific areas will vary depending on weather and latitude and different phenological events should be adjusted accordingly. Nesting success can be determined for many nests during this flight.

3. Ground Surveys.

   A. Utilizing the best access routes observed from the air or shown on maps, visit all nests and all potentially suitable nesting habitat.

   B. Examine all active nests and potential habitat until satisfied as to nesting species of raptors present. If this is done prior to egg hatching, binoculars should be used from a distance to obtain the desired information. After the young appear in the nest, there is less chance for nest abandonment and closer approaches may be made to the nest. Using a raptor data form, such as the example in Appendix 5, record the pertinent data for each raptor nest located.

C. All old nests should be mapped as these may be alternate nest sites for active pairs or may be used by other species in subsequent years.

D. Photographs of the general nesting area, or aspect, should be taken during the first visit. If young are in the nest, a close approach to the nest may be made to obtain a photographic record of the number of young in the nest and their relative condition and/or age.

4. Timing of Surveys.

A. Time of nesting surveys will depend on the nesting phenology of the species for which information is desired. Surveys should normally be timed to visit nests approximately one-half to three-fourths of the way through the nesting sequence. Disturbance of nesting birds should be avoided, especially during early courtship, nest building, egg laying, and incubating phases. Some raptors will abandon their nests even if visited by humans only once if the bird is in either the laying or incubating phase.

B. Appendix 4 presents average nesting sequences that may be used as a general guide. Recognize, however, that nesting sequences will vary, either earlier, or later, depending on latitude, seasonal variations in weather patterns, elevation, and possibly other factors.

Precautions at Nest Sites and Dangers to Birds of Nest Examinations

1. Adult birds should not be flushed from the nests, especially when eggs are present, unless necessary to collect data on nesting phenology or reproductive success. If adult birds are flushed from the nest, try to limit the stay at the nest to five minutes or less.

2. When adults are forced from the nest, there is increased chance for predation by both aerial and ground predators. Sprinkling napthalene crystals (moth balls) around a nest site and along your entrance trail will help to destroy your human scent and may decrease the chances of predation at the nest by ground predators.

3. Adult birds should not be flushed from the nest during rainstorms, in very cold weather, especially in windy weather, or in hot weather. To do so for longer than a very few minutes may cause the death of the embryos or young birds due to excessive cold or heat.

4. Be sure adult birds and/or young are aware of your presence as you approach the nest. Do not startle incubating or brooding adult birds as they may spring from the nest, knocking young birds or eggs from the nest.

5. Dehydration of eggs or an adverse change in humidity may occur if eggs are left unprotected for more than a few minutes.

6. Young birds may miss essential feedings and become weakened if adults are kept away from the nest for extended periods.

7. Be very careful in approaching nests where young birds are old enough to fledge at your approach. In fledging prematurely, they may damage bones, incur other injuries, or become lost and/or abandoned.

8. Do not handle eggs or young birds unless necessary for banding, weighing, etc. as part of a data collecting project approved by the State Wildlife Agency.

Special Precautions for Surveying Nesting Habitat of Endangered, Threatened, or Sensitive Species of Raptors.

1. Nests of raptor species having an endangered classification should not be visited unless accompanied by an authority on the species for a specific research or monitoring purpose. They should be observed only from such distance that the adult birds are not disturbed, i.e. either with binoculars or spotting scope.

2. Special caution should be exercised in visiting nests of any species known to be declining in numbers, either locally or nationally.

3. Nests of species that are known to be highly sensitive to humans and that abandon nests readily (such as Ferruginous Hawks) should not be visited until young birds can be discerned in the nest.

4. Nest locations of endangered or threatened species of raptors should be revealed only to competent State or Federal authorities. Loss of nests or young of such species from unnecessary human visitation cannot be tolerated for endangered, threatened, or sensitive species, or for any species whose overall habitat is known to be seriously declining.

5. All Bald and Golden Eagles are fully protected under the Bald Eagle Protection Act. All nesting surveys of these species *must* be conducted with minimal disturbance to the birds.

Specific Raptor Nest Characteristics and Survey Methods. In the following pages specific nest and nesting habitat characteristics and suggested survey procedures for the various species are discussed and illustrated.

DIURNAL SPECIES NEST SURVEYS

Bald Eagle
(Haliaeetus leucocephalus)

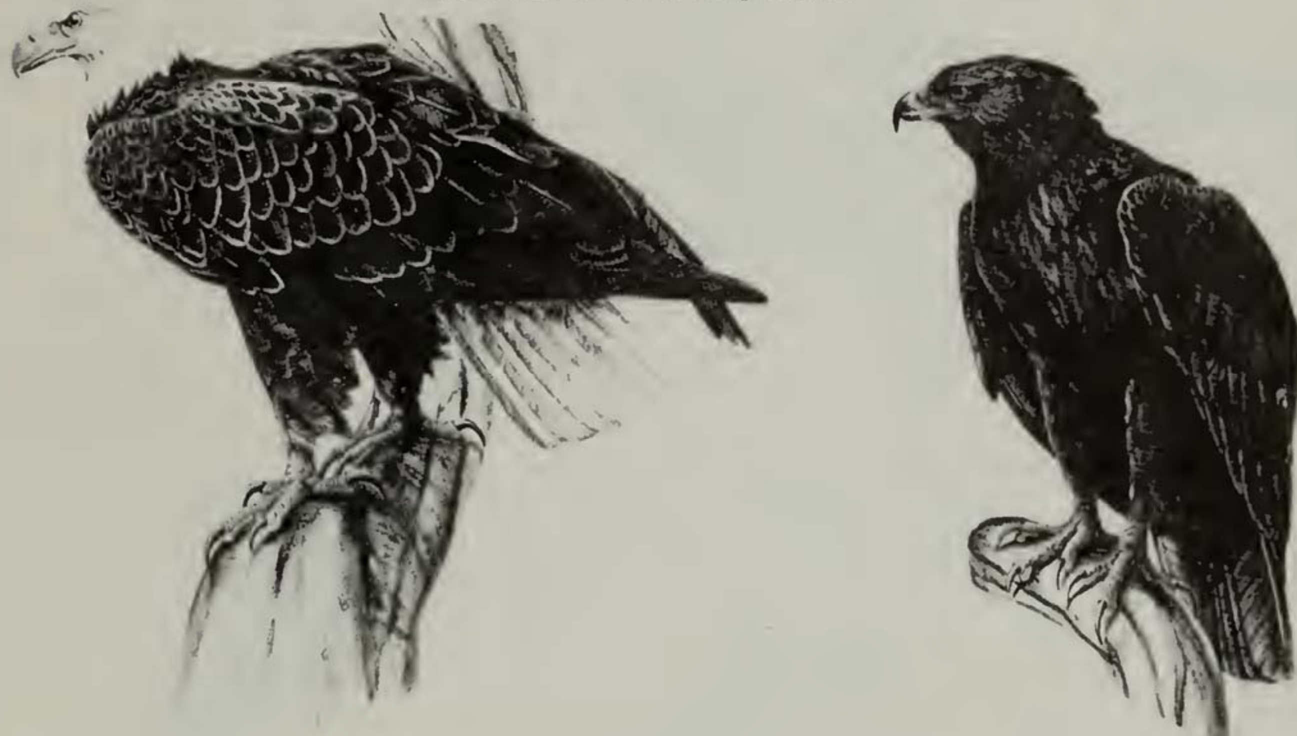

Fig. 1. Mature and Immature Bald Eagles.

Nest and Habitat Characteristics

Bald Eagles may nest on projections or ledges of cliff faces or on trees protruding from rock cliffs along seashores; in the tops of cottonwoods or other large deciduous trees where these are the predominant trees along waterways; or in the tops of conifers where these trees are the dominant species along waterways or around lakes. The tree species selected for the nest is not as important as the tree's total height and size. The tree selected is characteristically the largest or stoutest in the immediate surroundings. Researchers have observed that the average diameter of cottonwoods used for nesting is 24 inches; the average height of the nest above the ground is 50 feet; and the tree height above the nest averaged 23 feet. In three separate studies in Wyoming and Alaska the average height of coniferous nest trees was 114 feet, with the nest being placed within 25 feet of the top. Many nests were built in dead or dying trees.

Freedom from human disturbance or intervention is one of the most variable factors involved, but they do not *normally* begin a nest where human disturbance is evident.

In areas where ospreys are also nesting, there may be some difficulties with nest identification. Eagles usually nest near large water bodies or streams, but ospreys frequently nest near small potholes or beaver ponds. The eagles *almost* always nest in live trees, although sometimes the tops of these trees may be dead. The *majority* of osprey nests in trees are in dead trees. Eagle nests are *usually* located below the crown at a main branch and *usually* receive some cover from the part of the tree above the nest. Osprey nests are often located at the very top of the tree. Eagle nests also tend to be larger than osprey nests, flat topped, and somewhat cone shaped. Osprey nests are basically more rounded in appearance. The size of Bald Eagle nests ranges from a depth of two feet and a diameter of six feet to nests eight feet deep and as much as twelve feet in diameter. These are among the largest nest structures for any bird of prey in North America. (7).

Nest Survey Methods

The preferred method for surveying Bald Eagles is with slow-flying light aircraft, flying down drainages and around lake shores about 500 feet above the tree tops (or closer). Helicopter or fixed-wing aircraft should be flown on days of excellent visibility with overcast days being avoided. The survey should be conducted during the mid-portion of the day, or when the search area has direct sunlight. The adult birds are more apt to be near their nest site during the middle portion of the day. Watching for perched or flushed eagles and noting their exact locations will give a good indication of the approximate location of the nest. Once adult or immature birds are located, several passes, or a return trip on foot or boat, may be necessary to locate the nest site. (17). The reliability of all aerial surveys depends largely on the observers' experience with raptors and his flying experience. In most cases it is desirable to make at least two passes *down* a drainage, one on each side of the stream while watching for the most prominent trees within one-half mile of the river. Along the rocky cliffs and steep shorelines of Alaska, more than one flight altitude may need to be flown in order to adequately observe all possible nesting sites along the cliffs. Nests are occasionally found on ridges, but most nest sites are below the tops of major ridges.

Boat surveys are probably the most effective and cheapest methods to search for eagle territories and nests. The boat should travel at low speeds, approximately 30 to 60 yards from shore. The observer should be in a position to "skyline" the nest. Several passes may be necessary to adequately search an area. (17).

Fig. 2. Bald Eagle nest in normal tree, mostly hidden by foliage.

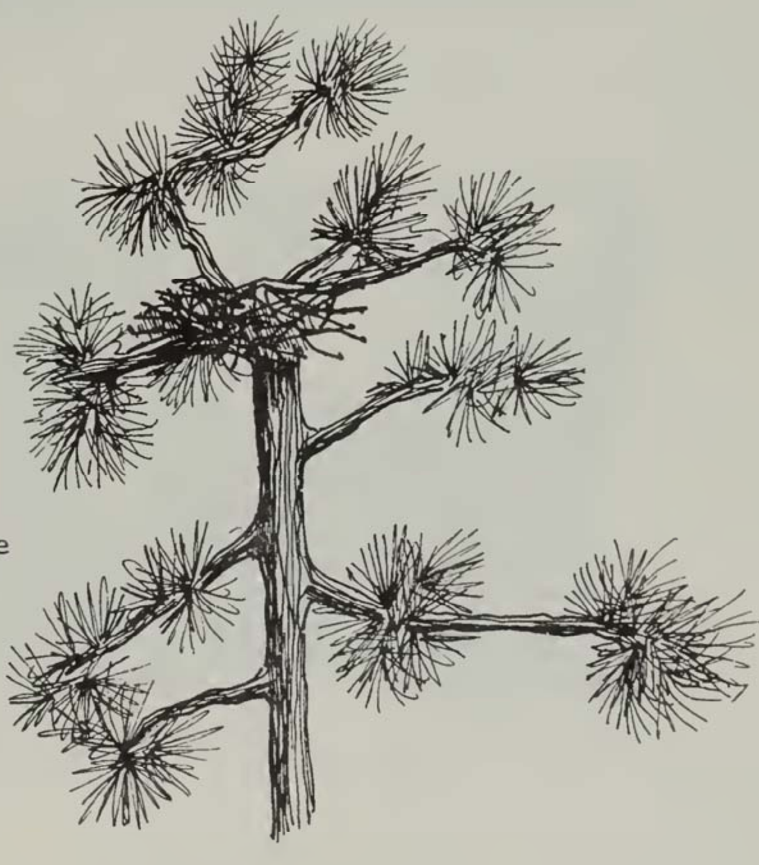

Fig. 3. Bald Eagle nest in bowl formed after tree top was damaged.

Surveying for bald eagles without the use of aircraft is extremely time consuming and relatively unreliable. Where roads run up stream bottoms, they may be used to good advantage, but nests away from the riverbanks are frequently missed by observers on the ground.

Comments:

Bald Eagles have been known to defend their eyries actively when disturbed by man. This is in contrast to the Golden Eagle that usually leaves the vicinity when its nest is approached.

Fig. 4. Typical nesting habitat of Bald Eagle, with nest in top of conifer.

Fig. 5. Bald Eagle at nest, showing general nest structure and location in tree.

<u>Golden Eagle</u>
(Aquila chrysaetos)

Fig. 6. Golden Eagle

<u>Nest and Habitat Characteristics</u>

Most eagle eyries are located on cliffs, although in some situations tree nests are fairly common. Nests may be located on the ground or on cliffs as high as 400 feet, or more. Tree nests have been located in Douglas fir, cottonwood, ponderosa pine, juniper, sycamores, eucalyptus, redwoods, oaks, and dead snags. The height of tree nests may vary from 10 to 100 feet above the ground. Cliffs chosen for nest sites tend to be relatively inaccessible, although some nests can be easily reached. (6).

Golden Eagle nests generally can be seen from some distance, appearing as dark objects on shelves or ledges on cliff faces. In most instances, a patch of whitewash from excretion is also visible. This characteristic is particularly useful for spotting eagle nests from the air. The rock surrounding an eagle nest may be covered with an orange foliose lichen, which is useful in detecting eyries. Many nests are protected by overhangs and are on cliffs which permit an extensive view of the surrounding countryside.

Golden Eagles commonly use alternate nests in different years. Some breeding pairs seem to use alternate nests in alternate years, others never use alternates, even though they spend time repairing all of their nests, and birds which are unsuccessful in their nesting attempt at one nest may use another nest the following year. Any eagle nesting surveys must take the useage of alternate nests into account. New "greenery" is an indication that a nest is being used by eagles.

The large size of eagle nests is an important clue as to the identification of the birds using a particular nest. Their nests average consistently larger than any Buteo nests, often being eight to ten feet across and three to four feet thick, or more. Tree nests tend to be deeper and more massive.

Nest Survey Methods

Golden Eagle nests may be readily surveyed from the air using light aircraft. Nests are more likely to be found on the lower half of mountains that contain cliffs from top to bottom. In extremely rough terrain or when wind velocity exceeds 15 knots, helicopters are more effective than Super-Cubs or other fixed-wing aircraft. Only experienced pilots having a good understanding of their aircraft capabilities at various altitudes (density), knowledge of the peculiarities of mountain air flows, and experience in low altitude mountain flying should be employed for these "close in" surveys. Such nesting surveys will normally be flown within about 200 to 300 feet of the cliff faces. These aerial nest checks are much faster and less costly than equivalent ground checks, but they do not allow the observer to gather additional information such as nestling weight, prey remains, etc., nor allow for photographs of the young. (16).

If surveys are timed so as to be conducted when the young are still white and downy, they can be seen from considerable distances. Also, when the birds develop their dark wing and body feathers from two to four weeks prior to fledging, they appear as large dark objects against cliff faces or amongst the branches of nesting trees. A wide range in cliff heights are acceptable for nesting by Golden Eagles. For aerial surveys it is advisable to fly slightly higher on the cliff face than one expects to find the nests so that he will be looking at an angle downwards at prospective sites.

Comments

Golden Eagles are generally unaggressive at the nest site and frequently fly off some distance when intruders approach. However, both eagles and falcons have been known to attack aircraft and can cause serious damage.

Fig. 7. Typical Golden Eagle nest on ledge in upper right portion of rocky projection in central Wyoming. Two large eaglets are on the nest. Note open hunting terrain.

Fig. 8. The most typical Golden Eagle nesting site is on a projection on a sheer cliff face. Open hunting terrain extends in three directions from the cliff.

Fig. 9. Golden Eagles will frequently nest on rocky or clay protuberances on steep sided canyon walls that are common along western rivers

Fig. 10. Low, rocky cliffs are commonly utilized as nesting sites by Golden Eagles throughout the West. Most sites receive at least a little shade during the hot hours of the afternoon.

Fig. 11. As depicted above, cottonwoods and other large trees are sometimes used for nesting sites by Golden Eagles.

Fig. 12. Rocky pinnacles are sometimes used as nesting sites by Golden Eagles, but nests built this close to highways are not often successful.

Fig. 13. Golden Eagles infrequently nest on the ground; when they do it is usually on top a bluff or point of a ridge.

Fig. 14. These Golden Eagle young are ready to fledge. If suddenly alarmed, they may take to flight and in landing may damage bones or other parts of the body. An effort should be made to not fledge birds prematurely, or before they are physically or mentally prepared.

Osprey

(Pandion haliaetus)

Fig. 15. Typical Osprey nest. Fig. 16. Osprey landing on nest on dead snag.

Nest and Habitat Characteristics

Ospreys may nest on rocky or dirt pinnacles, in the tops of dead snags, or in the tops of live trees. The tops of dead snags are the most common nesting site along rivers and around lakes of the Northwest, but rocky pinnacles are commonly used in some western states. Dead snags surrounded by water are preferred but in their absence Ospreys will utilize tall stumps, pilings, and even telephone poles and other artificial structures in proximity to a body of water. If nesting sites are in short supply they may nest a mile or more from water if the food supply proves adequate. The nest site should provide both security and good visibility. (11).

Completion between Ospreys and Canada Geese for nesting sites sometimes occurs. Since the geese arrive on the breeding grounds earlier, they may usurp nests traditionally used by Ospreys. Ospreys occasionally drive geese from these nests, but otherwise probably construct new ones.

Ospreys prefer to build their nests near accessory perches. They will utilize almost any elevated structure as a perch for sunning and protection from wind provided it remains within sight of the nest. The same nest site is normally used year after year, or as long as the tree remains standing. Nesting materials consist of large sticks, driftwood, and grasses or bark. Nests are most often constructed in the tops of conifers, but deciduous trees may also be used.

Fig. 17. Osprey nests are often constructed on top rock or clay pinnacles on the shores of lakes or rivers. This nest is on a rock pinnacle high on a canyon wall in Utah.

Fig. 18. This nest, containing one egg, shows typical nest structure for Ospreys. Nests are usually within one-quarter mile of water.

Fig. 19. Young Ospreys on nest atop dead snag.

Nest Survey Methods

Nesting surveys for Ospreys are much the same as for Bald Eagles. Light aircraft or helicopters are normally used to cruise the shorelines of lakes and rivers, while closely observing the tops of all snags or broken trees and any other pinnacle-like structure that might be used for nesting. Surveys should not be conducted during cold, rainy, hot, or windy weather because of potential adverse effects on the young if the adults leave the nest, and helicopters should not be hovered over the nest.

Comments

This species may violently defend its eyrie and young from molestation by man or animals by actually attacking the climber and intruder. Ospreys can inflict severe blows, and many individuals who have attempted to ascend to the high, tree-top eyries have been nearly knocked to the ground. A few have received such resounding blows on their heads as to render them unconscious for a few seconds in a dangerous situation.

Fig. 20. Ospreys will readily utilize man-made nesting platforms placed in suitable locations around the edges of lakes or reservoirs. Artificial nesting platforms can maintain Osprey populations in areas where natural snags in impounded areas gradually die and fall down.

Peregrine Falcon
(Falco peregrinus)

Fig. 21.
Peregrine Falcon

Nest and Habitat Characteristics

The vast majority of the Peregrine eyries in the Rocky Mountain Southwest region are within 1 mile of a stream or river. Such situations often provide lowlands rich in bird life and open areas over which to hunt. The walls of canyons and gorges are often used for nest sites. A few nests have been found away from major stream courses, but generally these have been associated with extensive oak bushland, pinyon-juniper woodland, or mixed coniferous forest. In the central part of the region there are very few records of Peregrines nesting above 9500 feet elevation.
Along the Pacific Coast Peregrines utilize nesting holes or ledges on cliffs and rocky islands.

The most frequently used nesting cliffs exceed 100 feet in height, are often at the top of a high talus slope, and have ledges or caves with gravel or soil in which a depression can be scraped for eggs. Cliffs with at least some southern exposure are preferred in the northern part of the region, but near the Mexican border, north-facing cliffs may be used. Generally, the higher the cliff in relation to adjacent lands, the better.

Nest Survey Methods

Aerial surveys are generally inefficient in identifying Peregrine Falcon eyries. "Whitewash" may be observed on cliffs but it is very difficult to differentiate between Peregrine eyries and Prairie Falcon eyries. However, if a helicopter is flown slowly across a cliff face where Peregrines are suspected, any birds present may flush from the cliff and can then be observed. In Alaska, where great distances and thousands of miles of streams are involved, aerial surveys are the most practical survey method. Suitable habitat is located from the air and then float trips or ground surveys are utilized to examine the better habitats.

Often one can determine if a cliff has Peregrines by looking for "whitewash" excrement on the cliffs. Usually a few marks, up to six feet long, can be found extending down from favorite perches, usually under an overhang. A spotting scope often makes it possible to see single marks not under favorite perches, the presence of which is usually a sign the cliff is occupied by falcons, either Prairie or Peregrine. Falcon droppings are not splashed outward on the cliff as are eagle and buteo hawk excrement, but run vertically downwards producing long streaks. To determine if Peregrines are present, ordinarily the first approach is to examine a cliff for whitewash. This can best be done with the aid of strong binoculars and a spotting scope. When possible, the top of the cliff should be walked, and occasionally a rock can be pushed over the ledge to flush a hidden bird. Even if the cliff is walked, at least five hours should be spent watching for birds before one concludes none is present. Better yet, return to the cliff on another day or two, and search it thoroughly for birds. A loud hand clap or other sharp noise may be produced which may cause a previously unobserved falcon to flush.

If adults spend long periods on the ledge, eggs or young are probably present. Avoid flushing the incubating or brooding birds suddenly. Do not disturb the birds so that they remain from the ledge for more than about 20 minutes if the temperature is below 60-65 degrees F., especially if a wind is blowing. After 1 June, the young are usually big enough so that they will not chill. Minimize disturbance at the cliff especially during egg-laying in April by relying on a spotting scope for observation. (3).

Comments

Peregrines are very defensive of their nest site and will often circle above a cliff site or in front of the cliff giving a rapidly repeated "cack" and may dive at intruders near the nest.

Fig. 22. Ledges or cavities in rock formations are most commonly used as nesting sites for Peregrine Falcons in the West and Southwest, usually in reasonably close proximity to streams or marshes. In Alaska, sloping ridges or hillsides adjacent to rivers are sometimes used in river sections where cliffs are not available.

Fig. 23. Adult Peregrine Falcon near nest.

Fig. 24. Peregrine Falcon on ledge with young. The nest consists of only a depression, or "scrape" in which the eggs are laid. None of the falcons build stick nests.

Fig. 25. A typical Peregrine Falcon eyrie. Most Peregrines nest much higher on the cliffs than do Prairie Falcons.

Prairie Falcon
(Falco mexicanus)

Fig. 26. Prairie Falcon.

Nest and Habitat Characteristics

Prairie Falcons (almost) always nest in crevices or holes in cliffs, which may range in height from low rock outcrops of thirty feet to verticle, 400-foot-high (or more) cliffs. The apparent ideal cliff has a sheltered ledge which provides the site for the eggs, has gravel or loose material on it for the falcon to make a "scrape" or nest depression, and overlooks at least some treeless country for hunting. They will also nest in potholes or larger caves. Prairie Falcons may also use inactive eagle or Red-tailed Hawk nests that are placed in suitable locations on ledges, especially where some overhang is provided, but never build stick nests themselves. (12).

Falcons usually have alternate nesting sites located on the same cliff or adjacent cliffs. They exhibit a tendency to use alternate ledges in succeeding years. Nesting failure does not seem to deter use of the cliff in the following year. Most eyrie sites are located in foothills and open sagebrush areas with suitable rock outcroppings or low cliffs. Holes in clay banks may be used where rock substrates are not available. Prairie Falcons generally tolerate very little human disturbance and abandon eyries where excessive human disturbance occurs.

Nest Survey Methods

Prairie Falcons may be readily surveyed from either the ground or from the air by watching for streaks or patches of whitewash (excrement) on cliff faces. While whitewash does not necessarily indicate the presence of falcons, it is almost always present in inhabited areas, either at perches or at the nest site. Some sites, used for many years, receive a considerable build-up of excrement which may be seen for a mile or more.

Comments

Parent birds are extremely vociferous when young are in the nest and the surveyor may be fairly certain that the nest is active when the birds show this alarm. When an intruder approaches the eyrie, the falcon's first defensive move is utterance of its battle cry, a sharp, continuous "jiiik, jiiik, jiiik" that increases in tempo as the eyrie is approached. Then the falcon will burst forth from the eyrie and, with terrific stoops marked by the shrill battle cry, fling herself at the intruder. These stoops are frequently carried to within a few feet of the intruder's head.

Fig. 26A. Prairie Falcon on rock.

Fig. 27. Typical Prairie Falcon nesting sites. These falcons commonly nest in cavities or on ledges of relatively low cliffs, pinnacles, or clay banks.

Fig. 28. Fairly high cliffs, such as those in the top two photos, attract many nesting Prairie Falcons. Where rocky cliffs are not available, cavities in relatively low rock formations or cliffs may be used.

Fig. 29. Prairie Falcons lay their eggs in a depression,or "scrape", which they scratch in the bottom of the cavity. The young are free to roam any part of the nesting ledge as they mature.

Fig. 30. This prairie Falcon eyrie was an active Golden Eagle nest the previous year. This falcon commonly uses other raptor cliff nests for its nesting site.

Fig. 31. This old Red-tailed Hawk nest has been used by Prairie Falcons for several years,as evidenced by the heavy layer of excrement on the floor of the cavity.

Gyrfalcon
(Falco rusticolus)

Fig. 32. Gyrfalcon.

Nest and Habitat Characteristics

Gyrfalcon habitat is found primarily in treeless Arctic and alpine terrain at low elevations. It frequently nests above 2,000 feet, but it is unlikely that it nests above 4,000 feet, since its major prey items, resident birds and small mammals are not found above this elevation.

A cliff or bluff is the most important physical feature in Gyrfalcon habitat. The distribution of Gyrfalcons is related to the presence of cliffs, bluffs and rock outcrops of suitable size. On the Seward Peninsula Gyrfalcons are present in areas characterized by many rock outcroppings. Gyrfalcons occupy sea cliffs, river bluffs, and isolated upland cliffs. They frequently utilize old Raven stick nests but never build their own stick nest. A typical Gyrfalcon nest is located on a ledge or platform protected from snow accumulation by an overhanging projection of rock.

The average height of the nest site is about 95 feet (25 to 300 feet); average distance below the brink of the cliff is 44 feet (0 to 200 feet) and the distance above the base of the vertical face averages 50 feet (6 to 200 feet). Nests may be on ledges of precipitous cliffs, in potholes, or on low slopes.

Most nesting cliffs have at least one and often two or more alternate nest sites which apparently are readily used by breeding Gyrfalcons. Nesting cliff tenancy is low on the Seward Peninsula, where nesting sites are abundant. It is likely that "cliff-shifting", the utilization of different cliffs by the same pair of Gyrfalcons, is common. The degree to which this phenomenon occurs is probably influenced by the abundance of suitable nesting sites, prey densities and the number of Gyrfalcons and other species of raptors in an area. (10).

Nest Survey Methods

Gyrfalcons are normally at their nesting site by April. Ground, aerial, or boat surveys should be conducted during April or May to determine occupancy of both potential and known sites. Re-checks of occupied sites should be made in mid-June to determine nesting success and/or productivity. Because of poor access into most nesting areas, the use of helicopters is the most desirable survey method. These surveys may often be conducted in conjunction with other resource management activities. For many surveys a Super Cub or Heliocarrier with tundra tires may be used. Checking of sites for nesting success in June may be done using a Super Cub and making several passes.

Fig.32A. Gyrfalcon feeding young at nest in Alaska.

Fig. 33. Gyrfalcons commonly nest on sloping river banks, such as these along an Alaskan river. Surveyors normally concentrate their nest searches on steep river banks or on rocky outcroppings on plain or tundra.

Fig. 34. A typical Gyrfalcon nest site on a rocky ridge. Old Rough-legged Hawk nests are also sometimes utilized.

Merlin
(Falco columbarius)

Fig. 35. Merlin (Pigeon Hawk).

Nest and Habitat Characteristics

The Richardson's Merlin, or Pigeon Hawk, breeds primarily in the prairie-parkland of the northern Great Plains with a small population of birds nesting along river bottoms in central Wyoming. Within this area, the subspecies seem to prefer isolated groves of trees with open prairie surroundings, mixed woods, and wooded areas along prairie river banks and islands. (14).

In the southern areas of the open grassland, Richardson's Merlins nest most frequently in deserted Crow and Magpie nests, and seem to have a preference for the latter. Their nests have been found in a variety of deciduous and coniferous trees, but the key determinant for the nest site seems to be the type of old nests available rather than the species of tree where it has been built. They have been found to nest most commonly in deciduous trees, but in areas where Crows and Magpies nest in conifers, Merlins will then nest in these nests. The prairie subspecies occasionally nest in tree cavities and in old Magpie nests placed in holes in cliffs. Nests are usually lined with dry inner bark of poplars. A few observers have recorded Richardson's Merlins nesting on the ground.

Nest Survey Methods

Merlin surveys need to be done from the ground or by boat along river bottoms. The birds may be easily confused with kestrels at a distance, but the call and flight pattern are usually distinctive. The surveyor should examine all likely looking habitats on foot, preferably when young would likely be in the nest. The alarm calls of the adults, especially the female, can be heard at some distance and indicates the presence of a nest. Nests may be located from boats as they drift along the shorelines of prairie rivers if the birds have nested sufficiently close to the banks to be alarmed at the boat's passing.

Fig. 36. Female Merlins stay close by the nest when humans approach. Their frantic call leaves little doubt that an active nest is nearby.

Fig. 37. Old Magpie nests are common nesting sites for Merlins. This nest is in a tall cottonwood tree, but Merlins have also been reported to use Magpie nests constructed in junipers.

Fig. 38. Parks with scattered trees, or a savannah-type habitat seem to be preferred by Merlins in some states. They occupy essentially the same areas as Kestrels along river bottoms, but they prey on different forms of wildlife.

Kestrel
(Falco sparverius)

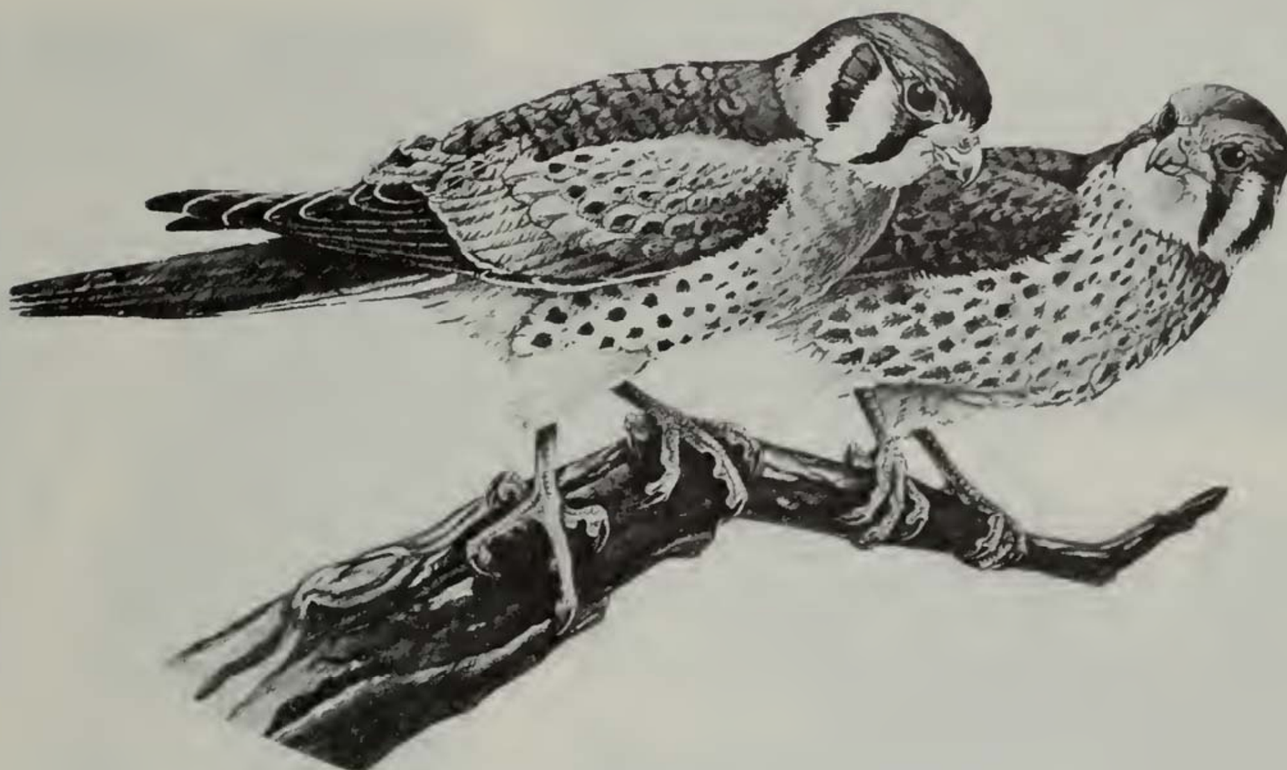

Fig. 39. Kestrel (Sparrow Hawk).

Nest and Habitat Characteristics

The Kestrel, or Sparrow Hawk, is one of the most abundant raptors in the West, commonly observed perched along roadways on power poles or telephone poles and the associated wires, or on fenceposts. They are relatively tolerant of the presence of man, frequently nesting in cavities of dead or living trees around farmyards. Abandoned Flicker holes or natural cavities created by rot or wind breakage are the most common nesting sites while cavities and holes in cliffs are commonly utilized in areas where trees are scarce. They are also known to have nested in holes in clay banks. They will readily utilize large-size bird boxes placed on dead or open trees or on telephone poles, etc.

Nest Survey Methods

Surveys for Kestrel nesting sites are conducted by systematically driving roads, searching clifflines, and examining areas containing scattered tree stands for the presence of the adult birds. Adults usually perch on conspicuous branches of dead snags or on powerlines where they are readily observed. Nests are usually within one-quarter to one-half mile of the observed birds.

Fig. 40. Kestrels will nest in practically any type of tree cavity, as depicted above, and will also nest in cavities in cliffs or clay banks. They may also nest in abandoned buildings and will readily accept large-size bird boxes.

Goshawk
(Accipiter gentilis)

Fig. 41. Goshawk at nest with young.

Nest and Habitat Characteristics

Nesting sites of the Goshawk vary in different parts of the country. In the Northwest it commonly nests in mature Douglas-fir, ponderosa, or lodgepole pine of varying densities. Beneath the mature canopy there is often a secondary canopy created by young seedlings of somewhat non-uniform height and age distribution. The mature trees serve as nest and perch trees. Plucking posts are, for the most part, located in the denser portions of the secondary canopy. Nests are usually located in the lower portions of the mature canopy, against the trunk or out on a limb. The same nest may be used for several seasons. In the coniferous type the Goshawk may require 25 acres of undisturbed timber for nesting. Understory adjacent to the nesting site is usually light. The nest is usually about two feet in diameter and consists of small and medium sized twigs.

Goshawks will also nest in cottonwoods and other deciduous trees in stream bottoms, especially in canyons, and in deciduous forests of Alaska, Michigan, and other areas. In such areas the nests are usually located in excess of 30 feet above the ground and are more commonly placed near the trunk.

Nest Survey Methods

Aerial surveys are ineffective when searching for nests in coniferous forests or in deciduous forests when the leaves are on. Throughout much of the West, Goshawks nest in moderately dense stands of coniferous forest, but also nest in mixed conifer and deciduous tree stands along the borders of mountain valleys and along stream bottoms. Nests are found by systematically searching stream bottoms and wooded slopes and by constantly watching for the adult birds.

Comments

The adults are extremely vociferous and defensive of the nest site. The larger female as well as the smaller male show no hesitation in attacking intruders, cleverly dodging limbs and tree trunks with remarkably rapid flight. They will commonly strike intruders who attempt to climb to their nests, knocking off hats or sinking talons into shirt or back.

Fig. 42. Male (left) and female (right) Goshawks.

Fig. 43. The nest of the Goshawk is normally in excess of 30 feet above the ground and is usually built against the trunk of the tree. Cooper's Hawk nests are frequently built on branches away from the trunk.

Fig. 44. A typical Goshawk nest built against the trunk of a Douglas fir tree in an area of relatively low tree density.

Cooper's Hawk
(Accipiter cooperi)

Fig. 45. Cooper's Hawk

Nest and Habitat Characteristics

In the Northwest the Cooper's Hawk commonly selects nest sites in dense, although somewhat older, second-growth Douglas-fir or lodgepole pine of uniform height and trunk diameter (12-18 inches, dbh). In the Douglas-fir regions, the nest grove consists of deciduous trees which are being shaded out by the dense canopy of the Douglas-fir. In areas of the Northwest where coniferous trees are not available, hardwoods may be selected. Cooper's Hawks may require a minimum of 15 acres of suitable, undisturbed timber for nesting and may use the same nest site for three or more years. The nest is usually located either beneath or just into the lower portion of the canopy, and may be either against the trunk or on forks of outer branches.

Throughout much of the West, Cooper's Hawks nest in stands of cottonwoods along stream courses, especially where the tree stands are fairly large. While Goshawks tend to nest more along valley foothills and into adjacent canyons, they may sometimes be found nesting along stream courses with Cooper's Hawks and their nests are quite similar. The nest is a substantial structure of sticks and twigs, lined with bark from pine or other trees or shrubs. Nests are not as frequently decorated with greenery as nests of buteos.

Fig. 46. Cooper's Hawk nest constructed against the trunk of an aspen. Nests are often built on outer branches.

Fig. 47. Cooper's Hawk preparing to settle down on eggs.

Fig. 48. Photo showing typical Cooper's Hawk nest structure.

Sharp-shinned Hawk
(Accipiter striatus)

Fig. 49. Sharp-shinned Hawk

Nest and Habitat Characteristics

These hawks select nest sites which are composed of dense stands of second-growth Douglas-fir, lodgepole pine, or other conifers (usually with trunk diameter of 8-15 inches dbh). Where coniferous trees are not available, dense stands of hardwoods or mountain brush may be utilized for nesting. Oakbrush is commonly used in the Intermountain states. Sharp-shins may use the same nest site for two or more years and may require a minimum of 10 acres of undisturbed vegetation for successful nesting. The nest consists of a platform, about one to one and one-half feet in diameter, and is normally built on a limb against the tree trunk. It is constructed of small twigs and, generally, lined with pine needles, leaves, or other debris. Because it is frequently built in tall evergreens, it is hard to see and difficult to find.

Nest Survey Methods

Sharp-shins may be surveyed by searching stands of conifers, hardwoods, or mountain brush and watching for the adults. Since accipiters are relatively late nesters, surveys are best conducted during late June and until mid-July. Nests of all accipiters average considerably smaller than those of the buteos that may be found in the same areas, such as Red-tailed Hawks. Swainson's Hawk nests are more flimsy in structure and are usually found in the tree canopy or outer branches, while the accipiter nests are most commonly found nearer to the trunk and under the canopy. Accipiter nests usually consist of larger twigs than those of the Swainson's Hawk.

Comments

Cries of derision greet any intruder that approaches this bird's nesting tree, with the usual Accipiter-type defense exhibited if the intruder attempts to climb the tree containing the nest.

Fig. 50. Sharp-shinned Hawk with young at nest, showing common nest construction and location against trunk of a lodgepole pine.

Ferruginous Hawk
(Buteo regalis)

Fig.51. Ferruginous Hawk on nest in Central Wyoming.

Nest and Habitat Characteristics

The Ferruginous Hawk is restricted almost totally to the western plains. On the prairie it nests in trees along streams. In badlands or treeless areas, it nests on low cliffs, buttes, and cutbanks. It also nests on the edges of pinyon-juniper communities in either junipers or sagebrush. In some areas, ground nests are quite common. In trees, the nest may be located anywhere from about 6 to 40 feet in the tree. This hawk is undoubtedly the most adaptable in its choice of nesting sites of any of the raptors. It has been known to nest on chimneys, windmills, pumping structures, on straw stacks, power poles, abandoned buildings, on large sagebrush, sheepherder monuments, spoil piles from test pits, and in a wide variety of trees. It will nest on practically any type of large boulder or pinnacle on the desert or prairie and on a wide variety of low bluffs and rocky outcroppings. They are consistently absent from areas of steepsided canyons, cliffs, or heavily wooded areas, including the interior of pinyon-juniper woodland.

Nesting material is composed of sticks up to one inch in diameter which are taken from whatever is available in the area around the nesting site. In juniper nests, juniper, shadscale, and sagebrush provide most of the materials used in nest building. Dried cow manure is probably the most commonly found item composing ferruginous hawk nests. It's function is unknown, but is highly characteristic of this species' nest.

Nest Survey Methods

Nests of these hawks are relatively conspicuous, whether constructed on the ground, in trees, or other elevated locations. Nests are quite easily located by knowledgeable persons by driving available roads in an area and examining with binoculars any dark-looking structure in likely looking nest sites. Nests can almost always be located if the adult birds are observed circling in the sky, usually within one-half mile. The adults are moderately to highly defensive of their young, normally circling in the sky above the nest and giving their characteristic whistling cry until the intruder leaves. Dives at nest examiners are quite common but contact is seldom made. Surveys are best accomplished during mid to late June when the young birds are conspicuous in the nest in either white or dark plumage. During the two weeks prior to fledging, the young will commonly stand on the edge of the nest to permit better cooling by desert breezes, and are very conspicuous at this time.

Fig. 52. Ferruginous Hawk on perch.

Fig. 53. The Ferruginous Hawk nests in a wider variety of nesting sites than any other Buteo. In some areas it commonly nests in isolated trees, such as this Chinese Elm at an abandoned homestead,

OR

Fig. 54. . . . in the tops of junipers or pinyon pines, near the stand peripheries,

OR

Fig. 55. . . . even in the tops of big sagebrush plants.

Fig. 56. The Ferruginous Hawk almost never nests on the sides of high cliffs, but commonly uses ledges or projecting points on low, rocky outcroppings, such as the one shown here.

Fig. 57. This hawk will nest on any type of rocky pinnacle on the desert or prairie.

Fig. 58. Where large boulders are not present, it will nest on the sides or ends of desert ridges, or even on the sides (banks) of eroded washes.

Fig. 59. This hillside nest of the Ferruginous Hawk was constructed on a small pile of rocks.

Fig. 60. In Wyoming and other states these hawks commonly nest directly on the ground, with surprisingly little mortality from predators. This nest was constructed predominantly with dried horse manure.

Fig. 61. Even uranium spoil piles are utilized as nesting sites in central Wyoming.

Fig. 62. Any elevated structure, natural or man-made, may be utilized by the Ferruginous Hawk for a nest platform. A pair has successfully used this sheepherder monument for two years.

Fig. 63. The chimney of an abandoned rock house was used as a nest site in northeastern Colorado.

Fig. 64. The use of power-line poles and transmission towers as nesting sites is fairly common.

Red-tailed Hawk
(Buteo jamaicensis)

Fig. 65. Red-tailed Hawk.

Nest and Habitat Characteristics

These birds commonly nest on sheer cliff faces, unlike Ferruginous Hawks, and in a variety of trees, usually more than 25 feet from the ground. Nests may be found on low "walk-in" ledges or high up on sheer cliffs. They commonly nest in agricultural areas in scattered trees found there and are tolerant of human activities up to 75 yards from the nest. The nest size and material used is similar to that used by Ferruginous Hawks and the two may be confused when the nest is located in large trees on the prairies. In trees, the nest is usually located near the canopy but may be placed near the trunk or on outer branches.

Nest Survey Methods

Surveys for red-tails are best accomplished by driving available roads and examining all nest-like structures observed in trees or by examining cliff lines with binoculars for the presence of stick nests. Isolated trees or small clumps are likely nest locations.

Comments

Red-tailed Hawks are very active in the defense of their young, often making numerous "stoops" at any intruders that approach the nest site. Both birds usually remain at the nest site when an intruder is near, periodically making dives, or otherwise circling overhead with watchful eyes.

Fig. 65A. Mature Red-tail (below) and immature Red-tail (above).

Fig. 66. Red-tailed Hawks are very vociferous when intruders are near the nest. While they normally do not dive at intruders as actively as Ferruginous Hawks, they will usually circle close overhead, hurling insults at the offending humans.

Fig. 67. Red-tails will nest in a wide variety of trees, usually near the tops. They sometimes alternate use of nests with Swainson's Hawks and Ferruginous Hawks. Their nests are common nesting sites for Great Horned Owls.

Fig. 68. Around the foothills or within the interior of desert mountain ranges, the Red-tail often uses juniper trees for nest sites. Such sites are also commonly used by Ferruginous Hawks.

Fig. 69. For any species of raptor, the nesting stages may vary considerably within a local area. These young Red-tailed Hawks in western Wyoming were only about one week old on June 25, while . . .

Fig. 70. . . . a nest only one mile away contained young birds almost ready to fledge on the same date.

Fig. 71. Red-tailed Hawks nest on cliff ledges with about the same frequency as they nest in trees. Unlike Ferruginous Hawks, they commonly nest on high, steep cliff faces.

Swainson's Hawk
(Buteo swainsoni)

Fig. 72. Swainson's Hawk at nest in tall yucca plant in Arizona.

Nest and Habitat Characteristics

This hawk nests most often in trees or tall bushes and almost always in the upper one-third of the tree. The nest is a relatively flimsy structure when compared to Red-tailed and Ferruginous Hawk nests. It sometimes appears more like a mashed-down tumbleweed than a nest and is usually composed of weed stems and small woody branches. It often blows out of trees in strong winds. It may be somewhat inconspicuous when built in the canopy of trees because of its relatively small size. When the birds are incubating, they are often difficult to flush and an observer may pass by the nest tree without being aware of the nest. These birds are quite trusting of humans and often construct their nests in close proximity of farm houses and other human activities. In western deserts the birds often construct nests in junipers or in isolated cottonwoods along dry stream bottoms and in the Southwest also commonly nest in mesquite and saguaro cacti. The author knows of only one nest that was constructed on the ground. This one was on a steep, rocky hillside and was the replacement for a tree nest when the tree blew down. An occasional pair of Swainson's Hawks will nest on transmission line poles.

Nest Survey Methods

Swainson's Hawks are common in agricultural areas and valleys throughout the West, and they nest primarily in the foothills and valleys. Nests are found primarily by driving available roads in desert or agricultural valleys and searching treetops for nests with the use of binoculars. The birds construct new nests almost every year, making them more obvious because of the fresh materials used. The birds will sometimes use old Red-tail, Raven, or Eagle nests, so these nests should all be scrutinized during any survey for raptors. The birds circle the nest site, uttering a plaintive, clear cry when humans are near.

Fig. 73. Adult and Immature Swainson's Hawks.

Fig. 74. The Swainson's Hawk Nest is usually a flimsy structure and, consequently, it is often blown down by high winds.

Fig. 75. The normal clutch size for Swainson's Hawks is two or three eggs.

Fig. 76. These young birds are about a week old. Note the relatively small weeds and other materials used for the nests in this photo and the one in Fig.75. Ferruginous Hawk and Red-tailed Hawk nesting materials are much more coarse. (See Figs. 59 and 71.)

Fig. 77. Swainson's Hawks nest in trees about 99 percent of the time, usually high in the canopy or in the outer edges. This nest is constructed mostly of small cottonwood branches and leaves.

Fig. 78. The young of all raptors have distinguishable plumage patterns that can be learned with a little experience. The Swainson's hawk is the most docile of the Buteos, sometimes nesting in trees within a short distance of occupied farm buildings.

Fig. 79. This is the only nest the author knows of that was constructed on the ground. It was constructed at the base of a rocky ledge on a steep hillside in western Utah.

Rough-legged Hawk
(Buteo lagopus)

Fig. 80. American Rough-legged Hawk.

Nest and Habitat Characteristics

The Rough-legged Hawk is the most common hawk of the American artic. While thousands of these birds annually migrate southward into the United States to spend the winter and early spring, they nest only in Canada and Alaska. In the far north the Rough-leg is essentially a cliff-nester, utilizing rocky outcroppings and ledges, often in locations which appear easily accessible to terrestrial predators. River bluffs, isolated upland outcrops, and continuous escarpments in the lower elevations of the Brooks Range form a conspicuous part of the topography in Alaska and also account for much of the cliff-nesting habitat. Of these three categories of cliffs, Rough-legs use the river bluffs most extensively, and the occurrence of bluffs strongly controls the species' breeding distribution. In southern portions of its breeding range, Rough-legs construct many nests in trees because of a shortage of other suitable nesting sites.

Rough-legs have strong affinities for nesting sites, often returning to the same nest year after year, and occasionally nesting very close to its own or to other raptor species. Territorial behavior in these instances is usually not too pronounced. Grasses and sticks of various sizes, piled together crosswise, form the nest. The amount of nesting material varies with location of the nest; a nest built on a flat rock may contain just enough material to keep the eggs from rolling out, while a nest located on a slope may contain much more material near the front in order to make the platform level. While nesting, adults display great excitement and concern, diving and screaming at the intruder, usually from a distance. (15).

Nest Survey Methods

Surveying for Rough-legs normally takes place in conjunction with surveys for other artic raptors, such as Peregrines and Gyrfalcons. Essentially the same types of nesting habitat are utilized by all three species, i.e., river banks, escarpments, bluffs, or rocky projections. Surveys for nest occurrence and activity would best be conducted during mid June when young should be in the nest and the adults' defensive actions would make them more conspicuous. In these remote areas, helicopter, boats, and Super-Cubs are the most practical means for making surveys. All potential and known nesting sites should be examined by making several passes with aircraft or with the use of binoculars and spotting scope when on foot or in boats.

Fig. 81. Rough-legged Hawks nest primarily on the steep, sloping banks of rivers in Canada and Alaska, as well as on hillsides and rocky outcroppings. They are defensive of their nests and often permit close approaches without flushing.

Red-shouldered Hawk
(Buteo lineatus)

Fig. 82. Red-shouldered Hawk nest in conifer.

Nest and Habitat Characteristics

The Red-shouldered Hawk in the West is found primarily in California and seems to prefer to nest in tall trees, frequently along river bottoms. The nest structure is very similar to those of Red-tailed Hawks but is generally somewhat smaller. There does not seem to be any special preference for the type of tree in which to build the nest, but the nest is usually quite close to the trunk. The nest is well built of sticks and twigs of medium size and lined with strips of inner bark, fine twigs, dry leaves, sprigs of evergreen, and feathers or down. The clutch usually consists of three eggs, with occasionally two or four. These birds are very consistent in returning to the same territory or nesting site each year.

Nest Survey Methods

Nests are surveyed about the same way as for Red-tailed Hawks, i.e. by driving available roads and searching trees in fields and along streams for fairly large nests, especially near the trunks. Red-tail nests, however, are just as apt to be on outer branches. Watch for the adult birds. When located, try to stay within one-quarter mile of the bird and observe it with binoculars. With luck, you will be watching when the bird returns to its nest tree.

Black Hawk
(Buteogallus anthracinus)

Fig. 83. Adult Black Hawk at nest with young.

Nest and Habitat Characteristics

The primary areas utilized by Black Hawks in the United States are the drainages flowing from the Mogollon Rim into the Verde River, Salt River, and Gila River. The Gila River, Eagle River, and Arivaipa River are all important nesting habitats. Small nesting populations may be found in Texas, New Mexico, and Arizona, predominantly in the southern half of each state. Most Black Hawks nest along permanent streams, generally between 3,000 and 5,000 feet in elevation.

The Black Hawk nests primarily along streams or rivers where it feeds on many forms of aquatic prey, including frogs, fish, snakes, etc. Riparian habitats containing cottonwoods, sycamores, or other tall trees are extremely crucial to the survival of this species, since they are almost completely dependent on riparian zones and the associated prey during their reproductive period. Nests have been found in cottonwoods, sycamores, ash, alder, and ponderosa pines. Unverified reports indicate that Black Hawks may nest on cliffs, but the birds may have been confused with the very similar Zone-tailed Hawk which occasionally uses cliffs for nesting sites.

Zone-tailed Hawk
(Buteo albonotatus)

Fig. 84. Zone-tailed Hawk at nest.

Nest and Habitat Characteristics

The Zone-tailed Hawk is another Central American species that reaches the northern limit of its range in our Southwestern States. It nests in Texas, New Mexico, and Arizona, mostly in the southern parts. Like the Black Hawk, it is largely tied to riparian zones during its reproductive period. It seems to prefer broad, deep, rocky canyons which contain streams flowing over stony beds. But it may be found nesting in canyons containing dry streams. It nests primarily in the cottonwoods and sycamore trees in the stream bottoms, or within the flood plain. The nest may be anywhere from about 40 to 100 feet up, depending on tree height. It is usually constructed high in the canopy in one of the main forks of the tree. Nesting material consists mostly of cottonwood twigs of medium size and the nest is often lined with green leaves. The nests may become quite bulky after several years use. The normal clutch is two eggs, but there may be one or three. The adults become very concerned when humans approach the nest and usually circle overhead, uttering a constant, loud, querulous cry.

Nests are usually placed on a broad-forking crotch near the trunk of the tree and generally about 40 to 50 feet above the ground. The nests are a little smaller than nests of Red-tailed Hawks and are usually within the upper one-fourth of the tree. Nests consist mostly of cottonwood twigs or other twigs from the tree in which they are nesting. The majority of all nests found have been within one-half mile of surface water.

Unfortunately, many of the riparian zones used for nesting are privately owned and are gradually deteriorating from excessive livestock grazing (which is preventing normal tree reproduction) and other land uses. Many of the nesting zones are in highly scenic canyons, such as Arivaipa Canyon, which attract large numbers of recreationists during late spring, just when the birds are beginning to lay eggs and start incubating. This human disturbance causes considerable nest abandonment in some canyons. Usually the birds will attempt to re-nest in an adjacent area, but such re-nesting attempts are frequently unsuccessful. Sometimes, birds at nests will sit "tight" on a branch in the tree canopy while humans pass close by; at other times they will leave the nest and fly overhead, calling excitedly.

Nest Survey Methods

Aerial surveys are useful in searching for suitable nesting areas along isolated riparian zones or other streams which the biologist is not familiar with. Areas containing large trees, such as cottonwoods, may be mapped and then visited on the ground to search for nests. Cottonwoods may be the only trees that have leafed out by the time the Black Hawks begin to nest; this is why cottonwoods are apparently used more than other trees. Nests probably cannot be seen from the air once the leaves are on the trees. Most nest surveying is conducted by walking along suitable stream bottoms and watching for either adult birds or for nests high in the trees with the aid of binoculars. Where the riparian zones are bounded by cliffs, the hawks will commonly use rocky perches on the cliffs for roosting and observation points.

Nest Survey Methods

Aerial surveys should be first employed to map out riparian zones that contain large tree types, such as sycamores or cottonwoods, that would be suitable as nesting trees for this species. Once the most likely looking riparian zones are determined, the survey becomes one of systematically searching for nests from the ground, using a good pair of binoculars. The nests are usually high in the canopies and may easily be missed if they are new. Normally, a general search of riparian zones is made to detect nests of all species using this specific kind of habitat, including Cooper's Hawks, Sharp-shinned Hawks, Gray Hawks, Black Hawks, Red-tailed Hawks, Great Horned Owls, Screech Owls, Saw-whet Owls, Long-eared Owls, and others depending on state and locality. Nests are most readily found by watching for adults flying nearby, observing their behavior, and then searching for nests in the vicinity they occupy most.

Fig. 85. Typical nesting habitat of the Black Hawk and Zone-tailed Hawk along riparian zones in Arizona.

Harris' Hawk
(Parabuteo unicinctus)

Fig. 86. Harris' Hawk at nest.

Nest and Habitat Characteristics

The Harris' Hawk is a common Mexican species that is found in the United States primarily in Texas, New Mexico, and Arizona. In the vicinity of Phoenix and southward it is farily common, nesting primarily in the tops of saguaro cacti and large bushes or trees, such as Palo Verde trees. The nest appears much the same as that of the Red-tailed Hawk which also nests in the tops of saguaro cacti in this area. It is constructed primarily of small to medium-sized twigs found scattered on the desert floor and lined with grasses, leaves, green mesquite, elm shoots, bark, Spanish moss, or roots. The nest may also be built in chaparral, mesquite, hackberry, or other trees. Generally, the nest is fairly low, being placed from about 10 to 30 feet above the ground.

The Harris'Hawk clutch usually consists of three or four eggs, sometimes five. The birds are known to practice polygyny, one male caring for two females which sometimes use the same nest. They also commonly have two clutches per year and the young from the first clutch have been observed helping feed the young in the second nesting.

Harris' Hawks may be found scattered across the Southwestern deserts and are not tied to riparian habitats like the Black, Gray, and Zone-tailed Hawks. This species and the Red-tailed Hawk are the dominant hawks of Southwestern desert regions.

Nest Survey Methods

Aerial surveys will assist the biologist in locating nests in saguaro cactus country, where nests are easily seen in the top forks of these plants, but nests in Palo Verde trees or other types of trees or bushes are very difficult to see from the air. Nests are most often located by driving desert roads that traverse suitable nesting habitats and watching for adult birds either soaring or perched on top of saguaro cacti or powerline poles. Their dark coloration readily distinguishes them from the white-fronted Red-tailed Hawks that may be common in the same area. While these hawks commonly nest in very dry environments, they may also utilize trees of the riparian zones as nesting sites, so these areas should also be checked.

Fig. 87. Typical nest of Harris' Hawk in saguaro cactus in Arizona.

Gray Hawk
(Buteo nitidus)

Fig. 88. Gray Hawk at nest.

Nest and Habitat Characteristics

The Gray Hawk, like the Zone-tailed Hawk and Black Hawk, represents the northern extension of a Central American species into the southern United States. Its primary nesting habitat is found in southern Arizona, almost entirely along riparian zones under private ownership. Its survival in the United States depends entirely on land use activities planned and conducted by private landowners. It is to be recommended that land exchanges be made, either by the State of Arizona or the Bureau of Land Management, with private landowners to obtain and manage its key riparian nesting habitats to assure the survival of this beautiful bluish-gray hawk. Surveys already conducted by researchers in Arizona have located *no* nests on public lands.

Nests are commonly used year after year and gradually develop considerable bulk, but are still smaller than old Red-tailed Hawk nests. They are built mostly of small to medium-sized twigs and lined with leaves or weeds. Nests are constructed only in high bushes or in trees lining water courses. Many nesting sites have been lost because of dams constructed along rivers, channelization of streams, or destruction of trees to create more farmland or to reduce water utilization.

Nest Survey Methods

Aerial flights conducted to determine suitable habitats for other species, such as Black Hawks and Zone-tailed Hawks, will apply as well to Gray Hawks. Suitable stretches of river or stream can then be searched for nests by carefully and slowly walking stream bottoms and watching for either the adult birds or their nests. The adults are quite vociferous when their nests are approached by humans, especially if young are in the nest. Therefore, surveys are best conducted at such time as one would expect to find young present, as indicated in the Appendix.

Marsh Hawk
(Circus cyaneus)

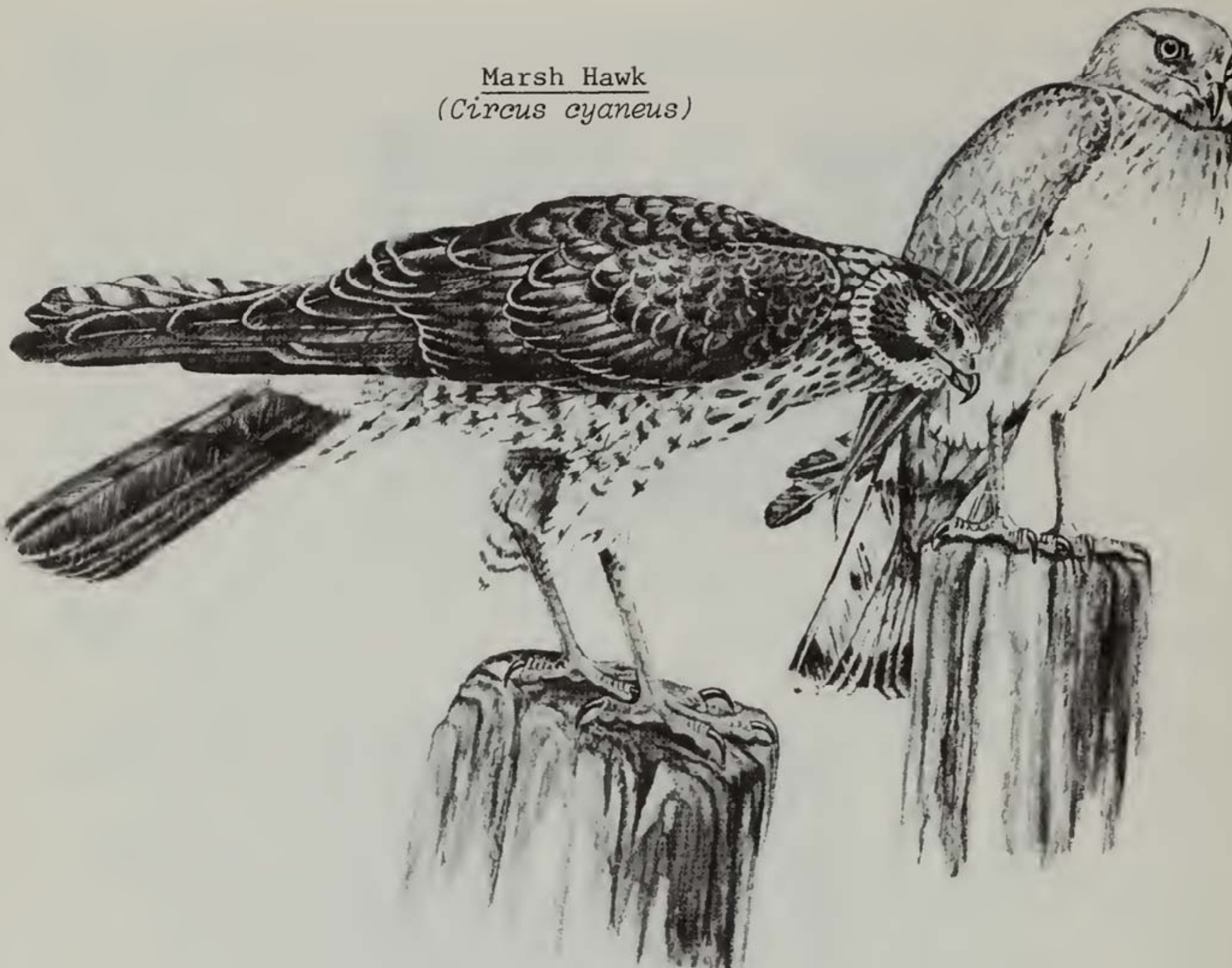

Fig.89. Female (left) and male (right) Marsh Hawks.

Nest and Habitat Characteristics

Marsh Hawks (Harriers) may be found nesting in all of the western states. While it seems to prefer to nest in the vicinity of marshes, rivers, or ponds, it may be found nesting in grassy valleys or on grass and sagebrush flats many miles from the nearest water. In general, it prefers saltwater marshes, wet meadows, sloughs, and bogs for its nesting and foraging habitat. Where these are absent, it hunts open fields and is frequently observed hunting over agricultural areas.

The nest is a flimsy to well-made structure of sticks, straws, grasses, or other small materials. Sometimes the nest will be built in reeds or bullrushes over water if they are matted down and will support a nest. The nest cup and structure usually become inconspicuous after the young hatch and begin moving around in the vicinity of the nest, seeking shade, etc. Normal clutches consist of from 4 to 6 eggs, occasionally more.

Polygyny has been reported for this species, i.e., one male defending nests of 2 females in the same area.

Nest Survey Methods

Marsh Hawks are frequently observed flying low over field and marsh, searching for mice, snakes, or other prey. The white rump patch and high dihedral of the wings makes the bird easy to identify. The females are brownish, while the males are slate-gray with white breasts. The only practical method for locating their nests is to drive all available roads around fields, sloughs, etc., watching for the adult birds. When located, the adults should be watched until they drop into the grass or brush. Then approach the spot, keeping your eyes fixed on the last spot where the bird was observed. After the young hatch, the adults will return to the nest quite often with food. The only other suitable method for locating nests is to use dogs, or to systematically search marshy areas or fields where the birds have been seen and hope to flush the bird from its nest. It is generally unfruitful to search for a Marsh Hawk nest unless an adult has been observed flying in the area.

Fig. 90. Typical Marsh Hawk nests.

Turkey Vulture
(Cathartes aura)

Fig. 91. Turkey Vulture.

Nest and Habitat Characteristics

The Turkey Vulture is one of the most common avian scavengers in the United States. Cliffs are the most common nesting sites throughout the West, but occasionally tree nests are found. Nests are usually built out of reach of terrestrial predators, possibly because of the odoriferous condition of the nesting site, a characteristic of carrion-feeding birds.

The nests are usually in clefts or cavities in sheer cliffs, often as high as 12,000 feet elevation in high mountains. In Colorado, they have been noted nesting in the tops of trees, along with Great Blue Herons, but this is very unusual. Nests have also been found on the ground under vegetation, in fallen hollow logs, in broken tree stubs at considerable heights, or in caves.

Nest Survey Methods

Nests of this vulture are best found by watching for the adult birds soaring in a particular area and then observing them until they go to their nests. Since the birds are quite wide-ranging in search of food, this may take considerable time. However, when the birds are seen in the vicinity of cliffs, it is possible that their nest sites are nearby, and they should be watched as long as possible. Usually, if adults are commonly observed frequenting a particular area, one can assume that their nests are not too far away.

California Condor
(Vultur californianus)

Fig. 92. The Endangered California Condor

Nest and Habitat Characteristics

Possibly less than fifty of these magnificent vultures still survive in the wilder portions of southern California, among the most rugged and rocky gorges and canyons of the less frequented mountain ranges.

The condor lays its single egg on the bare soil, gravel, or rocky floor of some more or less inaccessible cave or crevice in a cliff, or under rocks or boulders on the side of a mountain canyon. Sometimes the crevice is barely large enough to admit the bird and at other times it is quite open.

The California Condor lays only one egg in a season; and apparently it does not lay every year. Hence, it reproduces very slowly. Fortunately, the birds are relatively long-lived, having been known to live in zoos in excess of fifty years. Some of its more crucial habitats in California are being set aside and officially designated as Critical Areas. (1).

Nest Survey Methods

Those who have conducted specific research on this great bird generally know where its primary nesting habitats are located. Forest Service, Bureau of Land Management, and California Department of Fish and Game personnel are aware of its general nesting areas, but specific nests are still difficult to find. In general, no disturbance of its nests can be tolerated, since any disruption of its nesting sequence may mean the loss of another very critical egg or young bird.

Fig. 93. Turkey Vulture nest site with young. As pictured, these birds sometimes nest on the ground between boulders or under trees on hillsides.

Fig. 94. California Condors on ledge near nest in southern California.

Common Raven
(Corvus corax)

Nest and Habitat Characteristics

The Raven is classified by some as a raptor, and not by others. It is included in this bulletin because its food habits are much the same as some of the raptors that are included.

The Raven is well distributed throughout the West and probably nests in every western state. They range the rugged mountainous country but are apparently equally at home over the rolling, sage-covered hills of lower elevations. They commonly compete with Magpies and Golden Eagles for rabbits or other mammals crushed on the highways.

The Common Raven nests in cavities in cliffs, in a variety of different types of trees, both coniferous and deciduous, and on different types of man-made structures, including powerline poles. They may construct their own nests, which are fair sized structures of medium-sized twigs, or they may appropriate the old nests of other raptors. They seem to prefer to nest under some type of rocky overhang than completely exposed to the elements. The nest is usually lined with shredded bark, grasses, or other fine material.

Nest Survey Methods

Raven nests are usually found while searching for other raptor nests, either in cliffs or in tree stands. Aerial flights usually turn up a few Raven nests in cavities or on ledges of cliffs where the observer may be searching for Golden Eagle or hawk nests. Wherever adults are observed during the nesting season, there is probably a nest nearby in a rocky outcropping or other suitable site. If the observer watches the birds, they will usually go directly to the nest site. With a little experience with any raptor, the biologist eventually learns about how far from its nest a raptor will range and how the bird behaves in the vicinity of its nest, especially when an intruder approaches. Behavior patterns will vary somewhat, depending on whether the nest is in a cliff or canyon, or whether it is in open country.

Fig. 95. A usual nesting site of the Common Raven in a cavity in a cliff.

Fig. 96. A Raven nest on a ledge on a cliff face, showing nest structure and eggs.

NOCTURNAL SPECIES NEST SURVEYS

Surveys for Owl Nests and/or Territories. Many species of owls inhabit the public lands of the West, but because of their nocturnal habits it is very difficult to locate the birds and their nests, especially the smaller and more secretive species. Owls may nest in holes or cavities of cliffs or trees, in nests constructed by other birds, on the ground, or in holes in the ground. The biologist should become knowledgeable of the different nesting requirements of the various species so that he may make specific species nest surveys or watch for them during other raptor surveys. In searching for owls it may be advisable to survey by habitat types, i.e., look for owls nesting on, or in, the ground, or owls nesting in trees in other birds' nests, or owls nesting in cavities in trees.

Owls that normally use small cavities such as flicker holes in cottonwoods, saguaro cacti, etc., include the Elf Owl, Screech Owl, Whiskered Owl, Ferruginous Owl, Flammulated Owl, Boreal Owl, Saw-whet Owl, and Pygmy Owl. Owls that use larger cavities, such as those created by broken branches or tree trunks, include the Great Horned Owl, Barred Owl, Northern Spotted Owl, and the Hawk Owl. The Hawk Owl also sometimes uses the old stick nests of other birds.

Owls that commonly use the stick nests of other birds include the Great Horned Owl, Long-eared Owl, Great Gray Owl, and Hawk Owl. The Long-eared Owl commonly uses old Magpie or Cooper's Hawk nests, while the Great Horned Owl and Great Gray Owl utilize old Raven nests and other larger raptor nests.

Ground-nesting owls include the Burrowing Owl, Short-eared Owl, and Snowy Owl. Burrowing Owls utilize the burrows of prairie dogs, rabbits, badgers, or other hole-digging rodents. The Short-eared Owl nests in grasses, weeds, or shrubby areas in practically any grassy location. No nest is constructed. The Snowy Owl of the North nests amongst the lichens or in grassy areas of the tundra.

Barn Owls will nest in a variety of man-made structures, including old abandoned cement plants, mining buildings, barns, silos, and houses, as well as in cavities in dirt banks or cliffs.

Surveying of nesting owls is best accomplished during the period of breeding and egg-laying when most owls will respond to an imitation of their own hoot or call. The owl's nest can generally be assumed to be in the vicinity of the owl which has been located by its responding call (there is no way short of time consuming daylight searches and observations to differentiate between mated and unmated owls that may respond). Once the responding owls' locations have been plotted on a map, searches may be made in daylight and nests located. Caution should be used in soliciting responses from owls during the daytime as aerial predators (accipiters) may be attracted which could destroy either the adult owls or their young.

If the biologist desires to determine all species of owls using a particular woodlot or canyon by using taped owl calls, he should start his survey by playing the tape recorder or using voice imitations for smaller owls first and then gradually proceed with calls for the larger owls. The Great Horned Owl call should be the last one used. Reversing this procedure usually produces poor results, since larger owls intimidate and sometimes prey on smaller owls, making them reluctant to answer a call if a large owl is thought to be in the vicinity.

Great Horned Owls are fairly easy to survey in areas where deciduous trees predominate because the owls begin nesting in late February or early March when trees are still leafless, making it fairly easy to see the adult owl sitting on the nest. This, of course, is not true in coniferous tree stands. Nests can usually be located by driving the available roads and examining all stick nests with the aid of binoculars. Great Horned Owls create a conspicuous hump on a stick nest that is easily seen. Great Horned Owls also nest in cavities in cliffs. Such nest sites may or may not exhibit "whitewash" excrement from the young, depending on the type of cavity. Throwing objects at holes suspected of containing nesting owls will frequently cause the birds to flush, but not always. Owls will often use junipers and other conifers for nest sites, and in such places will need to be surveyed on an individual site basis, searching groves of trees for any type of stick nest that could be used. Even old Magpie nests are sometimes used by Great Horned Owls and other species. Striking trees with a stick or other object will often cause small owls, such as Saw-whet Owls, to reveal themselves if they are nesting or hiding in small cavities in trees.

In searching for owls, one should watch for pellets at the base of trees or cliffs. All birds of prey form pellets from the indigestible portion of their food and these are periodically regurgitated by the birds. Researchers can determine many of the food habits of the birds by studying the pellets, and they are also an important clue to the presence of owls or other raptors. Barn Owls, for example, that nest in cliffs, or banks, will leave a scattering of pellets beneath their roosting or nesting hole, making it easier to detect their presence.

In surveying for the presence of owls and/or their nests, there are five recommended procedures that may be used. In discussing nest survey methods for the various species of owls, these standard methods will be referred to.

Suggested Survey Methods

Survey Method No. 1. Drive all available roads in the area and examine all old stick nests observed in trees or bushes. With the aid of binoculars or spotting scope the observer can usually determine whether or not there is an owl sitting on the nest, especially one of the larger owls. If there is any question, you should approach the nest for closer examination. If roads are not available, you may need to walk close enough to examine stands of deciduous trees scattered around the prairie or desert.

Survey Method No. 2. In coniferous stands, make a systematic search of the trees to detect the presence of any owls or old nests that may be suitable for their use. In dense conifer stands the nests of Cooper's Hawks, Goshawks, and Sharp-shinned Hawks are commonly used for nesting by the larger owls. Where juniper trees or other conifers are scattered across an area, you will need to examine them on an individual tree or clump basis. Ravens, Crows, Magpies, Red-tailed Hawks, and Swainson's Hawks frequently nest in such trees, and any of these nests are suitable nesting sites for owls such as the Great Horned Owl, Great Gray Owl, and Long-eared Owl.

Survey Method No. 3. Keep watch for any trees, either living or dead, that contain woodpecker or flicker holes or any type of natural cavity created by accident or decay. On an individual tree basis, use a club or other device to strike the trunk of any tree that contains a hole or cavity while watching the hole for the appearance of a small owl. Strike the trunk many times, since some species of owls like the Saw-whet sometimes take some arousing. If an owl does not appear at the opening, it *probably is not being used for nesting or roosting, but you cannot be sure*. For most purposes, if a bird does not appear, assume there is not one present. Trying to climb to each individual hole can be time consuming and usually not worth the effort.

Survey Method No. 4. Drive all available roads while watching for any type of rodent colony, especially prairie dogs and ground squirrels. Map all prairie dog colonies as potential nesting sites for Burrowing owls and examine all such colonies with binoculars for the presence of Burrowing owls, which often sit on the dirt mounds throughout the day. Also, during the appropriate period, the young owls may be seen with just their heads protruding above the ground surface. Burrowing owls sometimes nest in isolated holes that may occur anywhere on the desert floor. Keep an eye out for such birds.

Short-eared Owls may be found in grassy, sagebrush, marshy, or wet meadow areas throughout the West. The nest is in a slight depression and usually lined with grass and weedstalks. These owls are primarily active at dusk and early dawn but sometimes hunt during the day, especially on cloudy days. Since they are quite widespread through a variety of habitats, it is generally feasible to try to survey for them only in the more likely locations, such as areas of valleys having relatively dense grass stands and around marshy areas. Clap your hands, or otherwise produce loud noises as you walk through the likely-looking areas and you will frequently flush one or more of these owls. Also, watch for these birds whenever you are conducting inventories for other wildlife or when you are driving along old trails leading through grassy habitats. They will usually flush from about 30 to 50 yards ahead of moving vehicles.

Snowy Owls, living in northern tundra, are quite readily found with the use of aircraft during their nesting season. Their white forms, while sometimes partially blending with surrounding rocks and vegetation can still be discerned once an observer becomes trained to look for them. Keep an eye out for these birds while routinely doing other resource surveys, or make special flights if you are particularly concerned about relative populations in a specific area.

Survey Method No. 5. Obtain taped bird calls from the National Audubon Society or other sources and play back these calls at appropriate crepuscular or nocturnal periods to solicit responses from specific species. For a general owl survey, play the calls for the smaller species of owls first and end up later playing the calls of the larger owls. Hearing the calls of the larger owls might intimidate the smaller owl species and they may not respond, since they serve as prey to some of the larger owls. Driving along back-country roads and stopping about every one-quarter mile to play the calls will usually provide the biologist with considerable information about the species and abundance of owls in the area. Trial and error efforts will usually provide the biologist with the most appropriate methods to use for his particular part of the country and for the species involved.

Use of taped or voice calls for Northern Spotted Owls has proved to be very effective in Oregon. At dusk, night, or morning the caller regularly emits the call at likely looking spots and then waits for a few minutes for a response. This is repeated at periodic intervals as he proceeds through the length of the suitable habitat. Responses are mapped and the locations later checked for possible nests.

Great Horned Owl
(Bubo virginianus)

Fig. 97. Great Horned Owl.

Nest and Habitat Characteristics

Great Horned Owls are found throughout the West in deserts, forests, canyons, mountains, and open country. They are universal in distribution and will nest on practically any old nest structure that will hold the incubating bird, as well as in a wide variety of cavities in both cliffs and trees. From one to four eggs are laid, generally from late January to late March.

Nest Survey Methods

Use suggested Methods No. 1, 2, and 5.

Fig. 98. Typical tree and cliff nesting sites for the Great Horned Owl.

Short-eared Owl
(Asio flammeus)

Fig. 99. Short-eared Owl.

Nest and Habitat Characteristics

Short-eared Owls may be found in a variety of habitats throughout the West, including grassy, sagebrush, marshy, and wet meadow areas. The nest may be placed in any of these habitats and consists of a slight depression that may be lined with grass or weedstalks. Sometimes the eggs are laid with little apparent effort to form a nest bowl. They always nest on the ground and may be flushed as the observer drives or walks through suitable habitats. It seems to nest more frequently around marshy or dense grass areas. This is one of the few owl species that frequently hunts during daylight hours, especially on dark, cloudy days.

Nest Survey Methods

Use suggested Methods 4 (Short-eared Owl portion) and 5.

Fig. 100. Typical nesting sites for Short-eared Owls.

Long-eared Owl
(Asio otus)

Fig. 101. Long-eared Owls.

Nest and Habitat Characteristics

This owl may be found in any area of the West where there is sufficient tree or brush growth to give it shelter for its nest and concealment during the day. It may be found in dense groves of coniferous trees in mountainous regions or in tree belts scattered along prairie streams. It seems to prefer areas having dense brush patches for roosting and is one of the most nocturnal of all owls. It usually uses an old hawk, squirrel, raven, or magpie nest as its nesting site. Old Crow, Raven, or Magpie nests in clumps of junipers or thickets of locust, willows, or other brush are commonly used. This owl has been *reported* to very rarely construct a nest of its own, usually a shabby structure composed of twigs of willow, aspen, etc. The birds have an uncanny capability for concealment. An old nest may appear completely empty, but when approached closely an owl will suddenly fly from the nest, coming as if from nowhere.

Nest Survey Methods

Use suggested Methods No. 1, 2, and 5. These birds sit very "tight" on the nest. Often, the surveyor needs to rap on the nest tree, or even the nest, before the bird will reveal itself. Every potential nest site must be examined closely; distant evaluations with binoculars usually will not reveal the birds.

Fig. 102. Nest site of a Long-eared Owl in an old Magpie nest in a locust thicket in Colorado.

Fig. 103. A pair of young Long-eared Owls, showing distinctive facial discs of this species.

Spotted Owl
(*Strix occidentalis sp.*)

Fig. 104. Northern Spotted Owl.

Nest and Habitat Characteristics

There are three subspecies of Spotted Owls that may be found on public lands, i.e., Northern Spotted Owl (*Strix occidentalis caurina)*, Mexican Spotted Owl (*Strix occidentalis lucida*), and the California Spotted Owl (*Strix occidentalis occidentalis*). The various species nest in different habitats, depending on their location in the West. The Northern Spotted Owl occurs primarily in heavily forested areas of western Oregon, Washington, and British Columbia. The California Spotted Owl is found on the west slope of the Sierra Nevada in forests at elevations of 2500 - 6600 feet and onto the east slope of the Sierras in the mountains north of Lake Tahoe near the California-Nevada border. The Mexican Spotted Owl ranges as far north as central Colorado, extending south along the foothills and adjacent areas east of the Front Range, through the mountainous central and southern part of the state and into eastern Arizona and New Mexico. The Guadalupe Mountains of southern New Mexico and western Texas represent the farthest southeastern extension of its range in the United States.

The Northern Spotted Owl nests exclusively in old-growth timber, usually in cavities created at the broken tops of old trees. Such "barber chair" platforms, or cavities, rarely occur in sturdy, dense stands of second growth forest. This sub-species is apparently habitat specific for nesting in the old-growth type.

Nests of the California Spotted Owl have been found on bare ground but are more often situated in trees, tree hollows and natural cliff-side cavities. One nest in Ventura County, California, which owls used repeatedly, was discovered in a roomy cavity about fifteen feet from the base of a 200-foot, north-facing granite cliff in a narrow gorge of a steep canyon. In another area, a hollow log was apparently used as a nesting site. In Riverside, California, owls laid one set of eggs on the floor of a small cave in a clay bank; another set was found at the base of a large rock on the bare ground. (13).

In Arizona and New Mexico, Mexican Spotted Owls are reported to have either constructed and/or renovated old hawk nests. The amount of actual construction by the owls is still questionable, since the basic structure usually is that of an abandoned raptor nest. The owls in New Mexico are also reported to sometimes nest in shaded fissures or cavities in cliffs in narrow canyons. They may also use old eagle or raven nests, especially in steep canyons with north-facing slopes.

Spotted Owls are generally very docile during human investigations of their nests, eggs, or young. They will sometimes perch within a few feet of the observer with little show of concern. Spotted Owls usually lay only two eggs, while three eggs is not uncommon. Four eggs are very rare.

Juvenile Spotted Owls leave the nest at a very early age, though they are still cared for by the adults. Therefore, a nest may be recently active, but the young may simply be sitting in an adjacent tree, or elsewhere in the nest tree.

The Spotted Owl is sedentary, heat intolerant, and almost totally nocturnal. Its habitat requirements reflect these characteristics.

Nest Survey Methods

Use Suggested Methods No. 2 (insofar as systematic searches of owls in suitable old-growth forest is concerned) and No. 5 (specifically calling for Spotted Owls).

Fig. 105. Typical old growth forest used for nesting by Northern Spotted Owls.

Fig. 106. A common nesting site for the Northern Spotted Owl is the cavity created when the top breaks off an old Douglas Fir tree in a dense old-growth stand.

Fig. 107. Young Northern Spotted Owls leave the nest early and perch on branches until ready to fledge.

<u>Great Gray Owl</u>
(Strix nebulosa)

Fig. 108. Great Gray Owl.

<u>Nest and Habitat Characteristics</u>

This species is found primarily in Canada and the northern latitudes of the United States. It is very commonly found in deciduous forests of poplar, birch, or aspen, or mixtures of these trees with conifers. It often uses the old nests of Goshawks, Red-tailed Hawks, Raven, or Broad-winged Hawks for its nesting site. The nest may vary from 10 to 60 feet above the ground, depending largely on what old nests are available and the tree type present. Unlike other owls, it sometimes brings fresh green sprigs or needles of pines for lining its nest. The birds may lay anywhere from two to five eggs, but three is the most common number. The female may sometimes line its nest with feathers or down from her breast. (2).

<u>Nest Survey Methods</u>

Use suggested Methods No. 1, 2, and 5. These birds are not found around human habitations nearly as frequently as Great Horned Owls and seem to prefer the seclusion of more isolated areas. Surveying for them will likely require considerable walking through suitable habitats.

<u>Snowy Owl</u>
(Nyctea Nyctea)

Fig. 109. Snowy Owl

Nest and Habitat Characteristics

This great white owl, one of the largest and most powerful, enjoys a wide circumpolar distribution throughout the Arctic regions of both hemispheres. It breeds north of the limits of trees on the Arctic tundras as far north as explorers have found suitable land that is not covered with perpetual ice and snow, and where it can find suitable food supply. It is by no means evenly distributed or universally abundant anywhere, on account of the periodic fluctuations in its food supply. In some regions, its abundance appears to be linked with the abundance of its favorite food, the lemming.

The nests of the Snowy Owl are ordinarily placed on the ground, usually on the highest and driest point in the surrounding tundra. Occasionally, a nesting site on a rocky ledge or a cliff is chosen. In either case the nest is but a flimsy affair at best, consisting, if on the ground, of a slight hollow scratched out by the birds, and this is usually lined with a little moss and a few feathers; if on top of a ledge or a cliff, the eggs frequently lie on the bare rock, with just enough material around them to keep them in place and prevent them from rolling about.

These owls commonly spend hours quitely perched on the summits of hillocks, where at a distance they look like small patches of snow. (2).

Nest Survey Methods

Use suggested Method No. 4. Widespread areas can only be surveyed by aircraft in remote regions such as Alaska. This is best done by systematically examining all elevated areas on the tundra for the tell-tale white plumages of the birds that may be either perched or sitting on flimsy nests.

Burrowing Owl
(Speotyto cunicularia)

Fig. 110. Burrowing Owl at prairie dog hole used for nest site.

Nest and Habitat Characteristics

This is the only small owl that habitually perches on the ground. They commonly use the burrows of prairie dogs as nesting sites and seen at distance, they somewhat resemble prairie dogs standing on top their mounds.

These owls are migratory in the northern part of their range, returning to their habitual nesting areas by mid-April. They often nest close to civilization and are able to live compatibly with man's activities so long as prairie dog burrows or other rodent holes are not all plowed under. It is not uncommon to see them living in prairie dog colonies within city limits, with housing developments nearby.

The species occurs on the plains and in unforested areas from British Columbia south through Baja California. They were formerly very common but numbers are gradually decreasing, probably due largely to a gradual disappearance of prairie dog colonies because of man's activities. (8).

Nest Survey Methods

Use suggested Method No. 4. With the use of binoculars or spotting scopes these birds are readily visible on open deserts or prairies. While a few isolated pairs or small colonies will be missed that are scattered through brushy areas, they are still probably the easiest of the owls to survey because, early in the mornings and late afternoons they will invariably be sitting out on prairie dog mounds or on fenceposts, about to commence their search for large insects or other prey.

Screech Owl
(Otus asio)

Fig. 111. Screech Owl.

Nest and Habitat Characteristics

Various races of the Screech Owl are found throughout the West. They apparently are not migratory and remain paired throughout the year. They are commonly found in wooded areas along stream bottoms where they utilize woodpecker holes for roosting and nesting. They also live in pine-clad hills up to about 8,000 feet elevation and also live in cavities in foothill stands of junipers. In the Southwest they utilize flicker holes in saguaro cacti as nesting sites.

They often remain in the same territory for several years, which may not be larger than 300 yards across. These birds are strictly nocturnal and are, therefore, more often heard than seen. (2).

Nest Survey Methods

Use suggested Methods No. 3 and 5. In surveying for this species a systematic search for and checking of flicker and woodpecker holes will be necessary. As you find each hole, rap the tree several times with a stick. If an owl is present, it will usually stick its head out of the hole to see who the intruder is. However, females incubating eggs may sit tight and refuse to show themselves. Close examination of each individual hole is too time consuming for anything but special research projects. Taped calls are often used to good advantage in soliciting responses at night.

Fig. 112. Burrowing Owl on typical nesting burrow in prairie dog colony.

Fig. 113. Screech Owl nest in a flicker hole in a tree.

Saw-whet Owl
(Aegolius acadicus)

Fig. 114. Saw-whet Owl.

Nest and Habitat Characteristics

The wide-ranging Saw-whet Owls, named for their distinctive call notes, are birds of the Sonoran to Transition Zones. They are scattered through the foothills in both coniferous and deciduous tree stands and are also occasionally found living in cottonwoods along river bottoms. They sit quietly, resting by day in clumps of pines, cottonwoods, or willow thickets, escaping notice by merely remaining motionless. They are very tame, often letting humans approach to within a few feet.

They frequently roost in natural cavities or woodpecker holes where they are seldom observed unless someone or something bumps their tree or raps it with a stick. They utilize the same kinds of cavities as nesting sites, with courtship starting in February and continuing through March.

Fig. 115. Saw-whet Owl at a nest site, an old hole in a cottonwood tree.

Fig. 116. Flicker holes in saguaro cacti are common nesting sites for Elf Owls and Screech Owls in the Southwest.

Pygmy Owl
(Calucidium gnoma)

Fig. 117. Pygmy Owl

Nest and Habitat Characteristics

The little Pygmy Owls are widespread through western mountains from Alaska south to Baja California. The birds are probably non-migratory but may seek lower elevations in winter. The Pygmies range higher into the mountains than the Saw-whet and Flammulated Owls, commonly up to twelve thousand feet, and are active by day instead of being almost entirely nocturnal as are the other two owls. The call of the Pygmy, or the scolding of chickadees or juncos and other species, alarmed by its presence, are the best clues for anyone hoping to make field observations of these interesting mountain owls. (2).

Like all other small owls except the Burrowing Owl, these birds also nest in woodpecker holes or natural cavities, usually in coniferous forests. Three to four white eggs are laid in May or June.

Nest Survey Methods

Use suggested Methods 3 and 5. Since these owls usually sit tight against a tree trunk or hide in cavities during the day, they are very difficult to find and are most often found accidentally while working in the forest. Most small birds scold angrily when they find a Pygmy Owl and one of the best clues to their presence is the angry scolding of small birds that we sometimes hear in the forest.

The call of the Pygmy Owl is easily imitated, and is effective in calling up these birds. Some field workers use the call of this owl to attract small perching birds for study. By imitating its call, you can often attract small birds to within very close range.

Elf Owl
(Micrathene whiteneyi)

Fig. 118. Elf Owl in nesting cavity in sycamore tree.

Nest and Habitat Characteristics

The chief haunts of the Elf Owl are the low, hot, dry Lower Sonoran plains of the river bottoms and the adjacent tablelands of the Southwest, primarily in Arizona. They are not limited to the saguaro cactus belts, as many have thought, but may also be found in canyons where walnut, live oak, sycamore, and cottonwood grow, sometimes in broken, high country. (2).

The best-known nesting sites are in woodpecker or flicker holes in saguaro cacti, but they also nest in holes in deciduous trees in adjacent areas. The most common number of eggs laid is three, but from two to five eggs are normal. After starting to lay, they usually lay one egg every other day.

Nest Survey Methods

Use suggested Methods No. 3 and 5. Searches for owls in old woodpecker holes or natural cavities is always interesting. Many species of small owls, as well as many other small birds, use woodpecker and flicker holes for nesting. Birds ranging from Sparrow Hawks to Ash-throated Flycatchers may stick their heads out to see who the intruder is.

Flammulated Owl
(Otus flammeolus)

Fig. 119. Flammulated Owl.

Nest and Habitat Characteristics

This pretty and gentle little owl is quite widely distributed in mountainous regions from southern British Columbia and Idaho southward through Mexico. However, it still appears to be one of the least commonly observed owls of the smaller species. So far as presently known, they are more common in mountainous regions, from 6,000 to 10,000 feet in elevation.

The Flammulated Owl is the only small owl in North America with dark eyes. It is rarely observed since it rests during the day, roosting near the trunk of pine or fir trees. Conifers, including juniper and pinyon pine, are its predominant habitat. Eggs are normally laid in late May or early June, possibly earlier in southern latitudes, usually in old woodpecker holes. (2).

Nest Survey Methods

Use suggested Methods 3 and 5. The most feasible method to locate them during the breeding season is to be afield after dark and listen for their ventriloquistic, single hoots, which follow one after another, repeated endlessly, and when they have been heard, to work the hillsides systematically in search of nesting places.

Barn Owl
(Tyto alba)

Fig. 120. Barn Owl

Nest and Habitat Characteristics

Nesting sites of the Barn Owl are quite variable and include all sorts of places, including holes and cavities in clay banks and cliffs, burrows under ground enlarged to suit their needs, natural hollows in trees, in the sides of old wells, abandoned mining shafts, in silos, barns, abandoned houses, and in the top of church steeples. Nests have even been found in exposed and unprotected places such as on flat roofs of buildings. All nests examined by the author have been in old buildings, barns, silos, water towers, or in clay banks or cliffs. They were reported by Bendire in 1892 as nesting in deserted burrows of badgers in Arizona. It is believed that the owls themselves may enlarge cavities in clay banks or ground burrows to suit their needs, using their powerful claws. (2).

In most cases, eggs are merely laid on any rubbish or debris that is present in the cavity where they are nesting. However, if the nest is in a barn or house, they may pull together some sticks, straw, or other rubbish to form a sort of nest base. The average number of eggs laid is from five to seven and up to eleven eggs is not uncommon. The eggs are pure white and mostly ovate in shape.

Nest Survey Methods

Barn Owls are most frequently located by searching old buildings, barns, silos, or similar structures where large cavities may be available for a nest. In Utah they seem to be found mostly in silos, barns, old cement plants, or abandoned mining buildings. However, in northern Colorado, they have been predominantly found nesting in cavities in clay banks and cliffs. Reasons for local preferences are unclear, so all potential types of nesting sites should be examined when searching for this species. Whenever Barn Owls are suspected of nesting in clay banks or cliffs, the biologist can easily check by examining the ground under all potential or suspected cavities for pellets, which tend to have a rather dark, amorphous shape when compared to the rather cylindrical shape for Great Horned, Long-eared, or Short-eared Owls. Such pellets will also be found in abundance at any other nesting site.

Fig. 121. Young Barn Owls at nest site in old barn.

Fig. 122. Cavities in clay banks such as shown here are frequently used as nesting sites by Barn Owls.

Fig. 123. These Barn Owls were nesting in a clay-shale bank in northern Colorado.

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WESTERN STATES IN WHICH BIRDS OF PREY NEST

SPECIES	AL	AZ	CA	CO	ID	MO	NV	NM	OR	UT	WA	WY
Turkey Vulture	X	X	X	X	X	X	X	X	X	X	X	X
Black Vulture		X						X				
California Condor			X									
White-tailed Kite			X									
Mississippi Kite				X								
Swallow-tailed Kite												
Everglade Kite												
Goshawk	X	X	X	X	X	X	X	X	X	X	X	X
Cooper's Hawk	X	X	X	X	X	X	X	X	X	X	X	X
Sharp-shinned Hawk	X	X	X	X	X	X	X	X	X	X	X	X
Marsh Hawk	X	X	X	X	X	X	X	X	X	X	X	X
Rough-legged Hawk	X											
Ferruginous Hawk		X	X	X	X	X	X	X	X	X	X	X
Red-tailed Hawk	X	X	X	X	X	X	X	X	X	X	X	X
Red-shouldered Hawk			X									
Swainson's Hawk	X	X	X	X	X	X	X	X	X	X	X	X
Broad-winged Hawk												
Harlan's Hawk				X	X	X						X
Harris's Hawk		X	X									
Black Hawk		X						X				
Zone-tailed Hawk		X	X					X				
White-tailed Hawk												
Short-tailed Hawk												
Gray Hawk		X										
Golden Eagle	X	X	X	X	X	X	X	X	X	X	X	X

WESTERN STATES IN WHICH BIRDS OF PREY NEST

SPECIES	AL	AZ	CA	CO	ID	MO	NV	NM	OR	UT	WA	WY
Bald Eagle	X		X		X	X			X		X	X
Osprey	X		X	X	X	X	X	X	X	X	X	X
Caracara		X										
Gyrfalcon	X					X						
Prairie Falcon		X	X	X	X	X	X	X	X	X	X	X
Peregrine Falcon	X	X	X	X	X	X	X	X	X	X	X	X
Pigeon Hawk (Merlin)	X	X	X	X	X	X	X	X	X	X	X	X
Sparrow Hawk (Am. Kestrel)	X	X	X	X	X	X	X	X	X	X	X	X
Aplomado Falcon		X										
Screech Owl		X	X	X	X	X	X	X	X	X	X	X
Great-horned Owl	X	X	X	X	X	X	X	X	X	X	X	X
Long-eared Owl		X	X	X	X	X	X	X	X	X	X	X
Short-eared Owl	X	X	X	X	X	X	X	X	X	X	X	X
Barn Owl		X	X	X	X	X	X	X	X	X	X	X
Snowy Owl	X											
Barred Owl				X	X	X						X
Spotted Owl		X	X	X	X			X	X	X	X	
Great Gray Owl	X		X		X	X			X		X	X
Hawk Owl	X											
Burrowing Owl		X	X	X	X	X	X	X	X	X	X	X
Boreal Owl	X											
Saw-whet Owl		X	X	X	X	X	X	X	X	X	X	X
Whiskered Owl		X										
Flammulated Owl		X	X	X	X		X	X	X	X	X	X
Pygmy Owl		X	X	X	X	X	X	X	X	X	X	X

WESTERN STATES IN WHICH BIRDS OF PREY NEST

SPECIES	AL	AZ	CA	CO	ID	MO	NV	NM	OR	UT	WA	WY
Elf Owl		X	X					X				
Ferruginous Owl		X										

RAPTOR NESTING SITE PREFERENCES

SPECIES	Location of Nest: Ledges/Holes in Sheer Cliffs	On Low Rocky Bluffs	On/In Ground	On Man-Made Structures	In Trees, Cactus or Bushes
Turkey Vulture	X				
Black Vulture	X			X	
California Condor	X				
White-tailed Kite					X
Mississippi Kite					X
Goshawk					X
Cooper's Hawk					X
Sharp-shinned Hawk					X
Marsh Hawk			X		
Rough-legged Hawk			X		
Ferruginous Hawk		X	X	X	X
Red-tailed Hawk	X	X			X
Red-shouldered Hawk					X
Swainson's Hawk					X
Harlan's Hawk					X
Harris' Hawk					X
Black Hawk					X
Zone-tailed Hawk					X
Gray Hawk					X
Golden Eagle	X				X
Bald Eagle	X				X
Osprey	X (pinnacles)				X
Caracara					X

RAPTOR NESTING SITE PREFERENCES

SPECIES	Location of Nest: Ledges/Holes in Sheer Cliffs	On Low Rocky Bluffs	On/In Ground	On Man-Made Structures	In Trees, Cactus or Bushes
Gryfalcon	X	X			
Prairie Falcon	X				
Peregrine Falcon	X				
Pigeon Hawk					X
Sparrow Hawk	X				X
Aplamado Falcon					X
Screech Owl					X
Great-horned Owl	X	X			X
Long-eared Owl					X
Short-eared Owl			X		
Barn Owl	X			X	
Snowy Owl			X		
Barred Owl					X
Spotted Owl	X				X
Great Gray Owl					X
Hawk Owl					X
Burrowing Owl			X		
Boreal Owl					X
Saw-whet Owl					X
Whiskered Owl					X
Flammulated Owl					X
Pygmy Owl					X
Elf Owl					X

RAPTOR NESTING SITE PREFERENCES

SPECIES	Location of Nest				
	Ledges/Holes in Sheer Cliffs	On Low Rocky Bluffs	On/In Ground	On Man-Made Structures	In Trees, Cactus or Bushes
Ferruginous Owl					X

TERRITORIAL REQUIREMENTS OF BIRDS OF PREY

SPECIES	AVERAGE TERRITORY OR RANGE	
	SQ. MI.	DIAMETER (mi.)
Goshawk	1.0 - 4.0	1.0 - 3.0
Cooper's Hawk	1.0 - 3.0	1.0 - 3.0
Sharp-shinned Hawk	1.0 - 3.0	1.0 - 3.0
Marsh Hawk	1.5 - 2.0	1.5 - 2.0
Rough-legged Hawk	.24-19.2	.5 - 8.0
Ferruginous Hawk	1.0 - 3.0	1.0 - 2.5
Red-tailed Hawk	1.5 - 3.5	2.0 - 2.5
Red-shouldered Hawk	1.5 - 3.5	2.0 - 2.5
Swainson's Hawk	1.5 - 2.0	1.5 - 2.5
Black Hawk	.5 - 2.0	.5 - 2.0
Zone-tailed Hawk	1.0 - 3.0	1.0 - 3.0
Golden Eagle	8.0 -10.0	3.0 - 5.0
Bald Eagle	2.0 - 6.0	1.0 - 5.0
Osprey	3.0 - 8.0	.5 - 3.0
Prairie Falcon	2.0 - 5.0	1.5 - 5.0
Peregrine Falcon	3.0 -10.0	3.0 - 8.0
Pigeon Hawk (Merlin)	1.0 - 2.0	1.0 - 2.0
Sparrow Hawk (Am. Kestrel)	.2 - .6	.5 - .8
Great Horned Owl	1.5 - 2.0	1.0 - 2.8
Long-eared Owl	.5 - 1.0	.5 - 1.0
Short-eared Owl	.5 - 1.0	.5 - 1.0
Barn Owl	.3 - 1.0	.3 - 1.0
Burrowing Owl	.16- .62	.20- .36

NESTING PHENOLOGY OF BIRDS OF PREY

SPECIES	Nest Building	Egg Laying	Incubation	Hatching	Fledging
Turkey Vulture		4-1 to 4-10	4-1 to 5-22	5-14 to 5-22	8-1 to 8-8
Black Vulture		3-3 tp 3-7	3-3 to 4-15	4-11 to 4-15	7-25 to 7-29
California Condor		2-23 to 2-25	2-23 to 3-22	3-20 to 3-22	9-18 to 9-20
White-tailed Kite					
Mississippi Kite	4-18 to 5-10	4-24 to 5-20	4-24 to 6-20	5-24 to 6-20	
Swallow-tailed Kite		4-15 to 5-15	4-15 to 6-9	5-6 to 6-9	
Everglade Kite				4-20 to 5-5	5-20 to 6-5
Goshawk		4-10 to 5-5	4-19 to 6-12	5-27 to 6-12	8-11 to 8-27
Cooper's Hawk	4-15 to 5-7	4-20 to 5-11	4-26 to 6-22	6-1 to 6-22	7-4 to 8-26
Sharp-shinned Hawk		5-30 to 6-15	6-8 to 7-9	7-2 to 7-9	7-26 to 8-1
Marsh Hawk	4-2 to 4-7	4-14 to 4-19	4-22 to 4-27	5-18 to 5-23	6-17 to 6-26
Rough-legged Hawk					
Ferruginous Hawk	3-10 to 3-16	3-17 to 4-1	3-21 to 5-21	4-16 to 5-21	6-4 to 7-2
Red-tailed Hawk	2-6 to 3-25	3-5 to 4-21	3-23 to 5-2	4-6 to 5-23	5-16 to 7-1
Red-shouldered Hawk	2-2 to 3-5	3-8 to 4-17	3-8 to 5-19	4-9 to 5-19	5-20 to 7-1
Swainson's Hawk	4-13 to 5-9	5-13 to 6-15	5-17 to 6-28	6-16 to 6-28	7-16 to 7-26
Broad-winged Hawk	5-7 to 5-17	5-18 to 5-25	5-22 to 5-29	6-12 to 6-23	7-11 to 7-29
Harlan's Hawk					
Harris's Hawk					
Black Hawk	3-15 to 4-15	4-15 to 5-15	5-15 to 6-10	5-20 to 6-20	6-25 to 7-25
Zone-tailed Hawk	3-25 to 4-20	4-20 to 4-27	4-24 to 5-30	5-24 to 7-1	6-20 to 7-25
White-tailed Hawk					
Short-tailed Hawk	3-10 to 4-8	3-14 to 4-10	3-16 to 4-30	4-5 to 5-1	
Gray Hawk					

NESTING PHENOLOGY OF BIRDS OF PREY

SPECIES	Nest Building	Egg Laying	Incubation	Hatching	Fledging
Golden Eagle	2-2 to 2-26	3-6 to 3-30	3-10 to 5-14	4-2 to 5-14	6-7 to 6-21
Bald Eagle	2-1 to 2-20	2-12 to 2-26	3-16 to 5-1	4-20 to 5-1	6-26 to 7-6
Osprey	4-22 to 5-31	5-21 to 6-7	5-25 to 7-10	6-23 to 7-10	7-11 to 8-1
Caracara					
Gyrfalcon		5-15 to 6-20	5-19 to 7-23	6-17 to 7-23	
Prairie Falcon		4-20 to 5-1	4-28 to 6-6	5-26 to 6-6	7-2 to 7-15
Peregrine Falcon		3-21 to 4-16	3-23 to 5-16	4-22 to 5-16	6-1 to 6-26
Merlin (Pigeon Hawk)		5-20 to 6-15	5-25 to 6-20	6-10 to 7-10	7-20 to 7-30
American Kestrel (Sparrow Hawk)	4-10 to 5-1	4-27 to 6-1	5-1 to 6-3	5-27 to 6-30	6-25 to 7-28
Aplomado Falcon					
Screech Owl	3-10 to 3-24	3-15 to 3-27	3-19 to 4-30	4-17 to 4-30	5-14 to 5-27
Great-horned Owl	1-1 to 2-30	1-20 to 4-10	1-25 to 5-12	2-27 to 5-12	3-31 to 6-17
Long-eared Owl					
Short-eared Owl	3-6 to 4-12	3-28 to 5-3	4-2 to 5-28	4-25 to 6-28	6-1 to 7-29
Barn Owl	1-6 to 4-10	2-6 to 5-18	2-14 to 6-17	3-4 to 6-17	4-28 to 7-23
Snowy Owl	5-15 to 6-1	5-25 to 6-10	5-25 to 7-12	6-25 to 7-12	7-16 to 8-5
Barred Owl		3-20 to	3-24 to	4-14 to	
Spotted Owl	3-20 to 4-10	3-30 to 4-20	4-1 to 6-2	5-5 to 6-2	
Great Gray Owl		4-4 to 6-15	4-12 to 7-12	5-17 to 7-12	
Hawk Owl		3-20 to 5-5	3-20 to 6-7	4-26 to 6-7	
Burrowing Owl	4-17 to 5-25	4-30 to 6-6	5-1 to 6-17	6-4 to 6-17	7-3 to 7-10
Boreal Owl					
Saw-whet Owl	3-2 to 4-30	4-1 to 6-7	4-1 to 7-3	4-21 to 7-3	5-21 to 8-37
Whiskered Owl					

NESTING PHENOLOGY OF BIRDS OF PREY

SPECIES	Nest Building	Egg Laying	Incubation	Hatching	Fledging
Flammulated Owl	4-22 to 5-12	5-18 to 6-4	5-20 to 7-10	6-14 to 7-10	
Pygmy Owl		4-26 to 5-10			
Elf Owl		5-15 to 5-30	5-23 to 6-23	6-6 to 6-23	
Ferruginous Owl					

RAPTOR INVENTORY DATA SHEET
[for field notebook (looseleaf)]

Observer ____________________ Nest Number ______________________

Date of Observation ________ Species __________________________

Land Ownership: P S BLM Location: T____ R______ Sec._____

Description of Nest Site:

Nest Substrate _______________

Height of Substrate __________

Height of Nest Above Ground___

Active_____ Inactive__________

No. of Eggs or Young__________

Exposure______________________

Elevation_____________________

Vegetative Type_______________

(Topographic Map)

Remarks:

(Photograph)

GPO 845-735

Exhibit 9. Colorado Natural Heritage Program Threatened and Endangered Plant Element Occurrence Field Form

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COLORADO NATURAL HERITAGE PROGRAM
T&E PLANT ELEMENT OCCURRENCE FIELD FORM
COLORADO STATE UNIVERSITY-WARNER COLLEGE OF NATURAL RESOURCES

Please submit copies of personal/agency field data forms, digital data (GIS or spreadsheet), or this field form to:
CNHP, 1475 Campus Delivery, Fort Collins, CO 80523 or Jill.Handwerk@colostate.edu (970) 491-5857
(For a list of elements tracked by CNHP, refer to http://www.cnhp.colostate.edu/download/list.asp)

Element Scientific Name: ______________________________
Survey Date: ______________ (yyyy-mm-dd)
Observer(s) Name & Affiliation: ______________________________
Observer(s) Address & Phone Number: ______________________________

Land Ownership
Owner Type: ☐ Private ☐ USFS ☐ BLM ☐ State ☐ Military ☐ Indian ☐ BuRec ☐ NPS ☐ Other:__________
Owner Name (or National Forest, BLM District, etc.): ______________________________
Owner Comments (special requests, permissions, circumstances): ______________________________
Data Sensitive Element Occurrence: ☐ Y ☐ N
If yes, list reason (i.e., landowner requests confidentiality): ______________________________

Locational Information **(REQUIRED)**
(Provide a photocopy of map with location of the occurrence marked or outlined, or a shapefile)

Surveysite Name (from 7.5' quad): ______________________________
County: _____ Elevation (range if applicable): _____ ☐ feet ☐ meters
Legal Description: Township: _____ Range: _____ Section: _____ ¼ Sec: _____
Additional T/R/S, Sections or ¼ Secs: ________________

GPS Coordinates: UTM Zone: ☐ 12 ☐ 13 Northing: __________ Easting: __________
Additional UTM coordinates: Northing: __________ Easting: __________ Northing: __________ Easting: __________
Datum: ☐ NAD27 ☐ NAD83 ☐ WGS84 ☐ Other: _____
GPS accuracy (if known): _____ ☐ autonomous(uncorrected) ☐ differentially corrected ☐ Other: __________
GPS make/model: ______________

Directions **(REQUIRED)**
Driving and hiking directions and prominent topographical features: _____

Element Occurrence Data **(REQUIRED)**
Number of Individuals (exact count, if feasible or check range below; if plants are spreading vegetatively, indicate number of aerial stems): ______________________________
1-10 ☐ 11-50 ☐ 51-100 ☐ 101-500 ☐ 501-1000 ☐ 1001-5000 ☐ 5001-10,000 ☐ 10,000+ ☐
Estimated Population Size: _____
Size of Area Covered by Population: _____ acres _____ sq ft _____ sq m
Full extent of occurrence visited/mapped: No: ☐ Yes: ☐ Comments: ______________________________
Additional EO Data Comments: ______________________________

Phenology (What percent of the observed individuals are vegetative, dormant, or in flower and fruit, note that you may have plants that are in both flower and fruit, and therefore the total % may be more than 100%. Ex. - Vegetative: 20%, Flower, 70%, Fruit: 80%, Dormant: 5%): Vegetative (leaf or bud): _____% Flower: _____% Fruit: _____% Dormant: _____%
Reproductive Success: (evidence of seed dispersal and establishment): _____
Age Classes Present: Seedling: _____% Immature: _____%Mature: _____% Senescent: _____%
Vigor: Feeble ☐ Normal ☐ Vigorous ☐
Pollinators (e.g number, types, etc.): ______________________________
Evidence of Disease, Predation, Herbivory or Injury (estimate % of individuals affected): ______________________________
Look alikes present: No: ☐ Yes: ☐ Comments on identification: ______________________________

Additional Site/Plant Condition Comments (details on productivity [vigor], health of population, degree of anthropogenic disturbance, naturalness of hydrology, and other ecological processes **within** the occurrence, not addressed above. Please provide % of occurrence affected, if known, following values for threats listed in Management Comments section): ______________________________

Landscape Context Comments (biological structure, species composition, degree of fragmentation or connectivity, and condition **of the surrounding landscape**. Please provide % of the surrounding landscape affected, if known, following values for threats listed in Management Comments section):
____

Rev. May 2008

Element Occurrence Habitat Description
Habitat in the immediate area (ex. shale barren): ____________________
Dominant Plant Community (list dominant species currently present, include age structure, and % cover if known): ________
____
Additional Associated Plant Species *(five most commonly seen with this species)*: ____________________
____

Topographic Position:
☐ Ridge Top/Interfluve ☐ Upper/High Slope ☐ Mesa or Plateau top ☐ Midslope ☐ Cliff Face/Back Slope
☐ Shelf on Cliff Face ☐ Low Slope ☐ Toe Slope ☐ Valley/Basin Floor
☐ Channel Wall ☐ Channel Bed

Aspect:
☐ Flat ☐ Variable ☐ N (338-22 degrees) ☐ NE (23-67 degrees) ☐ E (68-112 degrees)
☐ SE (113-157 degrees) ☐ S (158-202 degrees) ☐ SW (203-247 degrees) ☐ W (248-292 degrees) ☐ NW (293-337 degrees)

Slope:
☐ Flat 0% ☐ Gentle 1-6%
☐ Moderate 6-33% ☐ Steep 33-50%
☐ Very steep 50-67% ☐ Cliff 67-100%
☐ Overhanging/sheltered

Slope Shape: ☐ Concave ☐ Convex ☐ Straight ☐ Other ____________________
Light Exposure: ☐ Open ☐ Shaded ☐ Partial shade ☐ Other ____________________
Moisture: ☐ Dry ☐ Moist ☐ Saturated ☐ Inundated ☐ Seasonal Seepage ☐ Streambank ☐ Other ________
Proximity to Moisture: (for alpine sites is species influenced by snowmelt, on snow free sites or snow covered sites): ____________
____
Soil Texture: Silt ☐ Clay ☐ Loam ☐ Sand ☐ Gravel ☐ Cobble ☐ Cobble Size: ____________________
Geomorphic Landform (e.g., glaciated mountain slopes and ridges, alpine glacial valley, cirque, rolling uplands, breaklands, floodplain, cutbank, hogback, cliff, gully, canyon, etc.): ____________________

Protection Comments (Comments on any legal protection, special land designations, or strategies needed or in place.):
____

Management Comments
Threat and Management comments apply to: Entire occurrence ☐ Area surveyed ☐

Management Comments (This could include special fencing, signage and other concerns.): ____________________
____

Evidence of Threats and Disturbance (e.g. effects on population viability due to mining, recreation, grazing, exotic species; past/present/future recommendations): ____________________
____

Predominant Land Uses (recreation, grazing, open space, etc.): ____________________

Domain values for Scope of Threat (adapted from NatureServe Biotics):

High = > 60% of occurrence or area surveyed
Moderate = 20-60% of occurrence or area surveyed
Low = 5-20% of occurrence or area surveyed
Very Low = < 5% of occurrence or area surveyed
Trace + < 1% of occurrence or area surveyed
None = none observed in occurrence or area surveyed
Unknown = proportion of occurrence, or area surveyed is unknown
Null = Rank factor not assessed

Threat Categories (adapted from the Colorado Rare Plant SWAP):

Collection or other Direct Mortality Uses: High ☐ Moderate ☐ Low ☐ Very Low ☐ Trace ☐ None ☐ Unknown ☐
Comments: ____________________

Grazing: High ☐ Moderate ☐ Low ☐ Very Low ☐ Trace ☐ None ☐ Unknown ☐
Comments: ____

Recreational disturbance (motorized and non-motorized recreation): High ☐ Moderate ☐ Low ☐ Very Low ☐ Trace ☐
None ☐ Unknown ☐ Comments on type of recreational disturbance: ______________________________

Resource Extraction (mining, oil & gas drilling): High ☐ Moderate ☐ Low ☐ Very Low ☐ Trace ☐ None ☐
Unknown ☐ Comments on type of resource extraction: ______________________________________

Habitat Degradation (fragmentation, trail development, utility lines, hydrologic alteration, etc.): High ☐ Moderate ☐ Low ☐
Very Low ☐ Trace ☐ None ☐ Unknown ☐ Comments on type of habitat degradation: ______________________
____

Habitat Conversion (urban, industrial, agricultural development, etc): High ☐ Moderate ☐ Low ☐ Very Low ☐ Trace ☐
None ☐ Unknown ☐ Comments on type of habitat conversion: ______________________________________

Invasive or Exotic Species (plants, pathogens): High ☐ Moderate ☐ Low ☐ Very Low ☐ Trace ☐ None ☐ Unknown ☐
Comments on quantity (names of invasive or exotic species present , estimate % cover of each invasive species and/or ,
dominance of species at site): ____

Pollution (chemical run-off, dust, air pollution): High ☐ Moderate ☐ Low ☐ Very Low ☐ Trace ☐ None ☐ Unknown ☐
Comments on type of pollution at site: ____

Documentation
Photographs Taken: ☐ Y ☐ N Photographer: __________ Photo Number(s): ____________ Repository: __________
Specimens Taken: ☐ Y ☐ N Collector: __________ Collection Number(s): ____________ Repository: __________

Survey Effort
People hours: _____
Number of surveyors: _____
Survey time at site: _____
Extent of area surveyed: _____

Survey Method
Transect ☐ with a _____ meter separation distance
Ocular estimation ☐
Quadrat ☐ Size and number: _____
Other, describe: _____

Comments (areas needing additional surveys, how was suitable habitat identified, etc.): ____________________

General Comments (for information not captured above):
____

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