APPENDIX 2-1—DATA LIMITATIONS

This assessment included the compilation and analysis of many hundreds of individual data sets from a great number of sources; totaling approximately 10 GB of storage in reduced form. While a great number of data sets were compiled, only some were used in the assessments, while others were not. These determinations were made to illustrate what the authors felt was necessary and reasonable to include in the assessment, while minimizing superfluous data.

The following is a statement of the limitations of some of the spatial data used for analysis in this assessment. It should be noted that this statement may not be entirely complete, however an attempt was made to address all major sources of spatial data such that results from these analyses could be considered holistically. This statement includes the following topics:

- Current Vegetation
- Historic Vegetation
- Invasive Vegetation
- Vegetative Fragmentation
- Disturbance
- Altered Hydrology
- Altered Fire Regime
- Grazing
- Points of Diversion
- Geology
- Ownership
- Fish Distributions
- South West Idaho Eco-Group Data
- Urban Rural Development Class (Urban Sprawl)

Analysis of all spatial products was done utilizing Environmental Research Systems Institute (ESRI) ArcView, ArcMap, and ArcInfo software. It is notable that some coverages were continuous (e.g., vegetation) while others were not spatially continuous (e.g., grazing allotments). The analyses included intersecting and joining spatial layers and cross-tabulating attributes. Areas for polygons were calculated using the XTOOLS extension in ESRI ArcView, and the majority of tabular reports were generated in Microsoft Excel in pivot tables.

1 Current Vegetation Cover

Two data sets describing the current distribution of vegetation categories in the region were available for analysis. The first was a layer produced by ICBEMP, and the second produced by the GAP project. The ICBEMP layer did provide a seamless current vegetation coverage for the region, however after comparative analysis and data exploration, the authors of this project felt the GAP products were more representative, and thus were used in place of ICBEMP when available.

It is essential to consider that, as with any remotely derived product, there is a certain degree of uncertainty within the GAP product. In GAP, spatial and spectral resolutions, temporal constraints, cloud cover, and geometric correction accentuate this uncertainty. Thus, while it is imperative to include basal vegetation for spatial analysis, the GAP data should not be considered an ideal data set from which major decisions should be based. Instead, it should serve as a guideline for development of future projects, which in turn will improve our understanding of vegetative systems. It is important to note that GAP data was used to define the quantity of focal habitats and vegetative species distributions for this assessment.

Very little has been done to serve as a regional accuracy assessment for the GAP derived vegetation layer. In the late 1990's, field crews from the Bureau of Land Management and Pacific Northwest National Laboratories collected 1,168 field vegetation survey points and performed a first-cut accuracy assessment of the classification of GAP II vegetation in the state of Idaho (Table 1). The results demonstrate that GAP II performs respectably, producing accuracies commonly between 40% and 70%. Unfortunately, there is not a sufficient number of data points to reliably estimate the accuracy of all classes. Analysis of the data presented in Table 1 produces the accuracy summary presented in Table 2. It is notable that the Riparian classification produced an accuracy of zero percent; however, there was only one data point for comparison. It is also of note that this data point was grass, which may or may not be associated with a riparian system.

Table 1. Confidence levels for reference and classified habitat types using GAP II. Overall, 58%; khat 0.403. This table is an calculated product derived from related information provided by the BLM and is presumably very similar to original data.

		Classified							
		Shrub	**Conifer**	**Aspen**	**Juniper Pinyon**	**Grass**	**Riparian**	**Other**	**Totals**
Reference	**Shrub**	344	62	7	5	23	3	2	446
	Conifer	37	231	36	0	0	0	0	304
	Aspen	57	50	28	1	2	1	0	139
	Juniper Pinyon	25	4	0	38	0	0	0	67
	Grass	91	3	5	3	32	0	11	145
	Riparian	0	0	0	0	1	0	0	1
	Other	40	4	0	7	14	0	1	66
	Totals	594	354	76	54	72	4	14	1168

Table 2. Producer's accuracies for specified vegetation categories.

Cover Type	Producers Accuracy
Shrub	58%
Conifer	65%
Aspen	37%
Juniper/Pinyon Pine	70%
Grass	44%
Riparian	0%
Other	7%

The overall accuracy (58%) is the sum of all correct classifications divided by the count of all classifications tested. This calculation provides a broad analysis of the quality of the data set, but does not represent the quality of any one class. The Producer's accuracies illustrated in Table 2 are the estimated accuracies by class. While it is notable that there is considerable variance between class accuracies, it is also of note that there is also considerable difference between the numbers of field-validated plots (Table 1), which introduces a bias. As sample sizes increase, the certainty that the variance of the sample actually represents the variance of the data set increases. Congalton (1991) indicate that a minimum of 100 field samples per class is necessary to produce a meaningful result for geographically large data sets.

The final calculation is that of Khat, which is a measure of the probability that the resulting overall accuracy is due only to random variability (applied as a Kappa test of independence). A Khat value of 1 implies that there is no possibility that the calculations were due to chance, while a Khat value of 0 dictates that there is great probability of chance classification. The Khat value of the GAP II classification is 0.403, which is notably low and may reduce confidence in the classification.

For the state of Idaho, GAP II vegetation classifications were used. GAP II is a refinement of the original GAP vegetation classification, with finer spatial scale and assumedly higher accuracies. Where necessary, GAP classifications for other states in the region were used (Wyoming, Utah, and Nevada). Unfortunately, the different state projects did not always collaborate on processing methods and classifications systems, which resulted in products with different spatial scales and different names for the same vegetative categories. The boundaries between states are also commonly are expressed as abrupt changes in vegetative structure. Additionally, state boundaries do not always line up according to how different states performed their analyses. At times this resulted in large gaps of missing data between states. Where this occurred, the ICBEMP classification for current vegetation was utilized to fill these holes.

1.1 Data Documentation

Attribute_Accuracy_Report:
Accuracy is estimated at 67.27% (range 53.89% to 93.39%) for northern Idaho based on a scene by scene fuzzy set analysis. For southern Idaho, accuracy is estimated at 69.3% (range 63.6% to 79.3%) based on total percent correct over 9 regions.

Regarding inappropriate uses, it is far easier to identify appropriate uses than inappropriate ones. However, there is a "fuzzy line" that is eventually crossed when the differences in resolution of the data, size of geographic area being analyzed, and precision of the answer required for the question are no longer compatible. Following are several examples:

- Using the data as a "content" map for small areas (less than thousands of hectares), typically requiring mapping resolution at 1:24,000 scale and using aerial photographs or ground surveys.

- Combining GAP data with other data finer than 1:100,000 scale to produce new hybrid maps or answer queries resulting in precise measurements.

- Generating specific areal measurements from the data finer than the nearest thousand hectares. (Minimum mapping unit size and accuracy affect this precision.)

- Establishing exact boundaries for regulation or acquisition.

- Establishing definite occurrence or nonoccurrence of any feature for an exact geographic area. (For land cover, the percent accuracy will provide a measure of probability.)

- Determining abundance, health, or condition of any feature.
- Establishing a measure of accuracy of any other data by comparison with GAP data.
- Altering the data in any way and redistributing them as a GAP data product.
- Using the data without acquiring and reviewing the metadata and this report.

2 Historic Vegetation Cover

To estimate the relative degree of vegetative change (resulting from habitat or ecosystem fragmentation, urbanization, natural morphology, etc.), it was necessary to analyze a layer of historical natural vegetation cover. The layer used for this analysis was the Kuchler's Potential Natural Vegetation Polygon layer, maintained at ICBEMP. Unfortunately, there is no way to test the accuracy of a layer describing potential natural vegetation. It is assumed that this coverage is a broad overview of what an idealistic vegetative state might be like without any anthropogenic influence. The scale of these data is much larger than the scale of the GAP data used for the distribution of current vegetation. Unfortunately, the availability of regional, contiguous data sets describing potential natural vegetation is very limited, and Kuchler's classification was the best option found for spatial and temporal analysis of vegetation changes.

2.1 Data Documentation

Originator: U.S. Forest Service
Publication Date: 03/15/1995
Title: Kuchler's Potential Natural Vegetation –Polygon
Abstract: Kuchler's Potential Natural Vegetation–Polygon (1964)
Purpose: Used for analysis in Scientific Assessment of the ICBEMP.

Use Constraints

These data were intended for use at the broad-scale, generally the regional, subbasin (4th field HUC) or possibly the subwatershed (6th field HUC) level. The individual listed as contact person can answer questions concerning appropriate use of data.

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3 Invasive Vegetation

This assessment utilizes invasive species from the Idaho State Department of Agriculture and a variety of local agencies in Wyoming. While the Idaho data are statewide and contiguous, there are several limitations. Foremost is that the data were compiled by ISDA but collected by individual county weed control offices, presumably using different mapping techniques. Visual evaluation of this data set demonstrates strong biases in weed distributions as delineated by county boundaries.

The known distributions of invasive species in the State of Idaho is mapped only by dominant invasive by PLSS section. This implies that while a given section may have an abundant population of a particular invasive community, it may also have significant distributions of a second community that is not represented by this data set. Alternatively, presence of a particular invasive species may be over emphasized through the same bias.

Invasive weeds from Wyoming are not by PLSS section, but rather are represented by GPS polygons. While this distribution is more accurate for the weeds that are mapped, it omits weeds that are not inventoried using GPS that are known to exist.

These limitations effective prohibit the use of the data for area calculations or for relative impacts. They are useful to the extent that they demonstrate known occurrences of weeds, but they are by no means representative of the actually distribution of noxious weeds in any areas.

4 Vegetative Fragmentation

Vegetative fragmentation in the scope of this assessment is defined as the relative degree of fragmentation within a vegetative community, regardless of cause. The fragmentation factor utilized in this assessment was derived as part of the ICBEMP assessment.

4.1 Data Documentation

Originator: Interior Columbia Basin Ecosystem Management Project
Title: Similarity/Fragmentation Index for Succession/Disturbance and Vegetation Composition/Structure (ASMNT)
Other Citation Details: /emp/crbdb/crb/h6char/sim.dbf
Online Linkage: http://www.icbemp.gov/spatial/landchar/

Abstract

Similarity index of subwatershed succession/disturbance regime and vegetation composition/structure to historical range of variability pattern. The inverse of this similarity index provides an index of fragmentation. This is a broad-scale index classifying subwatersheds into classes of similarity to the historical landscape regime based on the system developed and described in the landscape assessment. The index is assigned to subwatersheds for the current conditions as a similarity comparison to the historical regime.

Purpose

Used for Supplemental Draft EIS and Integrated Risk Assessment analysis. At the broad-scale, summary of the classes of this variable can be used to identify how much area may be similar to the historical regime or the inverse can be used to estimate departure from the historical regime. In addition, this variable could be summarized at a 4th code HUC level to identify and assess subbasins in a similar manner. These broad-scale data should not be used to target specific subwatershed similarity or departure, since the classification is relative and has a potential error of 20%. Since classes are relative to each other, these data should be used in this context and not as an absolute calculation of conditions. For example, if one subwatershed has a given classification and the adjacent subwatershed has a different classification, the interpretation is that the one subwatershed has much higher probability of its assigned class than the other. Another way to consider this interpretation is that the absolute amount of a given class is unknown at this scale, but these data indicate that one subwatershed has much higher probability than the other of the assigned class.

This index ranks subwatersheds (6th field HUC) from 0 (lowest) to 10 (highest) based on similarity of the succession/disturbance regime, vegetation composition/structure, and landscape pattern to the historical range of variability pattern. Regional and landscape similarities of historical and current vegetation conditions, and succession/disturbance regimes are discussed on page 420 of Hann *et al.* (1997). Multiple input variables and calculations were used to classify this variable into a similarity to the historical regime. Definition and prediction of this variable is described in Hann *et al.* (1997).

Use Constraints

SIM is a single index calculated for each subwatershed based on the current or future broad- and mid-scale integrated departure from a 400-year pre-EuroAmerican settlement estimate of variation. The index calculation included integration of several variables that are listed in the Capture Methods section. Any summary of these subwatershed data to a finer stratification, such as potential vegetation group (PVG), will contain some error since multiple PVGs occur in any one subwatershed. This variable can be used to assess, identify, or correlate the general similarity or departure from the historical regime. This variable should not be used to summarize refined stratifications or small area absolute amounts similarity or departure, because of the inclusions and the generic nature of this classification.

These data were intended for use at the broad-scale, generally to summarize regional conditions, prioritize subbasins (4th field HUC), or identify large groups of subwatersheds (6th field HUC) that would contain a predominance of the conditions for the class. Data should not be used to target conditions for specific subwatersheds, because of accuracy limitations. The individual listed as the Contact Person can answer questions concerning appropriate use of data.

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Logical Consistency Report

The attributes in this data set are derived from a rule set linked to the intermediate input variables. Because these intermediate input variables are predicted, any one resulting subwatershed variable class has approximately 15 to 25% chance of error into an adjacent class and 5 to 15% chance of error to non-adjacent classes. When classes are summarized at the Basin or groups of subbasins scale, confidence in the class area summary is approximately plus or minus 10%. When classes are summarized at the subbasin scale, confidence in the class area summary is approximately plus or minus 20%. This can be improved to plus or minus 10% by grouping classes into a coarser (3 class; low, moderate, high) classification, which will improve accuracy. The classes are only applicable and accurate when considered in a relative sense to each other.

This variable should not be used to summarize absolute inferences. Confidence in correct classification of any one subwatershed compared to ground truth is estimated to be 65% (2 out of 3 chances of being right). Confidence in composition of the different classes summarized across the basin is estimated at 90% (9 out of 10 chances of being right), 85% for a group of subbasins, 80% for subwatersheds within a subbasin, and 70% for a smaller group (10 to 20) of subwatersheds.

5 Forest Management Activity

For the scope of this assessment, disturbance is defined as the change of a system from its natural state. This is important to consider for a subbasin assessment. The disturbance layer utilized in subbasin planning was derived from the ICBEMP project, and included many attributes. Of these attributes, the authors selected to only use Forest Management Activity.

Logically it would have been preferable to use GPS or higher resolution field data collections to more accurately represent timber harvest. Large logistical barriers were encountered, however, when attempting to coordinate with several government and private sector agencies as to the extent and type of timber management activities at the subbasin scale within the timeframe of this assessment. Therefore, the ICBEMP layer was utilized as the best available regional estimate of timber management activity through the subbasin.

5.1 Data Documentation

Abstract

Current Disturbance and Activities—The current time period generally reflects the current year (1999) plus or minus 5 years (i.e., 1994–2004). Developed from data and models using administrative unit data from the past 10 years as one input. Reflects the disturbance from 1988 to 1997 (10-year average). Current disturbance and activities include 10 variables of which most are expressed in relative low, moderate, and high classes. The data for these 10 variables for Forest Service and BLM lands came from administrative unit reports and wildfire reports, while data for other lands came from general resource reports and extrapolation of assumptions. Activities are planned treatments , while disturbances include unplanned effects. Planned activities include: livestock grazing measured in relative classes of animal unit months (AUMs) and range allotment restoration and maintenance (RST), which is measured in relative classes of area affected; timber and woodland harvest (HRV) and thinning (THN) measured in relative classes of area treated, while wood product volume (VOL) is measured in an approximate estimate of millions of board feet; and prescribed fire and fuel management (PRS) and prescribed natural fire (PNF), both also measured in relative classes of area treated. Two summary activity variables are provided: forest and woodland management activity (FMA) is a summary of HRV and THN, while fire activity (FAD) is a summary of PRS and PNF. The one unplanned disturbance variable is the amount of wildland fire (wildfire, WLF).

Purpose

The intent of current disturbance and activity data is to provide baseline information useful to understanding current activity and disturbance levels at the broad-scale. Future predictions of this information can be used at the broad-scale to evaluate scenarios or alternatives. The 10 disturbance and activity variables can be used to address an understanding of the relative location and relative amounts of management treatments and disturbance that are occurring currently and how those may change in the future under different scenarios or alternatives.

Use Constraints

All of the disturbance and activity variables are expressed as relative classes, except volume, which is expressed in millions of board feet. The classes are based on relativized indexes generated from actual data on acres of activity or disturbance. Consequently, the classes are only useful in a relative sense, i.e., comparing different areas or summarizing conditions within or across the whole area.

These data were intended for use at the broad-scale, generally to summarize regional levels of activities and disturbance, prioritize or plan subbasin (4th field HUC) outcomes for a given level of activity or disturbance. The individual listed as the Contact Person can answer questions concerning appropriate use of data

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Attribute Accuracy Report:

The attributes in this data set are derived from a rule set linked to the input of treatment and disturbance acre or volume data. The reported treatment and disturbance data was only spatially specific to the administrative unit. Consequently, this reported data was spatially redistributed through modeling and assumptions to a finer scale. Because of the general nature of the reported data and the extrapolation approach, any one resulting subbasin variable class has approximately 15 to 25% chance of error into an adjacent class and 5 to 15% chance of error to nonadjacent classes. When classes are summarized at the Basin or groups of subbasins scale, confidence in the class area summary is approximately plus or minus 10%. When classes are summarized at the subbasin scale, confidence in the class area summary is approximately plus or minus 20%. The classes are only applicable and accurate when considered in a relative sense to each other. The estimated timber volume has plus or minus 10% accuracy at the basin or groups of subbasin scale, which declines to plus or minus 20% for just one subbasin.

This variable should not be used to summarize absolute inferences. Confidence in correct classification of any one subbasin compared to ground truth is estimated to be 65% (2 out of 3 chances of being right). Confidence in composition of the different classes summarized across the basin is estimated at 90% (9 out of 10 chances of being right), 85% for a group of subbasins, 80% for subwatersheds within a subbasin, and 70% for a smaller group (10 to 20) of subwatersheds.

6 Altered Hydrology

As part of this subbasin assessment, it is necessary to evaluate the relationships between humans and the effect that they have on hydrologic systems. This is a very large and sweeping concept that may be impacted by factors ranging from construction of dams to urban sprawl, road construction, and timber harvest. ICBEMP performed a multivariate analysis of this type and derived an estimate of the relative impact that anthropogenic activity has effected regions in the Columbia River Basin. In this assessment, we utilized this factor, called the Hydro Human Impact factor, in our analysis.

6.1 Data Documentation

Abstract

Hydrologic Impacts Index. The hydrologic impacts index reflects the cumulative impacts from human associated developments of cropland agriculture, mining, dams, and roads. This is a broad-scale index classifying subwatersheds into classes from very low to very high relative probability of amounts of these impacts. The index is assigned to subwatersheds based on the presence or absence of substantial amounts of cropland, mines, and dams, and from road density classification.

Purpose

Used for Supplemental Draft EIS and Integrated Risk Assessment analysis. Can be used to assess the cumulative impacts from cropland, mines, dams and roads on hydrologic systems. At the broad-scale, summary of the classes of this variable can be used to identify how much area may have relatively high or low amounts of impacts.. In addition, this variable could be summarized at a 4th code HUC level to identify subbasins with levels of impact.. These broad-scale data should not be used to target specific subwatershed hydrologic or soil problems, since the very low to high type of classification is relative and has a potential error of 20%. Since classes are relative to each other, these data should be used in this context and not as an absolute calculation of conditions.

For example, if one subwatershed has a very high rating and the adjacent subwatershed has a low rating, the interpretation is that the one subwatershed has much higher probability of impact than the other. Another way to consider this interpretation is that the absolute amount of impact is unknown at this scale, but these data indicate that one subwatershed has much higher probability than the other.

These data were used for Supplemental Draft EIS and Integrated Risk Assessment analysis. The hydrologic impacts index was derived using 4 variables from the Watershed Characterization theme (ID #797, export name ATRINTRP): Cropland, Mines, Dams, and Road Class. See auxiliary metadata file (HII.PDF) to define the assignment process for the Dominant Impact variable and the Hydrologic Impact Index.

The rule set used to classify this variable into very low (L), low (L), moderate (M), or high (H) hydrologic impact index is based on logical relationships (Jenny 1980, Alexander 1988, Jensen *et al.* 1997, Megahan 1991, Rockwell 1998, Oregon State University 1993, U.S. Department of Agriculture 1993). These relationships assume that as the presence and amount of impacts of cropland, mines, dams, and roads increase the impact to hydrologic systems and soil processes accumulate through time.

The spatial distribution of the high and very high classes is concentrated in the areas of the Basin with cropland and high density roads or cropland. In contrast, the very low and low are concentrated in the areas of wilderness and roadless or rangeland with low road density. The moderate category tends to follow the areas with intermediate conditions.

Use Constraints

These data were intended for use at the broad-scale, generally to summarize regional conditions, prioritize subbasins (4th field HUC), or identify large groups of subwatersheds (6th field HUC) that would contain a predominance of the conditions for the class. Data should not be used to target conditions for specific subwatersheds, because of accuracy limitations. The individual listed as the Contact Person can answer questions concerning appropriate use of data.

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Attribute Accuracy Report

The attributes in this data set are derived from a rule set linked to the intermediate input variables. Because these intermediate input variables are predicted, any one resulting subwatershed variable class has approximately 15 to 25% chance of error into an adjacent class and 5 to 15% chance of error to non-adjacent classes. When classes are summarized at the Basin or groups of subbasins scale, confidence in the class area summary is approximately plus or minus 10%. When classes are summarized at the subbasin scale, confidence in the class area summary is approximately plus or minus 20%. This can be improved to plus or minus 10% by grouping classes into a coarser (3 class: low, moderate, high) classification, which will improve accuracy. The classes are only applicable and accurate when considered in a relative sense to each other.

This variable should not be used to summarize absolute inferences. Confidence in correct classification of any one subwatershed compared to ground truth is estimated to be 65% (2 out of 3 chances of being right). Confidence in composition of the different classes summarized across the basin is estimated at 90% (9 out of 10 chances of being right), 85% for a group of subbasins, 80% for subwatersheds within a subbasin, and 70% for a smaller group (10 to 20) of subwatersheds.

7 Altered Fire Regime

Ecosystems-at-risk (EAR) integrates ignition probability, fire weather hazard, and fire regime condition class (FRCC), based on the probability of severe fire effects. FRCC is a very large and complex data set that essentially represents how much damage might be done to any particular area in the event of a fire. Analysis of this type aids in the understanding of ecosystem health and sustainability, and when combined with data indicating how likely an area is to burn, assists in identifying areas in immanent danger of dramatic habitat changes.

7.1 Data Documentation

Entity and Attribute Overview

The fire regime condition class codes, short descriptions, and explanations follow:

Code	FRCC Description
1	Low departure—Fire regimes are within their historical range and the risk of losing key ecosystem components is low.
2	Moderate departure—At least one fire interval has been missed, or exotic species have altered native species composition (e.g., cheatgrass and blister rust). There is a moderate risk of losing key ecosystem components should a fire occur.
3	High departure—Several fire intervals have been missed, or exotic species have substantially altered native species composition (e.g., cheatgrass and blister rust). There is a high risk of losing key ecosystem components should a fire occur.
4	Moderate grass/shrub—Moderate departure in shrubland or grassland systems. At least one fire interval has been missed, or exotic species have substantially altered native species composition (e.g., cheatgrasss and blister rust). There is moderate risk of losing key ecosystem components should a fire occur.
8	Agriculture
9	Rock/barren
10	Urban
11	Water
12	Snow/ice
13	No information

We used three condition classes to qualitatively rank the departure from the historical fire-regimes. To a large extent, fire-regime condition classes were derived from a comparison of the historical fire regime and the current fire severity. To derive condition class, we simply assessed the transition between our projected current fire severity and the historical fire regime of a given site. If the evidence suggested that fire severity had changed by at least one class, then we would conclude that the condition class has a value that exceeds Class 1. In other words, we would infer that the fire effects would be something other than the effects expected if the structure and composition reflected the historical range of conditions. The greater the departure, the greater the probability that key components would be lost if a wildfire occurred.

Assumptions

We made many assumptions prior to developing the modeling rules to derive fire regime condition class:

1. The current fire severity, and consequently the condition class could only increase as a result of fire exclusion.

2 Condition Class 1 occurred if there had been no detectable change in fire severity between the historical fire regime and the current fire severity.

3. Although fire exclusion has likely resulted in an increase of the duff depth, and consequently future fires will probably be more severe, the resolution of our base data did not allow us to make inferences concerning duff depths.

4. Fire exclusion has not measurably changed fire severity of the communities within the MS3, SR1, and SR2 fire regimes. Our inability to detect change within these fire regimes is more of a function of an inappropriate scale - changes within these regimes (as well as MS2) are much better detected at a landscape scale, rather than at a stand scale. The attributes representing stand structure and composition in our database were not refined enough to detect change within these historical fire regimes.

We adjusted the FRC within tshe (western hemlock), abla4 (Subalpine Fir type 4), pial (whitebark pine), and laly (alpine larch) Potential Natural Vegetation (PNV) types to account for the potential effects of blister rust on western white pine and whitebark pine. The adjustment made to FRCC was relative to canopy cover. For example, if canopy cover = 3 (roughly 40–70%), the FRCC was changed from low to moderate. If canopy cover = 4 (roughly >70%), then FRCC was changed from low to high. We also adjusted the FRCC when broadleaf cover types occurred in coniferous forest PNVs. Since fire would likely be beneficial to aspen, the FRCC was changed to low.

Purpose

These data were designed to characterize broad scale patterns of fire regime departures for use in regional and subregional assessments. The departure of the current condition from the historical base line serves as a proxy to the potential of severe fire effects. In applying the condition class concept, we assume that historical fire regimes represent the conditions under which the ecosystem components within fire-adapted ecosystems evolved and have been maintained over time. Thus, if we projected that fire intervals and/or fire severity has changed from the historical conditions, we would expect that fire size, intensity, and burn patterns would also be subsequently altered if a fire occurred. Furthermore, we assumed that if these basic fire characteristics have changed, then it is likely that there would be subsequent effects to those ecosystem components that had adapted to the historical fire regimes. As used here, fire regime condition classes reflect the probability that key ecosystem components may be lost should a fire occur. Furthermore, a key ecosystem component can represent virtually any attribute of an ecosystem (for example, soil productivity, water quality, floral and faunal species, large-diameter trees, snags, etc.).

General Limitations

These data were designed to characterize broad scale patterns of fire-regime departures for use in regional and subregional assessments. Any decisions based on these data should be supported with field verification, especially at scales finer than 1:100,000. Although the resolution of the FRCC theme is 90-meter cell size, the expected accuracy does not warrant their use for analyses of areas smaller than about 10,000 acres (for example, assessments that typically require 1:24,000 data).

FRCC is based upon information associated to stands, i.e., stand level information. Since fire processes operate at a landscape level, it seems logical that FRCC should be derived at a landscape level instead of a stand level. However, we need to run vegetation simulation models to derive historical range of variability, which would allow FRCC to be modeled at landscape levels.

The derivation of FRCC for grassland and shrubland settings is overly simplistic at this time. Currently, there is little empirical data concerning fire regimes in non-forested settings.

Source Data

http://www.fs.fed.us/r1/cohesive_strategy/datafr.htm

8 Grazing

Two spatial coverages characterizing grazing in the subbasin were utilized in this assessment. The first was a grazing allotment coverage acquired from the ICBEMP website, used to determine type of domestic grazing. It was used because it provided contiguous grazing information compiled from various sources. The grazing data from this coverage is limited in that some records may be old our otherwise outdated, spatial accuracies are variable, and current allotment status is not always documented. These issues are not easily surmounted given the number of contributing source agencies and variability in data collection / record management. This layer was used to calculated percentages of areas grazed by animal type by watershed.

The second coverage used to evaluate grazing in the subbasin was an uncharacteristic grazing layer, also downloaded from the ICBEMP website. This layer is an indicator of the effect of grazing on a natural system, as compared to the predicted potential status of the natural system with only native ungulate grazing and browsing. This layer was used to generate the High, Moderate, and Low categories used in Appendix 3-1.

8.1 Data Documentation—Animal Type

Publication Date: 05/15/1995
Abstract: Range Allotments—Idaho
Purpose: Provide information on locations of grazing on federal lands, type of livestock, and seasonal use.

Use Constraints

These data were intended for use at the broad-scale, generally the regional, subbasin (4th field HUC), or possibly the subwatershed (6th field HUC) level. The individual listed as Contact Person can answer questions concerning appropriate use of data.

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Attribute Accuracy Report

Topology and attributes for this theme were manually checked by comparing plots of the processed data against original materials. Attribute accuracy information for source materials were not collected since acquisition of source data pre-dated FGDC metadata standards.

Completeness Report

Capture Method: Received digital files or manuscripts. Projections usually UTM (zone 10, 11, 12) or State Plane. Scales 1:24,000 to 1:126,720. Tabular data received in database format or hardcopy. Agencies/field units consulted for edits/data as needed.

Not all agencies submitted data. Received data from: Boise NF, Caribou NF, Challis NF, Clearwater NF, Idaho Panhandle NF, Nez Perce NF, Payette NF, Salmon NF, Sawtooth NF, Targhee NF, Wallowa-Whitman NF, BLM-Boise, BLM-Burley, BLM-Coeur d'Alene, BLM-Idaho Falls, BLM-Salmon, BLM-Shoshone, USFWS, Nat'l Park Service. Allotment number links the spatial and tabular data. Pastures (smaller divisions) are included in some places, but the tabular data applies at the allotment level. In merging the coverages, precedence was given to the most accurate coverage. The merged coverage was edited (eliminating slivers, etc.) and then clipped to state and CRBA boundaries to create seven state coverages.

8.2 Data Documentation—Uncharacteristic Grazing

Originator: Interior Columbia Basin Ecosystem Management Project
Title: Current Year Uncharacteristic Livestock Grazing
Other Citation Details: /emp/crbdb/crb/dst/bdbulg.dbf
Online Linkage: http://www.icbemp.gov/spatial/landchar/
Time Period of Content: 5/1/1999
Status: Progress: Complete

Purpose

The objective is to understand the cycles and relationships of current native ungulate regimes as it affects vegetative communities, as compared to the characteristics of natural (historical) ungulate regimes of the Pre-European settlement without the influence of livestock grazing.

Abstract

Uncharacteristic livestock grazing has effects outside of the normal range of effects that occurred in the historical (natural) system. The normal range is considered to be within the 400 year historic range of variability minimum +25% and maximum –25%. The 400 year period includes the variation that is predicted to occur within the recent and current climate without influence of Euro-American settlement influence. The historical regime accounts in general for influences of native species adaptations and soil development for the past 10 to 15 thousand years since the last glacial period. Some native species adaptations have evolved over the last 1 to 3 million years in response to changing paleoecological climates and disturbances.

Current time period generally reflects the current year (1999) plus or minus 5 years (i.e., 1994–2004). Developed from data and models using administrative unit data from the past 10 years as one input. Reflects the disturbance from 1988 to 1997 (10-year average).

Use Constraints

These data were intended for use at the broad-scale, generally the regional, subbasin (4th field HUC), or possibly the subwatershed (6th field HUC) level. The individual listed as contact person (Becky Gravenmier) can answer questions concerning appropriate use of data.

Attribute Definition

Description = Current Uncharacteristic Livestock Grazing Classification

VH: ≥ 0.900000001 to ≤ 1.0.

Very high probability of uncharacteristic livestock grazing in the subwatershed.

H: > 0.549471265 to 0.0.

High probability of extensive uncharacteristic livestock grazing effects in the subwatershed with considerable cumulative effects from high stocking levels in the early to mid 1900s. This level of uncharacteristic livestock grazing would likely result in negative effects to both upland and riparian systems, unless mitigated with distribution mgt. Spatial distribution highly correlated with the dry shrub PVGs.

M: ≥ 0.049981819 to < 0.549471264.

Moderate probability of extensive uncharacteristic livestock grazing effects in the subwatershed. This level of uncharacteristic livestock grazing could result in negative effects, particularly on riparian systems in steep, complex terrain, unless mitigated with distribution mgt. Spatial distribution highly correlated with the dry shrub, cool shrub, and moist forest.

L: ≥ 0.0000000002 to < 0.049981818.

Low probability of uncharacteristic livestock grazing in the subwatershed. It is unlikely that this level of uncharacteristic livestock grazing would cause extensive effects, but in steep, complex terrain could result in negative impacts on riparian systems. Spatial distribution highly correlated with the dry forest, moist forest, and cool shrub PVGs.

N: < 0.0000000001

Almost no probability of uncharacteristic livestock grazing in the subwatershed. Spatial distribution highly correlated with agricultural, urban lands, and moist forest.

9 Points of Diversion

The PODs summed in tables are actually water rights with surface water irrigation PODs associated with them. It consists of the Snake River Basin Adjudication recommended rights, the claims they are or will be processing, and any other licensed and permitted rights currently recognized. There can be more than one POD associated with a water right and vice versa, so the count is an estimate. Also, because the amount of water that can be diverted at any one time depends on available water and many other factors, no diversion rates or volumes have been given. Models are being developed for this, but these can only be verified and used in areas where there is a substantial effort at gauging the flow.

Points of diversion in across the basin may be in various states of adjudication. Until adjudicated, much of these data are as of date of the claim application in the late 1980s. Many POD locations are only accurate to the quarter-quarter or QQQ section. PODs for the state of Idaho are currently being adjudicated, and inventories are changing rapidly. It is notable that these points were acquired from IDWR in November 2003, and the database may have altered significantly since.

Diversion Rates

Also, because the amount of water that can be diverted at any one time depends on available water and many other factors, no diversion rates or volumes have been given. Models are being developed for this, but these can only be verified and used in areas where there is a substantial effort at gauging the flow. *MIKE Basin Surface Water Budget Modeling*, as well as projects by USBR, IDWR, and DHI, Inc., are examples of quantifying the amount of available water being diverted. PHabSim is an additional software approach that evaluates the effects on aquatic species.

10 Geology

Major geological features are important at the subbasin scale whereas they influence stream and slope stability, topography, stream incision, vegetative structure, and other factors. While much of the areas encompassed in creation of this assessment is mapped at a high resolution for geologic features, these records are scattered amongst several academic and governmental organizations, and many are not in formats easily utilized. Therefore, a major lithology coverage maintained by ICBEMP was used for this assessment. This coverage was intended for large scale (> 1:1000000) analysis, however for this application it was the best available data source, and since not direct decisions will be made based on high discritization of this layer, its relatively coarse resolution is considered acceptable.

10.1 Data Documentation

Citation Information

Originator: U.S. Geological Survey
Publication Date: 11/03/1995
Title: Major Lithology
Other Citation Details:
/emp/crbv/crb/min/lithm
Online Linkage:
http://www.icbemp.gov/spatial/min/

Abstract

Classification of Geologic Map Units According to their Major Lithology—The major lithologies classifications were used for the component Scientific Assessment portion of the project. Both the biophysical and economic sections utilize information provided in this data set.

Use Constraints

These data were intended for use at the broad-scale, generally the regional, subbasin (4th field HUC), or possibly the subwatershed (6th field HUC) level. The individual listed as Contact Person can answer questions concerning appropriate use of data.

Contact Information

Contact Person: Bruce Johnson
Contact Organization: U.S. Geological Survey
Contact Telephone: (509) 353-3176
Contact E-mail:
bjohnson@galileo.wr.usgs.gov
Native Data Set Environment: Computer Operating System: SUN/ARC/INFO
Filename: /emp/crbv/crb/min/lithm, Native File Size: 27.12 Mb, Export File Size: 50.22 Mb

Data Quality Information:

Topology and attributes for this theme were manually checked by comparing plots of the processed data against original materials. Attribute accuracy information for source materials were not collected since acquisition of source data pre-dated FGDC metadata standards.

State geologic maps digitized by scanning Washington, Idaho, and Montana from paper sources and Wyoming, Utah, Nevada, and California from stable base material made from publication mylars. Maps edgematched at state lines. Montana had an RMS error on transform of 965m, the rest had RMS errors<190m. Map units for each state were classified by expert team. Using the classifications, the maps were dissolved, unioned, slivers eliminated at state lines, then dissolved again. Classifications were then modified considering other geologic knowledge.

11 Ownership

Political components to this subbasin assessment are important whereas they commonly reflect land use practices and, in the case of private vs. public lands, ownership impacts the ability for management agencies to access areas for inventory or remediation purposes. For this reason, ownership was considered in this analysis at a broad scale using regional land ownership categories maintained by ICBEMP.

11.1 Data Documentation

Use Constraints

These data were intended for use at the broad-scale, generally the regional, subbasin (4th field HUC), or possibly the subwatershed (6th field HUC) level. The individual listed as Contact Person can answer questions concerning appropriate use of data.

Contact Information

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Attribute Domain Values

Enumerated Domain Value: 0

Enumerated Domain Value Definition: NOT ATTRIBUTED

Enumerated Domain Value: 11

Enumerated Domain Value Definition: FOREST SERVICE

Enumerated Domain Value: 20

Enumerated Domain Value Definition: DEPT OF DEFENSE

Enumerated Domain Value: 90

Enumerated Domain Value Definition: TRIBAL LAND

Enumerated Domain Value: 1

Enumerated Domain Value Definition: PRIVATE

Enumerated Domain Value: 80

Enumerated Domain Value Definition: STATE LAND

Enumerated Domain Value: 12

Enumerated Domain Value Definition: AGRICULTURAL RESEARCH SERVICE

12 Fish Distributions

Yellowstone cutthroat trout data used for the assessment were electrofishing surveys by various agencies, primarily relying on recent investiagions by IDFG through the Native Salmonid Assessment Project.

Estimation of fish distributions and populations is not a trivial science and has serious ramifications. It is important to note that, in this assessment, the best attempt possible was made to generate an objective and representative snapshot as to the current status of fish populations and distributions. There is obviously some degree of inherent error on both spatial and temporal scales, however it is felt that the analyses included in this assessment are representative of the most current and best estimation of distribution and status. More specific comments are referenced in the assessment text, and the authors are available for comment on their approaches.

Where appropriate, fish densities were calculated at survey locations for Yellowstone cutthroat trout. Densities were drawn from the number of fish surveyed (electrofishing) divided by the reach length, and then normalized by subbasin. Because fish density distributions are often strongly skewed toward lower densities, normalization provides a method to statistically separate low from nominal and high densities. For this assessment, low fish densities are ½ standard deviation below the mean, nominal densities are –1/2 to 1/2 standard deviations from the mean, and high densities are greater than ½ standard deviation above the mean of the normalized distribution. Normalization of data ideally forces distributions to mimic a Gaussian distribution, however due to the strong skew of fish densities, the resulting histogram is not normal in appearance. It is, however, more normal than it was before the transform and allows the data to be displayed more effectively.

13 Southwest Idaho Ecogroup Data

In 2001, the Southwest Idaho Ecogroup, made up of the Boise, Payette and Sawtooth National Forests, produced a series of ecoregional assessments for southwestern Idaho. As part of this assessment, they compiled a large amount of spatial data relative to subbasin planning and performed many high-quality analyses. While this was an excellent project, the study areas for their assessment and those for subbasin planning do not overlap, making it difficult to incorporate much of their product into subbasin planning assessments. An attempt was made to use their data as a reference to either substantiate or negate the findings of the authors in this subbasin assessment. However, large-scale implementation of their findings was very difficult to address.

Water quality integrity and geomorphic integrity were two figures that did incorporate the SWIEG data by replacing Inland West Watershed Initiative (IWWI) calls with the SWIEG calls in the 6th field HUCs covered by SWIEG. Fire perimeters and years compiled by SWIEG were also used.

14 Urban Rural Development Class (Urban Sprawl)

An assessment of how urbanization and urban sprawl are affecting natural systems could be an integral part of subbasin planning. In an attempt to constrain the effects of urban areas and their proximity to natural resources, we analyzed the Urban Rural Development Class layer maintained by ICBEMP. This layer provides a very sweeping picture of the geographic and intensity effects of population centers on nearby systems. This layer is based on a variety of older data; it is notable that there is more current information available. However, this layer was the only known source that assessed impacts of this type on a basin scale. It was not used for detailed analysis.

14.1 Data Documentation

Originator: Interior Columbia Basin Ecosystem Management Project
Publication Date: 05/30/1997
Title: Urban / Rural Classes
Other Citation Details: /emp/crbg/crb/demog/rurbclass
Online Linkage: http://www.icbemp.gov/spatial/demog/

Abstract

Urban Rural Development Class. A classification of influence to lands within the ICBEMP from human-created developments. **Purpose**: Used as one of the measures of human influence at the landscape level in the Scientific Assessment of the ICBEMP.

This theme is a general correlate for developments such as housing, roads, industry, utilities, and assorted human-created developments. Classes range from low influence to very high influence for all lands within the Basin.

Use Constraints

These data were intended for use at the broad-scale, generally the regional, subbasin (4th field HUC), or possibly the subwatershed (6th field HUC) level. The individual listed as Contact Person can answer questions concerning appropriate use of data.

Attribute Accuracy Report

This is a data set resulting from modeling or analysis. The accuracy of the attributes are dependent on the accuracy of source materials as well as the statistical accuracy of the modeling process. Attribute accuracy information for source materials were not collected since acquisition of source data pre-dated FGDC metadata standards.

Logical Consistency Report

Not applicable to raster data.

Completeness Report

These data are as complete as the source data maps: Towns DCW-1:1M Point (export name BVBTOWNB) and Road Density Predicted (export name BGBRDDN).

Originator: Intermountain Fire Science Lab - Missoula, MT
Publication Date: 02/29/1996
Title: Road Density (Predicted)
Other Citation Details: /emp/crbg/crb/culture/roaddens
Online Linkage: http://www.icbemp.gov/spatial/culture/

Originator: Census Bureau
Publication Date: 09/18/1995
Title: Towns—100k (Point)
Other Citation Details: /emp/subv/crb/demog/towns
Online Linkage: http://www.icbemp.gov/spatial/demog/

Process Description

Reclass Urban Pop Wildland Interface very high to high and very low to low; take category of towns (Yakima, Tri Cities, Spokane, Missoula, Boise, Caldwell) & assign very high class to all areas w/in 60 miles of center w/predicted road density ≥ moderate.

Attribute Domain Values

Enumerated Domain Value: 2

Enumerated Domain Value Definition: LOW—Influence from Human-Created Developments

Enumerated Domain Value: 3

Enumerated Domain Value Definition: MODERATE—Influence from Human-Created Developments

Enumerated Domain Value: 5

Enumerated Domain Value Definition: VERY HIGH—Influence from Human-Created Developments

Enumerated Domain Value: 4

Enumerated Domain Value Definition: HIGH—Influence from Human-Created Developments

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APPENDIX 2-2—KEY ECOLOGICAL FUNCTIONS OF SPECIES

A Hierarchical Classification of KEFs and KECs

I Major Assumptions with the IBIS Data set

The Northwest Habitat Institute (NHI) Interactive Biodiversity Information System (IBIS), supplied the data set used in the assessment of the key ecological functions for the wildlife species in the Upper Snake province. The data set included information from basinwide wildlife habitat maps. Vegetation maps from all or parts of seven states (Idaho, Montana, Nevada, Oregon, Utah, Washington and Wyoming) in the Columbia River Basin were used by NHI to develop the wildlife habitat maps depicting current conditions. These maps were developed to serve as an initial basis for large-scale mapping or database investigations.

Consequently, the wildlife habitat maps used in this assessment provide only an initial depiction of the amounts of wildlife habitats that may exist within watersheds, but are not of sufficient resolution for depicting the site-specific location of habitats within each watershed. Thus, wildlife habitats that occur in patch sizes less than 250 acres (i.e., linear riparian habitat) are likely underrepresented in the assessment.

Further, there has been no formal validation of the basinwide current wildlife habitat maps. Because maps are only a representation of reality and cannot depict all the detail represented in nature, some generalization is unavoidable. It is also important to not that remotely sensed maps developed from photograph interpretation or satellite imagery also contain errors.

NHI also developed a historic map by combining products from two previous works: Interior Columbia Basin Ecosystem Management Project (ICBEMP 1997) and the Oregon Biodiversity Project (Defenders of Wildlife 1998). These two mapping efforts used very different methods. The ICBEMP historic data were mostly derived from a modeling exercise, and the Oregon Biodiversity Project map was created from using surveyor notes from the 1850 land survey. Thus, the historic map is a theoretical construct with a coarse (1-km^2 pixel size) level of resolution. Wildlife habitats that are small or linear in size or shape (i.e., riparian or herbaceous wetlands) are underrepresented in the historic condition maps. In addition, no validation of the historic map was completed, and because there are no recognized historical data sets presently available, validation is difficult. Hence, the historic map best depicts gross generalizations of gains or loses of specific wildlife habitats.

IIClassification of the Key Ecological Functions (KEFs) of Wildlife

(Marcot and Vander Heyden 2001)

1. Trophic relationships
    - 1.1. heterotrophic consumer (an organism that is unable to manufacture its own food and must feed on other organisms)
        - 1.1.1. primary consumer (herbivore; an organism that feeds primarily on plant material) (also see below under Herbivory)

1.1.1.1. foliovore (leaf eater)

1.1.1.2. spermivore (seed eater)

1.1.1.3. browser (leaf, stem eater)

1.1.1.4. grazer (grass, forb eater)

1.1.1.5. frugivore (fruit eater)

1.1.1.6. sap feeder

1.1.1.7. root feeders

1.1.1.8. nectivore (nectar feeder)

1.1.1.9. fungivore (fungus feeder)

1.1.1.10. flower/bud/catkin feeder

1.1.1.11. aquatic herbivore

1.1.1.12. feeds in water on decomposing benthic substrate (benthic is the lowermost zone of a water body)

1.1.1.13. bark/cambium/bole feeder

1.1.2 secondary consumer (primary predator or primary carnivore; a carnivore that preys on other vertebrate or invertebrate animals, primarily herbivores)

1.1.2.1 invertebrate eater

1.1.2.1.1 terrestrial invertebrates

1.1.2.1.2 aquatic macroinvertebrates (e.g., not plankton)

1.1.2.1.3 freshwater or marine zooplankton

1.1.2.2 vertebrate eater (consumer or predator of herbivorous or carnivorous vertebrates)

1.1.2.2.1 piscivorous (fish eater)

1.1.2.3 ovivorous (egg eater)

1.1.3 tertiary consumer (secondary predator or secondary carnivore; a carnivore that preys on other carnivores)

1.1.4 carrion feeder (feeds on dead animals)

1.1.5 cannibalistic (eats members of its own species)

1.1.6 coprophagous (feeds on fecal material)

1.1.7 feeds on human garbage/refuse

1.1.7.1 aquatic (e.g., offal and bycatch of fishing boats)

1.1.7.2 terrestrial (e.g., garbage cans, landfills)

1.2 prey relationship

1.2.1 prey for secondary or tertiary consumer (primary or secondary predator)

2. Aids in physical transfer of substances for nutrient cycling (C,N,P, etc.)
3. Organismal relationships
    - 3.1. controls or depresses insect population peaks
    - 3.2. controls terrestrial vertebrate populations (through predation or displacement)
    - 3.3. pollination vector
    - 3.4. transportation of viable seeds, spores, plants, or animals (through ingestion, caching, caught in hair or mud on feet, etc.)
        - 3.4.1. disperses fungi
        - 3.4.2. disperses lichens
        - 3.4.3. disperses bryophytes, including mosses
        - 3.4.4. disperses insects and other invertebrates (phoresis)
        - 3.4.5. disperses seeds/fruits (through ingestion or caching)
        - 3.4.6. disperses vascular plants
    - 3.5. creates feeding, roosting, denning, or nesting opportunities for other organisms
        - 3.5.1. creates feeding opportunities (other than direct prey relations)
            - 3.5.1.1.creates sapwells in trees
        - 3.5.2. creates roosting, denning, or nesting opportunities
    - 3.6. primary creation of structures (possibly used by other organisms)
        - 3.6.1. aerial structures (typically large raptor or squirrel stick or leaf nests in trees or on platforms, or barn swallow/cliff swallow nests)
        - 3.6.2. ground structures (above-ground, nonaquatic nests and ends and other substrates, such as woodrat middens, nesting mounds of swans, for example)
        - 3.6.3. aquatic structures (muskrat lodges, beaver dams)
    - 3.7. user of structures created by other species
        - 3.7.1. aerial structures (typically large raptor or squirrel stick or leaf nests in trees or on platforms, or barn swallow/cliff swallow nests)
        - 3.7.2. ground structures (above-ground, nonaquatic nests and ends and other substrates, such as woodrat middens, nesting mounds of swans, for example)
        - 3.7.3. aquatic structures (muskrat lodges, beaver dams)
    - 3.8. nest parasite
        - 3.8.1. interspecies parasite (commonly lays eggs in nests of other species)
        - 3.8.2. common interspecific host (parasitized by other species)
    - 3.9. primary cavity excavator in snags or live trees (organisms able to excavate their own cavities)

3.10. secondary cavity user (organisms that do not excavate their own cavities and depend on primary cavity excavators or natural cavities)

3.11. primary burrow excavator (fossorial or underground burrows)

3.11.1. creates large burrows (rabbit-sized or larger)

3.11.2. creates small burrows (less than rabbit-sized)

3.12. uses burrows dug by other species (secondary burrow user)

3.13. creates runways (possibly used by other species; runways typically are worn paths in dense vegetation)

3.14. uses runways created by other species

3.15. pirates food from other species

3.16. interspecific hybridization (species known to regularly interbreed)

4. Carrier, transmitter, or reservoir of vertebrate diseases

4.1. diseases that affect humans

4.2. diseases that affect domestic animals

4.3. diseases that affect other wildlife species

5. Soil relationships

5.1. physically affects (improves) soil structure, aeration (typically by digging)

5.2. physically affects (degrades) soil structure, aeration (typically by trampling)

6. Wood structure relationships (either living or dead wood)

6.1. physically fragments down wood

6.2. physically fragments standing wood

7. Water relationships

7.1. impounds water by creating diversions or dams

7.2. creates ponds or wetlands through wallowing

8. Vegetation structure and composition relationships

8.1. creates standing dead trees (snags)

8.2. herbivory on trees or shrubs that may alter vegetation structure and composition (browsers)

8.3. herbivory on grasses or forbs that may alter vegetation structure and composition (grazers)

III Defining Habitat Elements—Key Environmental Correlates (KECs)

(O’Neil *et al.* 2001)

Site-specific habitat elements are those components of the environment believed to most influence wildlife species distribution, abundance, fitness, and viability (definition adapted from Marcot *et al*. (1997) and Mayer and Laudenslayer (1988). In this context, habitat elements include natural attributes, both biological and physical (e.g., large trees, woody debris, cliffs, and soil characteristics) as well as anthropogenic features and their effects such as roads, buildings, and pollution. Including these fine-scale attributes of an animal’s environment when describing the habitat associations for a particular species expands the concept and definition of habitat, a term widely used only to characterize the vegetative community or structural condition occupied by a species. Failing to assess and inventory habitat elements within these communities and conditions may lead to errors of commission; species may be presumed to occur when in actuality they do not. Habitat elements that influence a species negatively may preclude occupancy or breeding despite adequate floristic or structural conditions.

Traditionally defined, the term habitat is that set of environmental conditions, usually depicted as food, water, and cover, used and selected for by a given organism.

Despite this broad definition, many land management agencies use the term habitat to denote merely the vegetation conditions and/or structural or seral stages used by a particular species. However, many other environmental attributes or features influence and affect the population viability of wildlife species. Marcot *et al*. (1997) in their assessment of the terrestrial species of the Columbia River Basin emphasized the importance of examining all features that exert influence on wildlife by expanding the definition of habitat to encompass all environmental correlates, naming the entirety of these attributes key environmental correlates or KECs. All environmental scales, from broad floristic communities to fine-scale within-stand features, were included in their definition of a KEC. The word “key” in key environmental correlate refers to the high degree of influence (either positive or negative) the environmental correlates exert on the realized fitness of a given species. Nonetheless, when this information was determined, only direct relationships between the habitat element and a species were identified. Most of the habitat elements-species associations refer to mostly positive influences between the habitat elements and the species. Negative influence between habitat elements and the species may be viewed as environmental stressors; however, a comprehensive list of negative influences is not presented here.

The list of habitat elements and their definitions was derived from Marcot *et al*.1997 and was refined and edited based on the published literature and expert review. The final list comprises 287 habitat elements, including naturally occurring biological and physical elements as well as elements created or caused by human actions. Definitions are provided to characterize each element and clarify the nature of its influence on wildlife species. The following are habitat elements definitions.

1. Forest, shrubland, and grassland habitat elements

Biotic, naturally occurring attributes of forest and shrubland communities; the information that follows is for mostly positive relationships.

1.1 Forest/woodland vegetative elements or substrates. Biotic components found within a forested context.

1.1.1 Down wood. Includes downed logs, branches, and rootwads.

1.1.1.1 Decay class. A system by which down wood is classified based on its deterioration.

1.1.1.1.1 hard (class 1, 2). Little wood decay evident; bark and branches present; log resting on branches, not fully in contact with ground; includes classes 1 and 2 as described in Thomas 1979.

1.1.1.1.2 moderate (class 3). Moderate decay present; some branches and bark missing or loose; most of log in contact with ground; includes class 3 as described in Thomas 1979.

1.1.1.1.3 soft (class 4, 5). Well decayed logs; bark and branches missing; fully in contact with ground; includes classes 4 and 5 as described in Thomas 1979.

1.1.1.2 Down wood in riparian areas. Includes down wood in the terrestrial portion of riparian zones in forest habitats. Does not refer to instream woody debris.

1.1.1.3 Down wood in upland areas. Includes downed wood in upland areas of forest habitats.

1.1.2 Litter. The upper layer of loose, organic (primarily vegetative) debris on the forest floor. Decomposition may have begun, but components still recognizable.

1.1.3 Duff. The matted layer of organic debris beneath the litter layer. Decomposition more advanced than in litter layer; intergrades with uppermost humus layer of soil.

1.1.4 Shrub layer. Refers to the shrub strata within forest stands.

Biotic components found within a shrubland or grassland context (these are positive influences only).

1.2.1 Herbaceous layer. Zone of understory nonwoody vegetation beneath shrub layer (nonforest context). May include forbs, grasses.

1.2.2 Fruits/seeds/nuts. Plant reproductive bodies that are used by animals.

1.2.3 Moss. Large group of green plants without flowers but with small leafy stems growing in clumps.

1.2.4 Cactus. Any of a large group of drought resistant plants with fleshy, usually jointed stems and leaves replaced by scales or spines.

1.2.5 Flowers. A modified plant branch for the production of seeds and bearing leaves specialized into floral organs.

1.2.6 Shrubs. Plant with persistent woody stems and <16.5 feet tall; usually produces several basal shoots as opposed to a single bole.

1.2.6.1 Shrub size. Refers to shrub height.

1.2.6.1.1 small <2.0 feet

1.2.6.1.2 medium 2.0–6.5 feet

1.2.6.1.3 large 6.5–16.5 feet

1.2.6.2 Percent shrub canopy cover. Percent of ground covered by vertical projection of shrub crown diameter.

1.2.6.3 Shrub canopy layer. Within a shrub community, differences in shrub height and growth form produce multi-layered shrub canopies.

1.2.6.3.1 Subcanopy. The space below the predominant shrub crowns.

1.2.6.3.2 Above canopy. The space above the predominant shrub crowns.

1.2.7 Fungi. Mushrooms, molds, yeasts, rusts, etc.

1.2.8 Forbs. Broad-leaved herbaceous plants. Does not include grasses, sedges, or rushes.

1.2.9 Bulbs/tubers. Any underground part of a plant that functions in nutrient absorption, aeration, storage, reproduction and/or anchorage.

1.2.10 Grasses. Members of the Graminae family.

1.2.11 Cryptogamic crusts. Nonvascular plants that grow on the soil surface. Primarily lichens, mosses, and algae. Often found in arid or semiarid regions. May form soil surface pinnacles.

1.2.12 Trees (located in a shrubland/grassland context). Small groups of trees or isolated individuals.

1.2.12.1 Snags. Standing dead trees.

1.2.12.1.1 Decay class. System by which snags are classified based on their deterioration.

1.2.12.1.1.1 hard. Little wood decay evident; bark, branches, top, present; recently dead; includes class 1.

1.2.12.1.1.2 moderate. Moderately decayed wood; some branches and bark missing and/or loose; top broken; includes classes 2 and 3 as described in Brown 1985.

1.2.12.1.1.3 soft. Well-decayed wood; bark and branches generally absent; top broken; includes classes 4 and 5 as described in Brown 1985.

1.2.12.2 Snag size. Measured in dbh, as previously defined.

1.2.12.2.1 shrub/seedling <1 inch dbh

1.2.12.2.2 sapling/pole 1–9 inches dbh

1.2.12.2.3 small tree 10–14 inches dbh

1.2.12.2.4 medium tree 15–19 inches dbh

1.2.12.2.5 large tree 20–29 inches dbh

1.2.12.2.6 giant tree >30 inches dbh

1.2.12.3 Tree size. Measured in dbh, as previously defined.

1.2.12.3.1 shrub/seedling <1 inch dbh

1.2.12.3.2 sapling/pole 1–9 inches dbh

1.2.12.3.3 small tree 10–14 inches dbh

1.2.12.3.4 medium tree 15–19 inches dbh

1.2.12.3.5 large tree 20–29 inches dbh

1.2.12.3.6 giant tree >30 inches dbh

1.2.13 Edges. The place where plant communities meet or where successional stages or vegetative conditions within plant communities come together.

2. Ecological habitat elements

Selected interspecies relationships within the biotic community; they include both positive and negative influences.

2.1 Exotic species. Any nonnative plant or animal, including cats, dogs, and cattle.

2.1.1 Plants. This field refers to the relationship between an exotic plant species and animal species.

2.1.2 Animals. This field refers to the relationship between an exotic animal species and the animal species.

2.1.2.1 Predation. The species queried is preyed upon by or preys upon an exotic species.

2.1.2.2 Direct displacement. The species queried is physically displaced by an exotic species, either by competition or actual disturbance.

2.1.2.3 Habitat structure change. The species queried is affected by habitat structural changes caused by an exotic species, for example, cattle grazing.

2.1.2.4 Other. Any other effects of an exotic species on a native species.

2.2 Insect population irruptions. The species directly benefits from insect population irruptions (i.e., benefits from the insects themselves, not the resulting tree mortality or loss of foliage).

2.2.1 Mountain pine beetle. The species directly benefits from mountain pine beetle eruptions.

2.2.2 Spruce budworm. The species directly benefits from spruce budworm irruptions.

2.2.3 Gypsy moth. The species directly benefits from gypsy moth irruptions.

2.3 Beaver/muskrat activity. The results of beaver activity including dams, lodges, and ponds, that are beneficial to other species.

2.4 Burrows. Aquatic or terrestrial cavities produced by burrowing animals that are beneficial to other species.

3. Nonvegetative, Abiotic, Terrestrial Habitat Elements

Nonliving components found within any ecosystem. Primarily positive influences with a few exceptions as indicated.

3.1 Rocks. Solid mineral deposits.

3.1.1 Gravel. Particle size from 0.1–3.0 inches (0.2–7.6 cm) in diameter; gravel bars associated with streams and rivers are a separate category.

3.1.2 Talus. Accumulations of rocks at the base of cliffs or steep slopes; rock/boulder sizes varied and determine what species can inhabit the spaces between them.

3.1.3 Talus-like habitats. Refers to areas that contain many rocks and boulders but are not associated with cliffs or steep slopes.

3.2 Soils. Various soil characteristics.

3.2.1 Soil depth. The distance from the top layer of the soil to the bedrock or hardpan below.

3.2.2 Soil temperature. Any measure of soil temperature or range of temperatures that are key to the queried species.

3.2.3 Soil moisture. The amount of water contained within the soil.

3.2.4 Soil organic matter. The accumulation of decomposing plant and animal materials found within the soil.

3.2.5 Soil texture. Refers to size distribution and amount of mineral particles (sand, silt, and clay) in the soil; examples are sandy clay, sandy loam, silty clay, etc.

3.3 Rock substrates. Various rock formations.

3.3.1 Avalanche chute. An area where periodic snow or rock slides prevent the establishment of forest conditions; typically shrub and herb dominated (sitka alder, *Alnus sinuate*, and/or vine maple, *Acer circinatum*).

3.3.2 Cliffs. A high, steep formation, usually of rock. Coastal cliffs are a separate category under Marine Habitat Elements.

3.3.3 Caves. An underground chamber open to the surface with varied opening diameters and depths; includes cliff-face caves, intact lava tubes, coastal caves, and mine shafts.

3.3.4 Rocky outcrops and ridges. Areas of exposed rock.

3.3.5 Rock crevices. Refers to the joint spaces in cliffs, and fissures and openings between slab rock; crevices among rocks and boulders in talus fields are a separate category (talus).

3.3.6 Barren ground. Bare exposed soil with >40% of area not vegetated; includes mineral licks and bare agricultural fields; natural bare exposed rock is under the rocky outcrop category.

3.3.7 Playa (alkaline, saline). Shallow desert basins that are without natural drainage ways where water accumulates and evaporates seasonally.

3.4 Snow. Selected features of snow.

3.4.1 Snow depth. Any measure of the distance between the top layer of snow and the ground below.

3.4.2 Glaciers, snow field. Areas of permanent snow and ice.

4. Freshwater Riparian and Aquatic Bodies Habitat Elements

Includes selected forms and characteristics of any body of freshwater attributes. Ranges of continuous attributes that are key to the queried species, if known, will be in the comments.

4.1.1 Dissolved oxygen. Amount of oxygen passed into solution.

4.1.2 Water depth. Distance from the surface of the water to the bottom substrate.

4.1.3 Dissolved solids. A measure of dissolved minerals in water

4.1.4 Water pH. A measure of water acidity or alkalinity.

4.1.5 Water temperature. Water temperature range that is key to the queried species; if known, it is in the comments field.

4.1.6 Water velocity. Speed or momentum of water flow.

4.1.7 Water turbidity. Amount of roiled sediment within the water.

4.1.8 Free water. Water derived from any source.

4.1.9 Salinity and alkalinity. The presence of salts.

4.2 Rivers and streams. Various characteristics of streams and rivers.

4.2.1 Oxbows. A pond or wetland created when a river bend is cut off from the main channel of the river.

4.2.2 Order and class. Systems of stream classification.

4.2.2.1 Intermittent. Streams/rivers that contain nontidal flowing water for only part of the year; water may remain in isolated pools.

4.2.2.2 Upper perennial. Streams/rivers with a high gradient, fast water velocity, no tidal influence; some water flowing throughout the year, substrate consists of rock, cobbles, or gravel with occasional patches of sand; little floodplain development.

4.2.2.3 Lower perennial. Streams/rivers with a low gradient, slow water velocity, no tidal influence; some water flowing throughout the year, substrate consists mainly of sand and mud; floodplain is well developed.

4.2.3 Zone. System of water body classification based on the horizontal strata of the water column.

4.2.3.1 Open water. Open water areas not closely associated with the shoreline or bottom.

4.2.3.2 Submerged/benthic. Relating to the bottom of a body of water, includes the substrate and the overlaying body of water within 3.2 feet (1 m) of the substrate.

4.2.3.3 Shoreline. Continually exposed substrate that is subject to splash, waves, and/or periodic flooding. Includes gravel bars, islands, and immediate nearshore areas.

4.2.4 In-stream substrate. The bottom materials in a body of water.

4.2.4.1 Rocks. Rocks >10 inches (256 mm) in diameter.

4.2.4.2 Cobble/gravel. Rocks or pebbles, .1–10 inches (2.5–256 mm) in diameter, substrata may consist of cobbles, gravel, shell, and sand with no substratum type >70% cover.

4.2.4.3 Sand/mud. Fine substrata <.01 inch (1mm) in diameter, little gravel present, may be mixed with organics.

4.2.5 Vegetation. Herbaceous plants.

4.2.5.1 Submergent vegetation. Rooted aquatic plants that do not emerge above the water surface.

4.2.5.2 Emergent vegetation. Rooted aquatic plants that emerge above the water surface.

4.2.5.3 Floating mats. Unrooted plants that form vegetative masses on the surface of the water.

4.2.6 Coarse woody debris in streams and rivers. Any piece of woody material (debris piles, stumps, root wads, fallen trees) that intrudes into or lies within a river or stream.

4.2.7 Pools. Portions of the stream with reduced current velocity, often with water deeper than surrounding areas.

4.2.8 Riffles. Shallow rapids where the water flows swiftly over completely or partially submerged obstructions to produce surface agitation, but where standing waves are absent.

4.2.9 Runs/glides. Areas of swiftly flowing water, without surface agitation or waves, which approximates uniform flow and in which the slope of the water surface is roughly parallel to the overall gradient of the stream reach.

4.2.10 Overhanging vegetation. Herbaceous plants that cascade over stream and river banks and are <3.2 feet (1 m) above the water surface.

4.2.11 Waterfalls. Steep descent of water within a stream or river.

4.2.12 Banks. Rising ground that borders a body of water.

4.2.13 Seeps or springs. A concentrated flow of ground water issuing from openings in the ground.

4.3 Ephemeral pools. Pools that contain water for only brief periods of time usually associated with periods of high precipitation.

4.4 Sand bars. Exposed areas of sand or mud substrate.

4.5 Gravel bars. Exposed areas of gravel substrate.

4.6 Lakes/ponds/reservoirs. Various characteristics of lakes, ponds, and reservoirs.

4.6.1 Zone. System of water body classification based on the horizontal strata of the water column.

4.6.1.1 Open water. Open water areas not closely associated with the shoreline or bottom substrates.

4.6.1.2 Submerged/benthic. Relating to the bottom of a body of water, includes the substrate and the overlaying body of water within one meter of the substrate.

4.6.1.3 Shoreline. Continually exposed substrate that is subject to splash, waves, and/or periodic flooding. Includes gravel bars, islands, and immediate nearshore areas.

4.6.2 In-water substrate. The bottom materials in a body of water.

4.6.2.1 Rock. Rocks >10 inches (256 mm) in diameter.

4.6.2.2 Cobble/gravel. Rocks or pebbles, .1–10 inches (2.5–256 mm) in diameter, substrata may consist of cobbles, gravel, shell, and sand with no substratum type exceeding 70% cover.

4.6.2.3 Sand/mud. Fine substrata <.1 inch (2.5 mm) in diameter, little gravel present, may be mixed with organics.

4.6.3 Vegetation. Herbaceous plants.

4.6.3.1 Submergent vegetation. Rooted aquatic plants that do not emerge above the water surface.

4.6.3.2 Emergent vegetation. Rooted aquatic plants that emerge above the water surface.

4.6.3.3 Floating mats. Unrooted plants that form vegetative masses on the surface of the water.

4.6.4 Size. Refers to whether or not the species is differentially associated with water bodies based on their size.

4.6.4.1 Ponds. Bodies of water <5 acre (2 ha).

4.6.4.2 Lakes. Bodies of water >5 acre (2 ha).

4.7 Wetlands/marshes/wet meadows/bogs and swamps. Various components and characteristics related to any of these systems.

4.7.1 Riverine wetlands. Wetlands found in association with rivers.

4.7.2 Context When checked, indicates that the setting of the wetland, marsh, wet meadow, bog, or swamp is key to the queried species.

4.7.2.1 Forest. Wetlands within a forest.

4.7.2.2 Nonforest. Wetlands that are not surrounded by forest.

4.7.3 Size. When checked, indicates that the queried species is differentially associated with a wetland, marsh, wet meadow, bog, or swamp based on the size of the water body.

4.7.4 Marshes. Frequently or continually inundated wetlands characterized by emergent herbaceous vegetation (grasses, sedges, reeds) adapted to saturated soil conditions.

4.7.5 Wet meadows. Grasslands with waterlogged soil near the surface but without standing water for most of the year.

4.8 Islands. A piece of land made up of either rock and/or unconsolidated material that projects above and is completely surrounded by water.

4.9 Seasonal flooding. Flooding that occurs periodically due to precipitation patterns.

5. Marine Habitat Elements

Selected biotic and abiotic components and characteristics of marine systems - water depth, and relationship to substrate.

5.1.1 Supratidal. The zone that extends landward from the higher high water line up to either the top of a coastal cliff or the landward limit of marine process (i.e., storm surge limit).

5.1.2 Intertidal. The zone between the higher high water line and the lower low water line.

5.1.3 Nearshore subtidal. The zone that extends from the lower low water line seaward to the 65 foot (20 m) isobath, typically within 0.6 miles (1 km) of shore.

5.1.4 Shelf. The area between the 65–650 feet (20–200 m) isobath, typically within 36 miles (60 km) of shore.

5.1.5 Oceanic. The zone that extends seaward from the 650 feet (200 m) isobath.

5.2 Substrates. The bottom materials of a body of water.

5.2.1 Bedrock. The solid rock underlying surface materials.

5.2.2 Boulders. Large, worn, rocks >10 inches (256 mm) in diameter.

5.2.3 Hardpan. Consolidated clays forming a substratum firm enough to support an epibenthos and too firm to support a normal infauna (clams, worms, etc.), but with an unstable surface that sloughs frequently.

5.2.4 Cobble. Rocks or pebbles, 2.5–10 inches (64–256 mm) in diameter, may be a mix of cobbles, gravel, shells, and sand, with no type exceeding 70% cover.

5.2.5 Mixed-coarse. Substrata consisting of cobbles, gravel, shell, and sand with no substratum type exceeding 70% cover.

5.2.6 Gravel. Small rocks or pebbles, 0.2–2.5 inches (4–64 mm) in diameter.

5.2.7 Sand. Fine substrata <0.2 inch (4 mm) in diameter, little gravel present, may be mixed with organics.

5.2.8 Mixed-fine. Mixture of sand and mud particles <0.2 inch (4 mm) in diameter, little gravel present.

5.2.9 Mud. Fine substrata <0.002 inch (0.06 mm) in diameter, little gravel present, usually mixed with organics.

5.2.10 Organic. Substrata composed primarily of organic matter such as wood chips, leaf litter, or other detritus.

5.3 Energy. Degree of exposure to oceanic swell, currents, and wind waves.

5.3.1 Protected. No sea swells, little or no current, and restricted wind fetch.

5.3.2 Semi-protected. Shorelines protected from sea swell, but may receive waves generated by moderate wind fetch, and/or moderate-to-weak tidal currents.

5.3.3 Partially exposed. Oceanic swell attenuated by offshore reefs, islands, or headlands, but shoreline substantially exposed to wind waves, and/or strong-to-moderate tidal currents.

5.3.4 Exposed. Highly exposed to oceanic swell, wind waves, and/or very strong currents.

5.4 Vegetation. Includes herbaceous plants and plants lacking vascular systems.

5.4.1 Mixed macro algae. Includes brown, green, and red algae.

5.4.2 Kelp. Subaquatic rooted vegetation found in the nearshore marine environment

5.4.3 Eelgrass. Subaquatic rooted vegetation found in an estuarine environment

5.5 Water depth. Refers to the vertical layering of the water column.

5.5.1 Surface layer. The uppermost part of the water column.

5.5.1.1 Tide rip. A current of water disturbed by an opposing current, especially in tidal water or by passage over an irregular bottom.

5.5.1.2 Surface microlayer (neuston). The thin uppermost layer of the water surface.

5.5.2 Euphotic. Upper layer of a water body that receives sufficient sunlight for the photosynthesis of plants.

5.5.3 Disphotic. Area below the euphotic zone where photosynthesis ceases.

5.5.4 Demersal/benthic. Submerged lands including vegetated and unvegetated areas.

5.6 Water temperature. Measure of ocean water temperature.

5.7 Salinity. The presence and concentration of salts; salinity range that is key to the species, if it is known, will be in the comments field.

5.8 Forms. Morphological elements within marine areas.

5.8.1 Beach. An accumulation of unconsolidated material (sand, gravel, angular fragments) formed by waves and wave-induced currents in the intertidal and subtidal zones.

5.8.2 A piece of land made up of either rock and/or unconsolidated material that projects above and is completely surrounded by water at higher high water for large (spring) tide. Includes off-shore marine cliffs.

5.8.3 Marine cliffs (mainland). A sloping face steeper than 20½ usually formed by erosion and composed of either bedrock and/or unconsolidated materials.

5.8.4 Delta. An accumulation of sand, silt, and gravel deposited at the mouth of a stream where it discharges into the sea.

5.8.5 Dune. In a marine context; a mound or ridge formed by the transportation and deposition of wind-blown material (sand and occasionally silt).

5.8.6 Lagoon. Shallow depression within the shore zone continuously occupied by salt or brackish water lying roughly parallel to the shoreline and separated from the open sea by a barrier.

5.8.7 Salt marsh. A coastal wetland area that is periodically inundated by tidal brackish or salt water and that supports significant (15% cover) nonwoody vascular vegetation (e.g., grasses, rushes, sedges) for at least part of the year.

5.8.8 Reef. A rock outcrop, detached from the shore, with maximum elevations below the high-water line.

5.8.9 Tidal flat. A level or gently sloping (<5½) constructional surface exposed at low tide, usually consisting primarily of sand or mud with or without detritus, and resulting from tidal processes.

5.9 Water clarity. As influenced by sediment load.

6. (No Data)

Formerly contained topographic information, such as elevation, that has been moved to the life history matrix.

7. Fire as a Habitat Element

Refers to species that benefit from fire. The time frame after which the habitat is suitable for the species, if known, will be found in the comments field.

8. Anthropogenic Related Habitat Elements

This section contains selected examples of human-related habitat elements that may be a key part of the environment for many species. These habitat elements may have either a negative or positive influence on the queried species.

8.1 Campgrounds/picnic areas. Sites developed and maintained for camping and picnicking.

8.2 Roads. Either paved or unpaved.

8.3 Buildings. Permanent structures.

8.4 Bridges. Permanent structures typically over water or ravines.

8.5 Diseases transmitted by domestic animals. Some domestic animal diseases may be a source of mortality or reduced vigor for wild species.

8.6 Animal harvest or persecution. Includes illegal harvest/poaching, incidental take (resulting from fishing net by-catch, or by hay mowing, for example), and targeted removal for pest control.

8.7 Fences/corrals. Wood, barbed wire, or electric fences.

8.8 Supplemental food. Food deliberately provided for wildlife (e.g., bird feeders, ungulate feeding programs, etc.) as well as spilled or waste grain along railroads and cattle feedlots.

8.9 Refuse. Any source of human-derived garbage (includes landfills).

8.10 Supplemental boxes, structures and platforms. Includes bird houses, bat boxes, raptor and waterfowl nesting platforms.

8.11 Guzzlers and waterholes. Water sources typically built for domestic animal use.

8.12 Toxic chemical use. Proper use of regulated chemicals; documented effects only.

8.12.1 Herbicides/fungicides. Chemicals used to kill vegetation and fungi.

8.12.2 Insecticides. Chemicals used to kill insects.

8.12.3 Pesticides. Chemicals used to kill vertebrate species.

8.12.4 Fertilizers. Chemicals used to enhance vegetative growth.

8.13 Hedgerows/windbreaks. Woody and/or shrubby vegetation either planted or that develops naturally along fence lines and field borders.

8.14 Sewage treatment ponds. Settling ponds associated with sewage treatment plants.

8.15 Repellents. Various methods used to repel or deter wildlife species that damage crops or property (excluding pesticides and insecticides).

8.15.1 Chemical (taste, smell, or tactile). Chemical substances that repel wildlife.

8.15.2 Noise or visual disturbance. Nonchemical methods to deter wildlife.

8.16 Culverts. Drain crossings under roads or railroads.

8.17 Irrigation ditches/canals. Ditches built to transport water to agricultural crops or to handle runoff.

8.18 Powerlines/corridors. Utility lines, poles, and rights-of-way associated with transmission, telephone, and gas lines.

8.19 Pollution. Human-caused environmental contamination.

8.19.1 Chemical. Contamination caused by chemicals.

8.19.2 Sewage. Contamination caused by human waste.

8.19.3 Water. Aquatic contamination from any source.

8.20 Piers. Structures built out over water.

8.21 Mooring piles, dolphins, buoys. Floating objects anchored out in the water for nautical purposes.

8.22 Bulkheads, seawalls, revetment. Retaining structures built to protect the shoreline from wave action.

8.23 Jetties, groins, breakwaters. Structures built to influence the current or protect harbors.

8.24 Water diversion structures. Structures built to funnel or direct water, including dams, dikes and levies.

8.25 Log boom. A raft of logs lashed together either to transport the logs or as barriers to boat traffic near marinas or dams.

8.26 Boats/ships. Watercraft, either motorized or nonmotorized.

8.27 Dredge spoil islands. Sediment deposited from dredging operations.

8.28 Hatchery facilities and fish. Fish that are hatched in captivity and later released into the wild. For simplicity this refers to freshwater areas, though marine birds and mammals likely feed on hatchery released fish too. This also includes the facilities and their operation.

B Total Functional Richness

Total functional richness is an ecological functional pattern that totals the number of KEF categories in a community. Total functional richness denotes the degree of functional complexity in a community, such that the more functionally diverse communities have a greater measure of total functional richness. The total functional richness in a community also denotes the degree to which the full “functional web” of a community would be provided or conserved (Marcot and Vander Heyden, 2001).

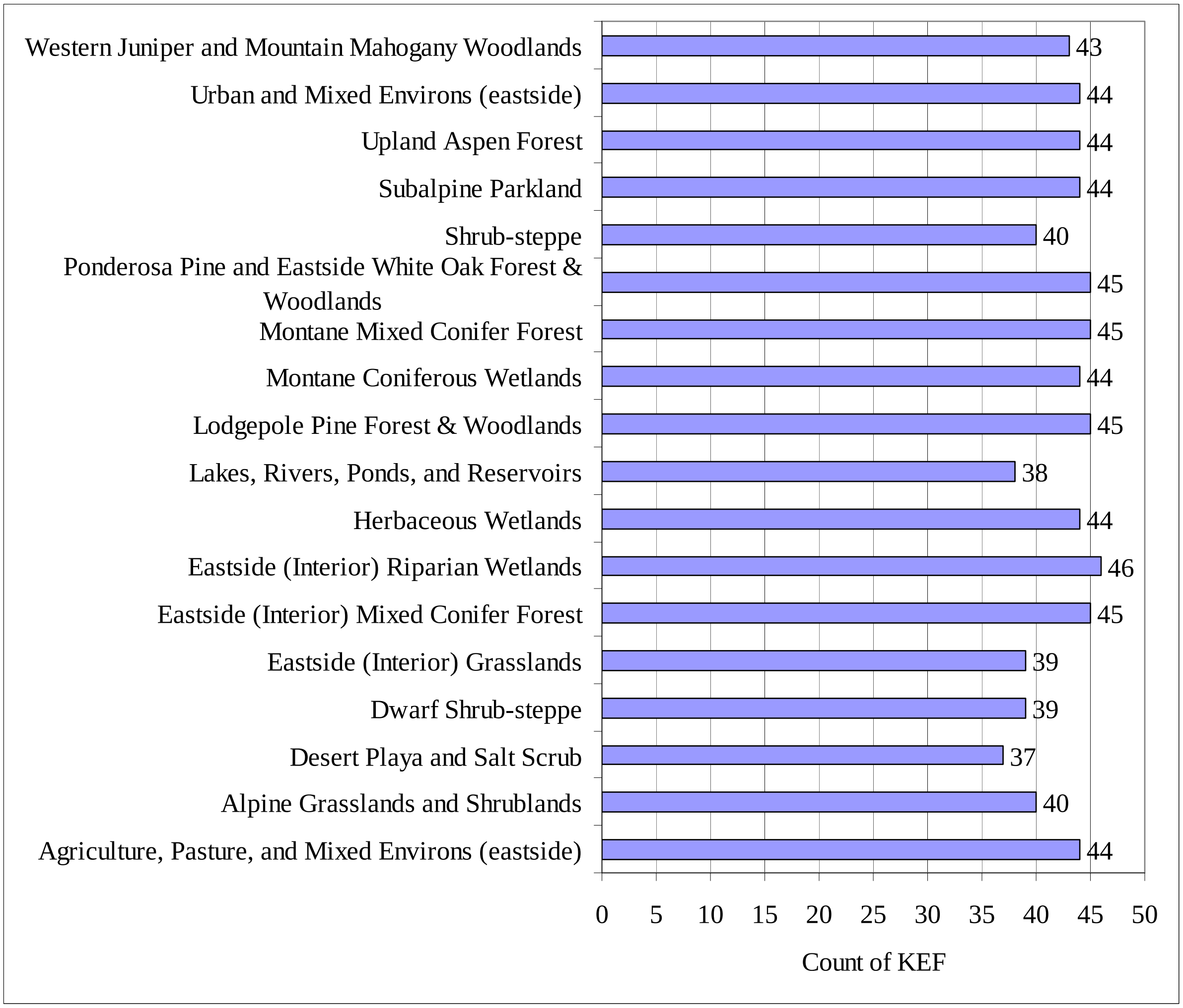

Figure 1. Total functional richness (number of KEFs) by wildlife habitat in the Upper Snake province (source: IBIS 2003).

C Wildlife Species Associated with Aquatic Environments

Table 1. Wildlife species identified as having associations with aquatic habitats in the Upper Snake province. This table was generated by searching the IBIS data set for species with category 4 KECs and then summing their respective KEFs and KECs.

Wildlife Species	KEF	KEC	Total Count
American avocet	12	4	16
American badger	1	5	6
American beaver	14	10	24
American bittern	4	2	6
American coot	8	8	16
American crow	4	7	11

Wildlife Species	KEF	KEC	Total Count
American dipper	13	2	15
American golden-plover	6	2	8
American marten	2	6	8
American tree sparrow	1	4	5
American white pelican	7	3	10
American wigeon	10	7	17
Baird’s sandpiper	13	2	15
Bald eagle	12	5	17
Band-tailed pigeon	1	3	4
Bank swallow	4	4	8
Barn owl	1	4	5
Barn swallow	2	3	5
Barred owl	3	5	8
Barrow’s goldeneye	7	5	12
Belted kingfisher	10	4	14
Bewick’s wren	1	4	5
Big brown bat	8	4	12
Black bear	2	14	16
Black swift	1	1	2
Black tern	3	8	11
Black-bellied plover	6	2	8
Black-billed magpie	1	6	7
Black-capped chickadee	1	6	7
Black-crowned night-heron	7	5	12
Black-necked stilt	11	4	15
Blue grouse	2	4	6
Blue-winged teal	7	6	13
Bobcat	1	3	4
Bobolink	1	3	4
Bonaparte’s gull	4	5	9
Bufflehead	9	5	14
Bullfrog	8	4	12
Burrowing owl	1	4	5
California gull	8	6	14
California myotis	8	3	11
California quail	1	4	5
Canada goose	8	4	12
Canvasback	15	7	22
Caspian tern	9	5	14
Cattle egret	1	5	6

Wildlife Species	KEF	KEC	Total Count
Chukar	1	4	5
Cinnamon teal	7	7	14
Clark’s grebe	6	4	10
Cliff swallow	4	3	7
Common garter snake	5	4	9
Common goldeneye	9	5	14
Common loon	5	3	8
Common merganser	12	5	17
Common nighthawk	2	1	3
Common raven	2	8	10
Common tern	4	4	8
Common yellowthroat	2	3	5
Cooper’s hawk	1	3	4
Coyote	1	8	9
Double-crested cormorant	8	5	13
Dunlin	14	2	16
Eared grebe	6	4	10
Eastern kingbird	1	5	6
Fisher	1	9	10
Forster’s tern	10	6	16
Franklin’s gull	4	7	11
Fringed myotis	6	3	9
Gadwall	8	7	15
Glaucous gull	4	6	10
Golden eagle	1	4	5
Gray partridge	1	4	5
Gray wolf	4	8	12
Great Basin spadefoot	9	7	16
Great blue heron	9	7	16
Great egret	10	6	16
Great gray owl	2	3	5
Great horned owl	1	4	5
Greater scaup	2	3	5
Greater white-fronted goose	7	7	14
Greater yellowlegs	16	2	18
Green heron	6	2	8
Green-winged teal	8	7	15
Harlequin duck	12	1	13
Herring gull	9	6	15
Hoary bat	6	3	9

Wildlife Species	KEF	KEC	Total Count
Hooded merganser	10	5	15
Horned grebe	6	4	10
Killdeer	17	5	22
Least bittern	3	5	8
Least sandpiper	15	2	17
Lesser scaup	13	7	20
Lesser yellowlegs	17	2	19
Lincoln's sparrow	1	6	7
Little brown myotis	7	3	10
Long-billed curlew	10	4	14
Long-billed dowitcher	9	2	11
Long-eared myotis	8	2	10
Long-legged myotis	8	3	11
Long-tailed vole	1	4	5
Long-toed salamander	14	6	20
Mallard	11	8	19
Marbled godwit	2	3	5
Marsh wren	4	2	6
Meadow vole	1	7	8
Merlin	2	1	3
Mink	5	7	12
Montane shrew	1	3	4
Montane vole	1	6	7
Moose	13	3	16
Mountain chickadee	1	7	8
Mountain goat	1	3	4
Mountain lion	1	4	5
Mountain quail	1	4	5
Mourning dove	4	3	7
Mule deer	2	8	10
Muskrat	9	6	15
Northern bog lemming	1	2	3
Northern goshawk	2	4	6
Northern harrier	3	2	5
Northern leopard frog	11	4	15
Northern pintail	8	7	15
Northern pocket gopher	1	4	5
Northern river otter	23	4	27
Northern rough-winged swallow	4	3	7
Northern saw-whet owl	1	2	3

Wildlife Species	KEF	KEC	Total Count
Northern shoveler	5	6	11
Northern shrike	1	2	3
Northern waterthrush	1	2	3
Osprey	7	2	9
Pacific chorus (tree) frog	9	6	15
Pacific-slope flycatcher	1	4	5
Painted turtle	8	4	12
Pallid bat	7	3	10
Pectoral sandpiper	11	2	13
Peregrine falcon	2	2	4
Pied-billed grebe	5	2	7
Pronghorn antelope	2	6	8
Purple martin	3	4	7
Raccoon	7	8	15
Red-breasted merganser	2	4	6
Red-eyed vireo	1	4	5
Redhead	13	8	21
Red-necked grebe	5	4	9
Red-necked phalarope	5	5	10
Red-tailed hawk	1	4	5
Red-winged blackbird	2	4	6
Ring-billed gull	8	7	15
Ring-necked duck	16	7	23
Ring-necked pheasant	3	4	7
Rocky Mountain bighorn sheep	1	3	4
Rocky Mountain elk	3	9	12
Ross’s goose	7	2	9
Ruddy duck	11	5	16
Ruffed grouse	3	4	7
Sandhill crane	8	7	15
Semipalmated plover	10	2	12
Semipalmated sandpiper	12	2	14
Sharp-shinned hawk	1	3	4
Sharp-tailed grouse	1	5	6
Short-billed dowitcher	9	2	11
Short-eared owl	2	2	4
Silver-haired bat	3	4	7
Snow goose	7	7	14
Snowy egret	6	5	11
Snowy plover	9	2	11

Wildlife Species	KEF	KEC	Total Count
Solitary sandpiper	10	2	12
Sora	6	6	12
Spotted bat	6	2	8
Spotted sandpiper	15	5	20
Spruce grouse	2	3	5
Stilt sandpiper	10	2	12
Striped skunk	5	7	12
Swainson’s hawk	1	2	3
Tailed frog	6	3	9
Thayer’s gull	8	5	13
Tiger salamander	9	6	15
Townsend’s big-eared bat	8	4	12
Tree swallow	1	4	5
Tricolored blackbird	1	3	4
Trumpeter swan	9	4	13
Tundra swan	8	5	13
Turkey vulture	2	1	3
Upland sandpiper	2	4	6
Violet-green swallow	2	4	6
Virginia rail	7	5	12
Water shrew	11	4	15
Water vole	5	6	11
Western grebe	6	5	11
Western harvest mouse	3	6	9
Western pipistrelle	6	2	8
Western sandpiper	14	2	16
Western screech-owl	1	2	3
Western small-footed myotis	7	3	10
Western terrestrial garter s	3	5	8
Western toad	15	5	20
White-faced ibis	5	5	10
White-tailed deer (eastside)	5	6	11
White-tailed ptarmigan	2	4	6
Whooping crane	8	7	15
Wild turkey	1	4	5
Willet	10	5	15
Wilson’s phalarope	9	6	15
Wilson’s snipe	10	4	14
Wolverine	2	2	4
Wood duck	10	6	16

Wildlife Species	KEF	KEC	Total Count
Yellow warbler	1	4	5
Yellow-billed cuckoo	5	4	9
Yellow-breasted chat	1	3	4
Yellow-headed blackbird	2	3	5
Yellow-pine chipmunk	1	6	7
Yuma myotis	7	3	10

D Critical Functional Link Species

Critical functional link species are those species that perform unique KEFs in a community. In other words, for a particular habitat or community, the critical functional link species are species that perform certain ecological functions that no other species perform.

Not all of the roles performed by critical functional link species are critical, however, such that communities would not collapse if some of these species were absent. For example, the brown-headed cowbird is identified as a critical functional link species for many habitats in the Upper Snake province because it is the only species that acts as a nest parasite (Table 2). Even though there would be impacts to communities if the brown-headed cowbird were to disappear from all the habitats it frequents, it is unlikely that the communities would collapse due to its absence. The disappearance of the brown-headed cowbird would most likely benefit communities because the reproductive success of other bird species would improve.

On the other hand, the rufous hummingbird and black-chinned hummingbird are vertebrate species that act as a pollination vectors for several habitats. If these hummingbirds were to disappear and there were no other pollinators for the plants in the communities they inhabited, then the effect could greatly alter the community habitat structure and function. In this scenario, the hummingbird species might be considered functional keystone species, such that their removal altered the structure and function of a community.

Table 2. List of species that perform critical functional roles in the Upper Snake province, Idaho (source: IBIS 2003).

Habitat	Critical Functional Link Species	KEF	KEF Description
Agriculture, pasture, and mixed environs (eastside)	American beaver	7.1	Impounds water by creating diversions or dams
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Great blue heron	3.5.2	Creates roosting, denning, or nesting opportunities
Alpine grasslands and shrublands	American pika	1.1.6	Coprophagous (feeds on fecal material)
	Black bear	6.2	Physically fragments standing wood
		8.1	Creates standing dead trees (snags)
	Deer mouse	3.7.2	Ground structures

Habitat	Critical Functional Link Species	KEF	KEF Description
	Great horned owl	3.7.1	Aerial structures
	Rocky Mountain elk	7.2	Creates ponds or wetlands through wallowing
	Rufous hummingbird	3.3	Pollination vector
Desert playa and salt scrub	Black-chinned hummingbird	3.3	Pollination vector
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Deer mouse	3.7.2	Ground structures
	Great Basin spadefoot	1.1.5	Cannibalistic
	Great horned owl	3.7.1	Aerial structures
	Mink	3.7.3	Aquatic structures
Dwarf shrub-steppe	Black bear	3.9	Primary cavity excavator in snags or live trees
		6.2	Physically fragments standing wood
		8.1	Creates standing dead trees (snags)
	Black-chinned hummingbird	3.3	Pollination vector
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Rocky Mountain elk	7.2	Creates ponds or wetlands through wallowing
Eastside (interior) grasslands	Black bear	3.9	Primary cavity excavator in snags or live trees
		8.1	Creates standing dead trees (snags)
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Grizzly bear	3.5.1	Creates feeding opportunities (other than direct prey relations)
	Mink	3.7.3	Aquatic structures
	Rocky Mountain elk	7.2	Creates ponds or wetlands through wallowing
Eastside (interior) mixed conifer forest	American beaver	3.6.3	Aquatic structures
		7.1	Impounds water by creating diversions or dams
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Red squirrel	3.5.2	Creates roosting, denning, or nesting opportunities
Eastside (interior) riparian wetlands	American beaver	7.1	Impounds water by creating diversions or dams
	Bushy-tailed woodrat	3.6.2	Ground structures
	Double-crested cormorant	4.2	Diseases that affect domestic animals
	Great blue heron	3.5.2	Creates roosting, denning, or nesting opportunities
Herbaceous wetlands	American beaver	7.1	Impounds water by creating diversions or dams

Habitat	Critical Functional Link Species	KEF	KEF Description
	Black bear	3.9	Primary cavity excavator in snags or live trees
		6.2	Physically fragments standing wood
	Double-crested cormorant	4.2	Diseases that affect domestic animals
	Great blue heron	3.5.2	Creates roosting, denning, or nesting opportunities
Lakes, rivers, ponds, and reservoirs	American beaver	7.1	Impounds water by creating diversions or dams
		7.2	Creates ponds or wetlands through wallowing
	Black tern	3.7.1	Aerial structures
	Canada goose	8.3	Herbivory on grasses or forbs that may alter vegetation structure and composition (grazers)
	Double-crested cormorant	4.2	Diseases that affect domestic animals
	Great blue heron	3.5.1	Creates feeding opportunities (other than direct prey relations)
		3.5.2	Creates roosting, denning, or nesting opportunities
	Greater scaup	3.8.2	Common interspecific host
	Moose	8.2	Herbivory on trees or shrubs that may alter vegetation structure and composition (browsers)
	Peregrine falcon	1.1.3	Tertiary consumer (secondary predator or secondary carnivore)
	Redhead	3.8.1	Interspecies parasite
Lodgepole pine forest & woodlands	American beaver	3.6.3	Aquatic structures
		7.1	Impounds water by creating diversions or dams
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Golden-mantled ground squirrel	3.4.4	Disperses insects and other invertebrates
	Mink	3.7.3	Aquatic structures
	Red squirrel	3.5.2	Creates roosting, denning, or nesting opportunities
	Snowshoe hare	1.1.6	Coprophagous (feeds on fecal material)
Montane coniferous wetlands	American beaver	3.6.3	Aquatic structures
		7.1	Impounds water by creating diversions or dams
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Bushy-tailed woodrat	3.6.2	Ground structures

Habitat	Critical Functional Link Species	KEF	KEF Description
	Common porcupine	4.3	Diseases that affect other wildlife species
	Deer mouse	3.7.2	Ground structures
	Snowshoe hare	1.1.6	Coprophagous (feeds on fecal material)
Montane mixed conifer forest	American beaver	3.6.3	Aquatic structures
		7.1	Impounds water by creating diversions or dams
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Deer mouse	3.7.2	Ground structures
	Red squirrel	3.5.2	Creates roosting, denning, or nesting opportunities
Ponderosa pine and eastside white oak forest & woodlands	American beaver	3.6.3	Aquatic structures
		7.1	Impounds water by creating diversions or dams
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Red squirrel	3.5.2	Creates roosting, denning, or nesting opportunities
	Snowshoe hare	1.1.6	Coprophagous (feeds on fecal material)
Shrub-steppe	Black-chinned hummingbird	3.3	Pollination vector
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Mink	3.7.3	Aquatic structures
	Rocky Mountain elk	7.2	Creates ponds or wetlands through wallowing
Subalpine parkland	American beaver	3.6.3	Aquatic structures
		7.1	Impounds water by creating diversions or dams
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Deer mouse	3.7.2	Ground structures
	Fisher	3.7.3	Aquatic structures
Upland aspen forest	American beaver	3.6.3	Aquatic structures
		7.1	Impounds water by creating diversions or dams
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Bushy-tailed woodrat	3.6.2	Ground structures
	Deer mouse	3.7.2	Ground structures
	Golden-mantled ground squirrel	3.4.4	Disperses insects and other invertebrates
		3.4.6	Disperses vascular plants
	Mink	3.7.3	Aquatic structures

Habitat	Critical Functional Link Species	KEF	KEF Description
Urban and mixed environs (eastside)	American beaver	7.1	Impounds water by creating diversions or dams
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Bushy-tailed woodrat	3.6.2	Ground structures
	Great blue heron	3.5.2	Creates roosting, denning, or nesting opportunities
	Great horned owl	3.7.1	Aerial structures
	Mink	3.7.3	Aquatic structures
	Nutall’s (mountain) cottontail	1.1.6	Coprophagous (feeds on fecal material)
Western juniper and mountain mahogany woodlands	American beaver	3.6.3	Aquatic structures
		7.1	Impounds water by creating diversions or dams
	Brown-headed cowbird	3.8.1	Interspecies parasite
	Golden-mantled ground squirrel	3.4.6	Disperses vascular plants
	Great Basin spadefoot	1.1.5	Cannibalistic
	Mink	3.7.3	Aquatic structures
	Nutall’s (mountain) cottontail	1.1.6	Coprophagous (feeds on fecal material)

E Functional Specialists

Species with the fewest KEFs are functional specialists and may be more vulnerable to extirpation from changes in environmental conditions supporting their ecological functions. There may be several species that perform the same function in a particular habitat, but the functional specialists are species that perform only one or two key ecological functions.

The functional specialist species in the Upper Snake province are listed in Table 3. There is a total of 60 species.

Table 3. Functional specialist species and their associated KEF count and KEC code in the Upper Snake province, Idaho (IBIS 2003). KEC codes are provided in section A.

Functional Specialist Common Name	Count of Key Environmental Correlates Under Each Major Category						Habitat Code[a]
	Category 1.0	Category 2.0	Category 3.0	Category 4.0	Category 7.0	Category 8.0	
American bittern				4			a, h
American dipper		1	1	13		2	g, h, i, o
American golden-plover		2	2	6			I
Baird's sandpiper		1	3	13		1	a, b, c, h, I
Black phoebe	4	1				3	I
Black swift	1		2	1			b, f, g, h, i, j, k, l, m, o
Black-bellied plover		2	3	6		4	c, I
Boreal owl	2					1	f, j, l, p
Brown creeper	2						a, f, g, j, k, l, m, p, q
Canyon wren			4				b, d, e, f, g, j, l, m, n, o, r
Common nighthawk		1	5	2	1	3	a, c, d, e, f, g, h, i, j, k, l, m, n, p, q, r
Common poorwill	1		3		1	1	a, c, d, e, f, i, j, m, n, r
Dunlin		2	3	14		8	h, I
Ferruginous hawk	3		2		1	1	a, c, d, e, n, r
Greater yellowlegs		1	2	16		2	a, c, d, e, g, h, i, n
Green heron	1	1		6		1	h, I
Harlequin duck	3			12		4	g, I
Least sandpiper		1	3	15		3	a, c, h, I
Lesser yellowlegs		1	2	17		2	a, c, d, e, g, h, i, n
Loggerhead shrike	3				1	4	a, c, d, e, h, n, r
Long-billed dowitcher		1	5	9		5	a, c, h, I
Long-eared myotis	5	2	6	8		10	a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, q, r
Lynx	3		1			2	b, f, j, k, l, o
Marsh wren		1		4		1	h
Masked shrew	3	1					f, g, j, k, l, m, o
Merlin	3	1		2		3	b, d, e, f, g, h, i, j, k, l, m, n, o, r
Northern bog lemming		1	1	1			f, h, j, k, l, o
Northern harrier	3		1	3	1	2	a, b, c, d, e, g, h, n, o, q

Functional Specialist Common Name	Count of Key Environmental Correlates Under Each Major Category						Habitat Code[a]
	Category 1.0	Category 2.0	Category 3.0	Category 4.0	Category 7.0	Category 8.0	
Northern pygmy-owl	1						a, f, g, h, j, k, l, m, o, q, r
Northern saw-whet owl	1		1	1		1	a, f, g, j, k, l, m, p, q, r
Northern shrike	3		1	1	1	3	a, c, d, e, h, n, r
Northern waterthrush	3			1			g
Olive-sided flycatcher	2				1		f, g, j, k, l, m, o
Osprey	4	2		7		4	a, b, f, g, i, j, l, m, n, o, q
Pectoral sandpiper		1	2	11		1	a, h, i
Peregrine falcon	4	1	3	2		3	c, d, e, f, g, h, i, j, k, l, m, n, p, r
Pied-billed grebe				5		1	g, h, I
Ringneck snake	2	3	4		1		a, m, n, q
Rock wren			7				b, c, d, e, f, m, n, o, r
Ross's goose				7			h, i
Rough-legged hawk	3		1			3	a, b, c, d, e, g, h, m, n, q, r
Sanderling		1					c, i
Semipalmated plover		2	3	10		1	c, i
Semipalmated sandpiper		1		12		4	i
Short-billed dowitcher		1	4	9		5	i
Short-eared owl	4	2	1	2	1	3	a, c, d, e, h, n
Snowy plover		1	4	9		2	i
Solitary sandpiper	2	2	2	10		4	a, c, d, e, g, h, i, n
Spotted bat	1		3	6		1	a, c, d, e, g, h, i, m, n
Stilt sandpiper		1		10		1	i
Swainson's hawk	5	1		1	1	4	a, b, c, d, e, g, h, n, r
Turkey vulture	3		6	2		3	a, b, c, d, e, f, g, h, j, k, l, m, n, o, p, q, r
Vaux's swift	2	1				1	a, f, g, h, i, j, k, l, m, o, p, q
Western pipistrelle	2		5	6		3	a, c, d, e, f, g, i, m, n, q, r
Western sandpiper		2	3	14		6	a, c, h, i

Functional Specialist Common Name	Count of Key Environmental Correlates Under Each Major Category						Habitat Code[a]
	Category 1.0	Category 2.0	Category 3.0	Category 4.0	Category 7.0	Category 8.0	
Western screech-owl	1			1		2	a, f, g, h, j, k, m, p, q, r
Western wood-pewee	2				1	2	a, f, g, l, m, o, p, q
White-throated swift			2			2	a, c, d, e, f, g, h, i, l, m, n, q, r
Winter wren	6						b, f, g, k, l, o
Wolverine			7	2		2	b, k, l, o

[a] Habitat Codes: a = agriculture, pasture, and mixed environments (eastside); b = alpine grasslands and shrublands; c = desert playa and salt scrub; d = dwarf shrub-steppe; e = eastside (interior) grasslands; f = eastside (interior) mixed conifer forest; g = eastside (interior) riparian wetlands; h = herbaceous wetlands; i = lakes, rivers, ponds, and reservoirs; j = lodgepole pine forest and woodlands; k = montane coniferous wetlands; l = montane mixed conifer forest; m = ponderosa pine and eastside white oak forest and woodlands; n = shrub-steppe; o = subalpine parkland; p = upland aspen forest; q = urban and mixed environments (eastside); r = western juniper and mountain mahogany woodlands

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APPENDIX 2-3—FOCAL HABITAT DESCRIPTIONS

1 Riparian/Herbaceous Wetlands

Geographic Distribution—Riparian and wetland habitats dominated by woody plants are found throughout the Columbia River basin. Lowland willow and other riparian shrublands are the major riparian types throughout the Upper Snake province at lower elevations. Common shrub associates include sandbar willow (*Salix exigua*), water birch (*Betula occidentalis*), yellow willow (*Salix lutea*), and Woods' rose (*Rosa woodsii*) (Tuhy and Jensen 1982, Hall and Hansen 1997, Jankovsky-Jones *et al*. 1999). Black cottonwood riparian habitats occur at low to middle elevations and develop best along large rivers, but these habitats are also present in narrow bands along small streams in the subalpine zone (Hall and Hansen 1997). Subdominant members of the overstory include narrowleaf cottonwood (*Populus angustifolia*), lanceleaf cottonwood (*P. acuminata*), and peachleaf willow (*Salix amygdaloides* var. *wrightii*).

White alder riparian habitats are restricted to perennial streams at low elevations, in drier climatic zones in Hells Canyon at the border of Oregon, Washington, and Idaho, in the Malheur River drainage, and in western Klickitat and south-central Yakima counties, Washington. Quaking aspen wetlands and riparian habitats are widespread but rarely a major component throughout the basin. Ponderosa pine–Douglas-fir riparian habitat occurs only around the periphery of the Columbia River basin in Washington and up into lower montane forests.

Physical Setting—Riparian habitats appear along perennial and intermittent rivers and streams. This habitat also appears in impounded wetlands and along lakes and ponds. Their associated streams flow along low to high gradients. The riparian and wetland forests are usually in fairly narrow bands along the moving water that follows a corridor along montane or valley streams. The most typical stand is limited to 100 to 200 ft (31–61 m) from streams. Riparian forests also appear on sites subject to temporary flooding during spring runoff. Irrigation of streamsides and toeslopes provides more water than precipitation and is important in the development of this habitat, particularly in drier climatic regions. Hydrogeomorphic surfaces along streams supporting this habitat have seasonally to temporarily flooded hydrologic regimes. Riparian and wetland habitats are found at elevations from 100 to 9,500 ft (31–2,896 m).

Landscape Setting—Riparian habitats occur along streams, seeps, and lakes within the mixed conifer forest, ponderosa pine forest and woodland, western juniper and mountain mahogany woodlands, and (part of the) shrub-steppe habitats. The riparian/herbaceous wetland habitat may be described as occupying warm montane and adjacent valley and plain riparian environments.

Structure—This habitat contains shrubland, woodland, and forest communities. Stands are closed to open canopies and often multilayered. A typical riparian habitat would be a mosaic of forest, woodland, and shrubland patches along a stream course. The tree layer can be dominated by broadleaf, conifer, or mixed canopies. Tall shrub layers, with and without trees, are deciduous and often nearly completely closed thickets. These woody riparian habitats have undergrowth of low shrubs or dense patches of grasses, sedges, or forbs. Tall shrub communities (20–98 ft [6–30 m], occasionally tall enough to be considered woodlands or forests) can be interspersed with sedge meadows or moist, forb-rich grasslands. Intermittently flooded riparian habitat has groundcover composed of steppe grasses and forbs. Rocks and boulders may be a prominent feature in this habitat.

Composition—Black cottonwood (*Populus balsamifera* ssp. *trichocarpa*), quaking aspen (*P. tremuloides*), white alder (*Alnus rhombifolia*), peachleaf willow, and in northeast Washington, paper birch (*Betula papyrifera*) are dominant and characteristic tall deciduous trees. Water birch (*B. occidentalis*), shining willow (*Salix lucida* ssp. *caudata*), and, rarely, mountain alder (*Alnus incana*) are codominant to dominant mid-size deciduous trees. Each can be the sole dominant in stands. Conifers can occur in this habitat, though rarely in abundance and more often as individual trees. The exception is ponderosa pine (*Pinus ponderosa*) or Douglas-fir (*Pseudotsuga menziesii*) that characterizes a conifer–riparian habitat in portions of the shrub-steppe zones.

A wide variety of shrubs are found in association with forest/woodland versions of this habitat. Redosier dogwood (*Cornus sericea*), mountain alder, gooseberry (*Ribes* spp.), rose (*Rosa* spp.), common snowberry (*Symphoricarpos albus*), and Drummond's willow (*Salix drummondii*) are important shrubs in this habitat. Bog birch (*B. nana*) and Douglas spiraea (*Spiraea douglasii*) can occur in wetter stands. Redosier dogwood and common snowberry are shade tolerant and dominate stand interiors, while these shrubs and others occur along forest or woodland edges and openings. Mountain alder is frequently a prominent shrub, especially at middle elevations. Tall shrubs (or small trees) often growing under or with white alder include chokecherry (*Prunus virginiana*), water birch, shining willow, and netleaf hackberry (*Celtis reticulata*).

Shrub-dominated communities contain most of the species associated with tree communities. Willow species (*Salix bebbiana*, *S. boothii*, *S. exigua*, *S. geyeriana*, or *S. emmonii*) dominate many sites. Mountain alder can be dominant and is at least codominant at many sites. Chokecherry, water birch, Saskatoon serviceberry (*Amelanchier alnifolia*), black hawthorn (*Crataegus douglasii*), and redosier dogwood can also be codominant to dominant. Shorter shrubs, such as Woods' rose, spiraea, snowberry, and gooseberry, are usually present in the undergrowth.

The herb layer is highly variable and composed of an assortment of graminoids and broadleaf herbs. Native grasses (*Calamagrostis canadensis*, *Elymus glaucus*, *Glyceria* spp., and *Agrostis* spp.) and sedges (*Carex aquatilis*, *C. angustata*, *C. lanuginosa*, *C. lasiocarpa*, *C. nebrascensis*, *C. microptera*, and *C. utriculata*) are significant in many habitats. Kentucky bluegrass (*Poa pratensis*) can be abundant in areas that were heavily grazed in the past. Other weedy grasses, such as orchard grass (*Dactylis glomerata*), reed canarygrass (*Phalaris arundinacea*), timothy (*Phleum pratense*), bluegrass (*Poa bulbosa* and *P. compressa*), and tall fescue (*Festuca arundinacea*), often dominate disturbed areas. A short list of the great variety of forbs that grow in this habitat includes Columbian monkshood (*Aconitum columbianum*), alpine leafybract aster (*Aster foliaceus*), ladyfern (*Athyrium filix-femina*), field horsetail (*Equisetum arvense*), cow parsnip (*Heracleum maximum*), skunkcabbage (*Lysichiton americanus*), arrowleaf groundsel (*Senecio triangularis*), stinging nettle (*Urtica dioica*), California false hellebore (*Veratrum californicum*), American speedwell (*Veronica americana*), and pioneer violet (*Viola glabella*).

Other Classifications and Key References—Cowardin *et al*. (1979) called this habitat palustrine scrub-shrub and forest.

Other references that describe this habitat are Daubenmire 1970, Miller 1976, Manning and Padgett 1992, Kovalchik 1993, Christy and Titus 1996, and Crowe and Clausnitzer 1997. This habitat occurs in both lotic and lentic systems and is represented as riparian and wetland areas in the Idaho gap analysis (Scott *et al*. 2002) and as palustrine forest, palustrine shrubland, and palustrine emergent in the National Wetland Inventory (NWI).

Natural Disturbance Regime—This habitat is tightly associated with stream dynamics and hydrology. Flood cycles occur within 20 to 30 years in most riparian shrublands, although flood regimes vary among stream types. Fires recur typically every 25 to 50 years, but fire can be nearly absent in colder regions or on topographically protected streams. Rafted ice and logs in freshets may cause considerable damage to tree boles in mountain habitats. Beavers crop younger cottonwood and willows and frequently dam side channels in these stands. These forests and woodlands require various flooding regimes and specific substrate conditions for reestablishment. Grazing and trampling is a major influence in altering structure, composition, and function of this habitat; some portions are very sensitive to heavy grazing.

Succession and Stand Dynamics—Riparian vegetation undergoes "typical" stand development that is strongly controlled by a site's conditions immediately following flooding and shifts in hydrology, or its "initial condition." The initial condition of any hydrogeomorphic surface is made up of the plants that survived the disturbance, the plants that can get to the site, and the amount of unoccupied habitat that is available for plant invasions. These factors select the species that can survive or grow at the site. Subsequent or repeated floods, or other influences on the initial condition, also affect that selection of species. A typical woody riparian habitat dynamic is the invasion of woody and herbaceous plants onto a new alluvial bar away from the main channel. If the bar is not scoured in 20 years, a tall shrub and small deciduous tree stand develops. Approximately 30 years without disturbance or change in hydrology allows trees to overtop shrubs and form woodland. Another 50 years without disturbance allows conifers to invade, and in another 50 years, a mixed hardwood–conifer stand develops. Many deciduous tall shrubs and trees cannot be invaded by conifers. Each stage can be reinitiated, held in place, or shunted into different vegetation by changes in stream or wetland hydrology, fire, grazing, or an interaction of those factors.

Effects of Management and Anthropogenic Impacts—Management effects on woody riparian vegetation can be obvious (e.g., removal of vegetation by dam construction, roads, or logging), or they can be subtle (e.g., removing beavers from a watershed, removing large woody debris, or constructing a weir dam for fish habitat). In general, excessive livestock or native ungulate use leads to less woody cover and an increase in sod-forming grasses, particularly on fine-textured soils. Undesirable forb species, such as stinging nettle and horsetail, increase with livestock use.

Status and Trends—Quigley and Arbelbide (1997) concluded that the cottonwood–willow cover type covers significantly less area now than it did before 1900 in the Inland Pacific Northwest. The authors also concluded that, although riparian shrubland had been a minor part of the landscape, occupying 2%, it had since declined to 0.5% of the landscape. Before 1900, approximately 40% of riparian shrublands occurred above 3,280 ft (1,000 m); now, nearly 80% is found above that elevation. This change reflects losses to agricultural development, roads, and dams and other flood-control activities. The current riparian shrublands contain many exotic plant species and generally are less productive than they were historically. Quigley and Arbelbide (1997) found that riparian woodland was always rare and that the change in extent from the past is substantial.

2 Open Water

Geographic Distribution—Lakes in Idaho occur statewide and are found from 234 m to about 3,302 m above sea level. There are over 5,000 lakes and reservoirs in Idaho, of which 1,228 have been named. They total 265,822 hectares (ha). The largest and deepest lake in Idaho is Lake Pend Oreille at 38,331 ha and 347 m deep.

Streams and rivers are distributed statewide in Idaho, forming a continuous network connecting high mountain areas to lowlands. There are thousands of named rivers and streams in Idaho, totaling 133,055 km. Idaho has areas of both substantial and negligible topographic relief due to geographic and geologic features creating rivers, creeks, and lakes. Several major river systems cross Idaho and two large rivers are contained completely within the state. The single most unifying geographical feature is the Snake River, which has its source in the mountains of Yellowstone National Park and meanders west to the Oregon border and then north to Hells Canyon, where it joins the Salmon River, continues north to Lewiston where the Clearwater enters, and heads west to join the Columbia River. The river is more than 1,609 km long and drains more than 258,998 km^2 of country. The Snake River carries 40 million acre-feet of water and drops more than 2,133 m in elevation by the time it empties into the Columbia River (Digital Atlas of Idaho 2003).

The Snake River system contains many canyons along its expanses across Idaho. The Snake runs through a canyon fifty miles long as it enters Idaho from Wyoming. Several rivers and tributaries flow into the Snake and enter through their own canyons. Blue Lakes Canyon is on the Snake River five miles below Shoshone Falls near the city of Twin Falls. Blue Lakes Canyon contains farmland and a country club along the Snake River almost 152 m straight down from the desert floor. The Hagerman Valley is another interesting segment of the winding Snake River containing a grand canyon. This valley is a wide canyon having a high, steep north wall that issues beautiful flowing springs called Thousand Springs. Here, millions of gallons of water gush from the rocky canyon wall and cascade into the Snake River. Hydrologists infer that the water source is the Big Lost Sinks where the Big and Little Lost river's disappear into the lava beds near Arco about 240 km northeast of Hagerman Valley (Digital Atlas of Idaho 2003).

The most well-known part of the Snake River Canyon, however, is between Idaho and Oregon. It is Hells Canyon, the Grand Canyon of the Snake, or Seven Devils Canyon. It is 2,407 m from the bottom of the canyon to the top of Devil Peak. This makes it the deepest gorge in North America. It is about 685 m deeper than the Grand Canyon of the Colorado River in Arizona (Digital Atlas of Idaho 2003).

In addition to deep canyon gorges, the Snake River also has several important waterfalls as a result of sudden regional changes in elevation. These include the spectacular Shoshone Falls, which boasts 64 m of relief, 16 m more than Niagara. Other waterfalls in the state include Big Fiddler Creek, which has one of the highest falls in Idaho at 186 m high. It is on the South Fork Boise River above Arrowrock Dam. Moyie Falls on the Moyie River near Bonners Ferry, Idaho, is noted for its stone formations, which make the water seem to be full of colored glass crystals. Several towns in Idaho are named after waterfalls: American Falls, Idaho Falls, Post Falls, and Twin Falls (Digital Atlas of Idaho 2003).

The untamed and imposing Salmon River-“River of No Return”-winds 684 km through the mountains of central Idaho, its canyon gorge deeper than the Grand Canyon of the Colorado. It flows through the Sawtooth Wilderness Area and finally joins the Snake River about 50 miles south of Lewiston. A spawning stream for Pacific salmon, it is one of the longest and most rugged rivers lying wholly within one state (Digital Atlas of Idaho 2003).

The Boise, Payette, and Weiser rivers flow into the Snake River in southwestern Idaho as it forms the Oregon–Idaho border. In addition, there are many shorter tributaries of the Snake River in southern Idaho (Digital Atlas of Idaho 2003).

Rivers and streams in Idaho are fed by rain and located in areas with terrain of varying stability. Rivers and streams composed of sheared bedrock have high suspended-sediment loads. Beds composed of gravel and sand are easily transported during floods. Rivers and streams composed of volcanically derived bedrock are more stable. They have low sediment-transport rates and stable beds composed largely of cobbles and boulders, which move only during extreme events (Everest *et al*. 1987).

Physical Setting—Continental glaciers melted and left depressions where water accumulated and formed many lakes in the region. Many of Idaho’s lakes are actually reservoirs formed behind the numerous dams on the state’s waterways. Dams are constructed to store water for irrigation, generate hydroelectric power, and keep floodwater from destroying farms and cities.

All areas of Idaho undergo the transition through the four seasons, but the seasons manifest differently according to geographic location. Idaho has three main geographic provinces: mountains, valleys, and plains. There is little difference in climate between the mountains and the valleys, except that the mountains shelter valleys, resulting in a moderated climate compared with that in the mountains.

The plains are semiarid flatlands that have nearly equal amounts of precipitation and evaporation. Annual highs and lows, or seasonal extremes, also vary greatly, resulting in bone-chilling winters and blistering summers.

January is the coldest month of the year in Idaho, usually having average temperatures below freezing. Some areas have temperatures well below zero through much of the winter. The record low in Idaho is −51 °C, recorded at the Island Park Dam in 1943. Temperatures routinely drop to −28 °C in mountainous northern and eastern Idaho. Snowfall is often heavy in these areas, and the annual precipitation from snow and rain is between 50 and 89 cm, respectively. However, the average annual precipitation for Idaho is 31.6 cm, a result of the very dry conditions existing on the plains.

Landscape Setting—This habitat occurs throughout Idaho. Ponds, lakes, and reservoirs are typically adjacent to herbaceous wetlands, while rivers and streams typically adjoin the riparian wetlands or herbaceous wetlands.

Structure—There are four distinct zones within this aquatic system: 1) the littoral zone at the edge of lakes is the most productive with diverse aquatic beds and emergent wetlands (part of herbaceous wetland’s habitat); 2) the limnetic zone is deep open water, dominated by phytoplankton and freshwater fish, and extends down to the limits of light penetration; 3) the profundal zone below the limnetic zone is devoid of plant life and dominated with detritivores; and 4) the benthic zone reflecting bottom soil and sediments. Nutrients from the profundal zone are recycled back to upper layers by the spring and fall turnover of the water. Water in temperate climates stratifies because of the changes in water density. The uppermost layer, the epilimnion, is where water is warmer (less dense). Next, the metalimnion or thermocline is a narrow layer that prevents the mixing of the upper- and lowermost layers. The lowest layer is the hypolimnion, with colder and denser waters. During the fall turnover, the cooled upper layers are mixed with other layers through wind action.

Other Classifications and Key References—This habitat is called riverine and lacustrine in Anderson *et al.* (1998), Cowardin *et al.* (1979), Mayer and Laudenslayer (1988), and Wetzel (1983). However, it is referred to as open water in the Idaho gap analysis (Scott *et al.* 2002).

Natural Disturbance Regime—There are seasonal and decadal variations in the patterns of precipitation. The majority of the precipitation occurs in the form of snow at the higher elevations. The snowmelt-driven flow regimes result in low water levels in fall and winter and high water levels during spring and early summer. High-elevation lands with deeper snowpacks generate peak runoff beginning in late April and lasting until late May. Floods occur in Idaho every year. Flooding season generally occurs during late winter and early spring and is typically caused by melting snow. The amount of flooding depends on how fast the snow melts. Significant flooding may result from cloudbursts caused by thunderstorms, primarily during the summer months, but cloudbursts may occur throughout the year.

Effects of Management and Anthropogenic Impacts—Sewage effluents and agricultural runoff can cause significant eutrophication to water bodies such as occurred at Cascade Reservoir (Zimmer 1983). The situation has improved with public education, cleanup efforts, and planning (USBOR 2002).

Removal of gravel results in reduction of spawning areas for anadromous fish. Overgrazing and loss of vegetation caused by logging produce increased water temperatures and excessive siltation, harming the invertebrate communities (Mac *et al.* 1998). Incorrectly installed culverts may act as barriers to migrating fish and contribute to erosion and siltation downstream (Phinney and Bucknell 1975). Construction of dams is associated with changes in water quality, loss of fish passage, competition between species, loss of spawning areas because of flooding, and declines in native fish populations (Mac *et al.* 1998). Historically, the region's rivers contained more braided multi-channels. Flood-control measures—such as channel straightening, diking, or removal of streambed material, along with urban and agriculture development—have all contributed to a loss of oxbows, river meanders, and floodplains. Unauthorized or overappropriated withdrawals of water from the natural drainages have also caused a loss of open water habitat that has been detrimental to fish and wildlife production, particularly in the summer (Phinney and Bucknell 1975).

Agricultural, industrial, and sewage runoff such as salts, sediments, fertilizers, pesticides, and bacteria harm aquatic species (Mac *et al.* 1998). Sludge and heavy waste buildup in estuaries is harmful to fish and shellfish. Unregulated aerial spraying of pesticides over agricultural areas also poses a threat to aquatic and terrestrial life (IDEQ and ODEQ 2001). Clearcut logging can alter snow accumulation and increase the size of peak flows during times of snowmelt (Sullivan *et al.* 1987). Clearcutting and vegetation removal affects the temperatures of streams, increasing them in the summer and decreasing them in winter. Building of roads, especially those of poor quality can be a major contributor to sedimentation in the streams (Everest *et al*. 1987).

Status and Trends—The principal trend has been in relationship to dam building or channelization for hydroelectric power, flood control, or irrigation purposes.

3 Shrub-Steppe

Geographic Distribution—Shrub-steppe habitats are common across the Columbia Plateau of Washington, Oregon, Idaho, as well as in adjacent Wyoming, Utah, and Nevada. This habitat type extends up into the cold, dry environments of surrounding mountains.

Basin big sagebrush shrub-steppe occurs along stream channels and in valley bottoms and flats throughout Idaho. Wyoming sagebrush shrub-steppe is the most widespread habitat, occurring throughout the Columbia Plateau and the northern Great Basin. Mountain big sagebrush shrub-steppe habitat occurs throughout the mountains of Idaho. Bitterbrush shrub-steppe habitat appears primarily in the southern portion of Idaho. Interior shrub dunes and sandy steppe and shrub-steppe habitat is concentrated at low elevations in isolated pockets in the Owyhee Uplands.

Physical Setting—Generally, this habitat is associated with dry, hot environments in the Pacific Northwest, although variants appear in cool, moist areas with some snow accumulation in climatically dry mountains. Elevation range is wide (300–9,000 ft [91–2,743 m]), with most habitats occurring between 2,000 and 6,000 ft (610–1,830 m). Habitat occurs on deep alluvial, loess, silty, or sandy-silty soils on stony flats, ridges, mountain slopes, or slopes of lakebeds with ash or pumice soils.

Landscape Setting—Shrub-steppe habitat defines a biogeographic region and is the major vegetation on average sites in the Columbia Plateau, usually below ponderosa pine forest and woodland and below western juniper and mountain mahogany woodland habitats. It forms mosaic landscapes with these woodland habitats and grasslands, dwarf shrub-steppe, and desert playa and salt scrub habitats. Mountain big sagebrush shrub-steppe occurs at high elevations, occasionally within the dry mixed conifer forest and montane mixed conifer forest habitats. Shrub-steppe habitat can appear in large landscape patches. Livestock grazing is the primary land use in the shrub-steppe, although much has been converted to irrigation or dryland agriculture. Large areas occur in military training areas and wildlife refuges.

Structure—This habitat is a shrub savanna or shrubland with shrub coverage of 10 to 60%. In an undisturbed condition, shrub cover varies between 10 and 30%. Shrubs are generally evergreen, although deciduous shrubs are prominent in many habitats. Shrub height is typically medium tall (1.6–3.3 ft [0.5–1.0 m]), although some sites support shrubs approaching 9 ft (2.7 m). Vegetation structure in this habitat is characteristically an open shrub layer over a moderately open to closed bunchgrass layer. The more northern or productive sites generally have a denser grass layer and sparser shrub layer than southern or more xeric sites do. In fact, the rare site in good condition is better characterized as grassland with shrubs than as shrubland. The bunchgrass layer may contain a variety of forbs. Good-condition habitat has very little exposed bare ground: mosses and lichens carpet the area between taller plants. However, heavily grazed sites have dense shrubs making up greater than 40% cover, with introduced annual grasses and little or no moss or lichen cover. Moist sites may support tall bunchgrasses (> 3.3 ft [1 m]) or rhizomatous grasses. More southern shrub-steppe may have native low shrubs dominating with bunchgrasses.

Composition—Characteristic and dominant mid-tall shrubs in the shrub-steppe habitat include all three subspecies of big sagebrush (basin [*Artemisia tridentata* ssp. *tridentata*], Wyoming [*A. t.* ssp. *wyomingensis*] or mountain [*A. t.* ssp. *vaseyana*]), antelope bitterbrush (*Purshia tridentata*), and two shorter sagebrushes (silver [*A. cana*] and three-tip [*A. tripartite*]). Each of these species can be the only shrub or they can appear in complex seral conditions with other shrubs. Common shrub complexes are bitterbrush and Wyoming big sagebrush, bitterbrush and three-tip sagebrush, Wyoming big sagebrush and three-tip sagebrush, and mountain big sagebrush and silver sagebrush. Wyoming and mountain big sagebrush can codominate areas with tobacco brush (*Ceanothus velutinus*). Rabbitbrush (*Chrysothamnus viscidiflorus*) and short-spine horsebrush (*Tetradymia spinosa*) are common associates and often dominate sites after disturbance. Big sagebrush occurs with the shorter stiff sagebrush (*A. rigida*) or low sagebrush (*A. arbuscula*) on shallow soils or high-elevation sites. Many sandy areas are shrub-free or open to patchy shrublands of bitterbrush and/or rabbitbrush. Silver sagebrush is the dominant and characteristic shrub along the edges of stream courses, moist meadows, and ponds. Silver sagebrush and rabbitbrush are associates in disturbed areas.

When this habitat is in good or better ecological condition, a bunchgrass-steppe layer is characteristic. Diagnostic native bunchgrasses that often dominate different shrub-steppe habitats are 1) mid-grasses: bluebunch wheatgrass (*Pseudoroegneria spicata*), Idaho fescue (*Festuca idahoensis*), bottlebrush squirreltail (*Elymus elymoides*), and Thurber needlegrass (*Stipa thurberiana)*; 2) short grasses: threadleaf sedge (*Carex filifolia*) and Sandberg bluegrass (*Poa sandbergii*); and 3) the tall grass: basin wildrye (*Leymus cinereus*). Idaho fescue is characteristic of the most productive shrub-steppe vegetation. Bluebunch wheatgrass is codominant at xeric locations, whereas western needlegrass (*Stipa occidentalis*), long-stolon sedge (*Carex inops*), or Geyer's sedge (*C. geyeri*) increase in abundance in higher-elevation shrub-steppe habitats. Needle and thread (*Hesperostipa comata*) is the characteristic native bunchgrass on stabilized, sandy soils. Indian ricegrass (*Achnatherum hymenoides*) characterizes dunes. Grass layers on montane sites contain slender wheatgrass (*Elymus trachycaulus*), mountain fescue (*F. brachyphylla*), green fescue (*F. viridula*), Geyer's sedge, or tall bluegrasses (*Poa* spp.). Bottlebrush squirreltail can be locally important in the Columbia River basin, sand dropseed (*Sporobolus cryptandrus*) is important in the Basin and Range Province, and basin wildrye is common in the more alkaline areas. Nevada bluegrass (*Poa secunda*), Richardson muhly (*Muhlenbergia richardsonis*), or alkali grass (*Puccinella* spp.) can dominate silver sagebrush flats. Many sites support nonnative plants, primarily cheatgrass (*Bromus tectorum*) or crested wheatgrass (*Agropyron cristatum*) with or without native grasses. Shrub-steppe habitat, depending on site potential and disturbance history, can be rich in forbs or have little forb cover. Trees may be present in some shrub-steppe habitats, usually as isolated individuals from adjacent forest or woodland habitats.

Other Classifications and Key References—Kuchler (1964) called this habitat sagebrush steppe and Great Basin sagebrush. This habitat has also been called xeric shrublands (Scott *et al*. 2002). Other references describing this habitat include Daubenmire 1970, Winward 1970, Winward 1980, Hironaka *et al*. 1983, Volland 1985, Johnson and Clausnitzer 1992, and Johnson and Simon 1987.

Natural Disturbance Regime—Barrett *et al*. (1997) concluded that the fire-return interval for this habitat is 25 years. The native shrub-steppe habitat apparently lacked extensive herds of large grazing and browsing animals until the late 1800s. Burrowing animals and their predators likely played important roles in creating small-scale patch patterns.

Succession and Stand Dynamics—With disturbance, mature stands of big sagebrush are reinvaded through soil-stored or windborne seeds. Invasion can be slow because sagebrush is not disseminated over long distances. Site dominance by big sagebrush usually takes a decade or more, depending on fire severity and season, seed, rain, post-fire moisture, and plant competition. Three-tip sagebrush is a climax species that reestablishes (from seeds or commonly from sprouts) within 5 to 10 years following a disturbance. Certain disturbance regimes promote three-tip sagebrush, which can outcompete herbaceous species. Bitterbrush is a climax species that plays a seral role, colonizing by seed onto rocky and/or pumice soils. Bitterbrush may be declining, replaced by woodlands in the absence of fire. Silver sagebrush is a climax species that establishes during early seral stages and coexists with later-arriving species. Big sagebrush, rabbitbrush, and short-spine horsebrush invade and can form dense stands after fire or livestock grazing. Frequent or high-intensity fire can create a patchy shrub cover or eliminate shrub cover and create grassland habitat.

Effects of Management and Anthropogenic Impacts—Shrub density and annual cover increase with livestock use, whereas bunchgrass density decreases. Repeated or intense disturbance, particularly on drier sites, leads to cheatgrass dominance and replacement of native bunchgrasses. Dry and sandy soils are sensitive to grazing, with needle and thread replaced by cheatgrass at most sites. These disturbed sites can be converted to modified grasslands in the agriculture habitats.

Status and Trends—Shrub-steppe habitat still dominates most of southeastern Oregon, although half of its original distribution in the Columbia River basin has been converted to agriculture. Alteration of fire regimes, fragmentation, livestock grazing, and the addition of over 800 exotic plant species have changed the character of shrub-steppe habitat. Quigley and Arbelbide (1997) concluded that big sagebrush and mountain sagebrush cover types are significantly smaller in area than they were before 1900 and that the bitterbrush/bluebunch wheatgrass cover type is similar to the pre-1900 extent. They also concluded that successional pathways for basin big sagebrush and big sagebrush-warm potential vegetation types are altered, that some pathways of antelope bitterbrush are altered, and that most pathways for big sagebrush-cool are unaltered. Overall, this habitat has seen an increase in exotic plant importance and a decrease in native bunchgrasses. More than half of the Pacific Northwest shrub-steppe habitat community types listed in the National Vegetation Classification are considered imperiled or critically imperiled (Anderson *et al*. 1998).

4 Pine/Fir Forest

Geographic Distribution—Ponderosa pine is the most widely distributed pine species in North America, ranging north to south from southern British Columbia to central Mexico and east to west from central Nebraska to the west coast (Little 1979). Ponderosa pine ecosystems occupy about 15.4 million ha across 14 states (Garrison *et al*. 1977). Pacific ponderosa pine ranges from latitude 52 degrees N in the Fraser River drainage of southern British Columbia south through the mountains of Washington, Oregon, and California to latitude 33 degrees N near San Diego. In the northeastern part of its range, it extends east of the Continental Divide to longitude 110 degrees W in Montana and south to the Snake River Plain in Idaho (Oliver and Ryker 1990).

Physical Setting—This habitat generally occurs on the driest sites supporting conifers in the Pacific Northwest. Tree species that thrive on sites that are relatively warm and dry tend to dominate. These species include ponderosa pine, Douglas-fir, and western larch (*Larix occidentalis*). This habitat is widespread and variable, appearing on moderate to steep slopes in canyons and foothills and on plateaus or plains near mountains. In Idaho, this habitat can be maintained by the dry pumice soils. Average annual precipitation ranges from about 36 to 76 cm on ponderosa pine sites, often as snow.

Both the mildest and coldest of these dry montane forests can support pure stands of Douglas-fir. On the warmest and driest sites, ponderosa pine tends to grow in pure stands. These stands become increasingly open with decreasing elevation or increasingly dry soils until they are so sparse that they are no longer considered forests. Ponderosa pine "woodlands," in which trees are so few and widely spaced that none of their crowns touch, are common at lower timberline and typically mark the transition from forest to grassland or shrubland. This transition generally occurs within 300 m of the valley base elevation (Arno 1979).

Landscape Setting—This woodland habitat typifies the lower tree line zone, forming transitions with mixed conifer forest and western juniper and mountain mahogany woodlands, shrub-steppe, grassland, or agriculture habitats. Douglas-fir–ponderosa pine woodlands are found near or within the mixed conifer forest habitat. Ponderosa pine woodland is the vegetation type that Americans most commonly associate with western mountains (Peet 1988). However, the warm, dry conditions that naturally favor development and persistence of these open, parklike stands are characteristic of only a small fraction of the forested area within the northern Rocky Mountains. Douglas-fir often predominates at lower elevations, where valley base elevations are high and winter temperatures are too low for ponderosa pine. Western larch, the only deciduous conifer in the region, is an often conspicuous component of low-elevation forests.

Structure—This habitat is typically a woodland or savanna with tree canopy coverage of 10 to 60%, although closed-canopy stands are possible. The tree layer is usually composed of widely spaced, large conifer trees. Many stands tend toward a multilayered condition, with encroaching conifer regeneration. Isolated, taller conifers above broadleaf deciduous trees characterize part of this habitat. Deciduous woodlands or forests are an important part of the structural variety of this habitat. Clonal deciduous trees can create dense patches across a grassy landscape rather than scattered individual trees. The undergrowth may include dense stands of shrubs or, more often, be dominated by grasses, sedges, or forbs. Shrub-steppe shrubs may be prominent in some stands and create a distinct grassland habitat that is sparse in trees and shrubs.

Composition—Ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*) are the most common evergreen trees in this habitat. The deciduous conifer western larch (*Larix occidentalis*) can be a codominant with the evergreen conifers, but it is seldom a canopy dominant. Grand fir (*Abies grandis*) may be frequent in the undergrowth on more productive sites, giving stands a multilayered structure. In rare instances, grand fir can be codominant in the upper canopy.

The understories of xeric, old forests are usually sparse due to the lack of moisture. Common native grasses and grasslike plants include Idaho fescue, rough fescue, bluebunch wheatgrass, pinegrass (*Calamagrostis rubescens*), and elk sedge (*Carex garberi*). Forbs include arrowleaf balsamroot (*Balsamorhiza sagittata*), lupines (*Lupinus* spp.), heartleaf arnica (*Arnica cordifolia*), and western meadow-rue (*Thalictrum occidentale*). Common snowberry, mountain snowberry (*Symphoricarpos oreophilus*), antelope bitterbrush, white spirea (*Spiraea betulifolia*), Oregon grape (*Mahonia aquifolium*, formerly *Berberis aquifolium*), Saskatoon serviceberry (*Amelanchier alnifolia*), ninebark (*Physocarpus* spp.), russet buffaloberry (*Shepherdia canadensis*), common juniper (*Juniperus communis*), and chokecherry are important woody species (Pfister *et al*. 1977, Cooper *et al*. 1991).

Other Classifications and Key References—The Society of American Foresters refers to this habitat as Pacific ponderosa pine–Douglas-fir. Scott *et al*. (2002) called this habitat needleleaf forest–ponderosa pine. Other references describing elements of this habitat include Volland 1985, Johnson and Clausnitzer 1992, and Lillybridge *et al*. 1995.

Natural Disturbance Regime—Fire plays an important role in creating vegetation structure and composition in this habitat. Most of the habitat has experienced frequent low-severity fires that maintained woodland or savanna conditions. A mean fire interval of 20 years for ponderosa pine is the shortest interval for the vegetation types listed by Barrett *et al*. (1997). Soil drought plays a role in maintaining an open tree canopy in part of this dry woodland habitat.

Succession and Stand Dynamics—This habitat is climax on sites near the dry limits of each of the dominant conifer species and more seral as the environment becomes more favorable for tree growth. Open seral stands are gradually replaced by more closed, shade-tolerant climax stands.

Effects of Management and Anthropogenic Impacts—Before 1900, this habitat was mostly open and park-like with relatively few undergrowth trees. Currently, much of this habitat has a younger tree cohort of more shade-tolerant species that give the habitat a more closed, multilayered canopy. For example, this habitat includes previously natural fire-maintained stands in which grand fir can eventually become the canopy dominant. Fire suppression has led to a buildup of fuels that increase the likelihood of stand-replacing fires. Heavy grazing, in contrast to fire, removes the grass cover and tends to favor shrub and conifer species. Fire suppression, combined with grazing, creates conditions that support invasion by conifers. Large, late seral ponderosa pine and Douglas-fir are harvested in much of this habitat. Under most management regimes, typical tree size decreases and tree density increases in this habitat. In some areas, patchy tree establishment at the forest-steppe boundary has created new woodlands.

Status and Trends—Quigley and Arbelbide (1987) concluded that the interior ponderosa pine cover type is significantly less in extent than it was before 1900. They included much of this habitat in their dry forest potential vegetation group 181, which they concluded has departed from natural succession and disturbance conditions. The greatest structural change in this habitat is the reduced extent of the late seral, single-layer condition. This habitat is generally degraded because of increased exotic plants and decreased native bunchgrasses. One-third of ponderosa pine and dry Douglas-fir or grand fir community types listed in the National Vegetation Classification are considered imperiled or critically imperiled (Anderson *et al*. 1998).

5 Juniper/Mountain Mahogany

Geographic Distribution—Western juniper occurs from southeastern Washington and Oregon southward to the upper slopes of the Sierra Nevada and San Bernardino mountains of southern California (Sowder *et al*. 1965). The species occurs along the western edge of the Great Basin in southwestern Idaho and northwestern Nevada (Meeuwig and Murray 1978). Western juniper woodlands with shrub-steppe species appear throughout the range of the juniper/mountain mahogany habitat. Many isolated mahogany communities occur throughout canyons and mountains across the range of this habitat.

During the past 150 years, western juniper has extended its range and now occupies approximately 42 million acres (17 million ha) in the Intermountain West (Bunting 1990, Ferry *et al*. 1995). It grows over approximately 4 million acres (1.6 million ha) in the Pacific Northwest (Eddleman *et al.* 1994).

Physical Setting—This habitat is widespread and variable, occurring in basins and canyons and on slopes and valley margins in the southern Columbia Plateau, as well as on fire-protected sites in the northern Basin and Range Province. It may be found on benches and foothills. Western juniper and/or mountain mahogany woodlands are often found on shallow soils on flats at middle to high elevations, usually on basalts. Other sites range from deep, loess soils and sandy slopes to very stony canyon slopes. At lower elevations or in areas outside shrub-steppe, this habitat occurs on slopes and in areas with shallow soils. Mountain mahogany can occur on steep rimrock slopes, usually in areas of shallow soils or protected slopes. This habitat can be found at elevations of 1,500 to 8,000 ft (457–2,438 m) but mostly from 4,000 to 6,000 ft (1,220–1,830 m). Average annual precipitation ranges from approximately 10 to 13 inches (25–33 cm), with most occurring as winter snow.

Landscape Setting—This habitat reflects a transition between ponderosa pine forest and woodland and shrub-steppe, grasslands, and rarely desert playa and salt desert scrub habitats. Western juniper generally occurs on higher topography, whereas the shrub communities are more common in depressions or steep slopes with bunchgrass undergrowth. In the Great Basin, mountain mahogany may form a distinct belt on mountain slopes and ridgetops above pinyon–juniper woodland. Mountain mahogany can occur in isolated, pure patches that are often very dense. The primary land use is livestock grazing.

Structure—This habitat is made up of savannas, woodlands, or open forests with 10 to 60% canopy cover. The tallest layer is composed of short (6.6–40 ft [2–12 m] tall) evergreen trees. Dominant plants may assume a tall-shrub growth form on some sites. The short trees appear in a mosaic pattern, with areas of low or medium-tall (usually evergreen) shrubs alternating with areas of tree layers and widely spaced low or medium-tall shrubs. The herbaceous layer is usually composed of short or medium-tall bunchgrass or, rarely, rhizomatous grass–forb undergrowth. These vegetated areas can be interspersed with rimrock or scree. A well-developed cryptogam layer often covers the ground, although bare rock can make up much of the groundcover.

Composition—Western juniper and/or mountain mahogany dominate these woodlands with either bunchgrass or shrub-steppe undergrowth. Western juniper (*Juniperus occidentalis*) is the most common dominant tree in these woodlands. Part of this habitat has curl-leaf mountain mahogany (*Cercocarpus ledifolius*) as the only dominant tall shrub or small tree. Mahogany may be codominant with western juniper. Ponderosa pine (*Pinus ponderosa*) can grow in this habitat and, in some rare instances, may be an important part of the canopy.

The most common shrubs in this habitat are basin, Wyoming, or mountain big sagebrush (*Artemisia tridentata* ssp. *tridentata*, *A. t.* ssp. *wyomingensis*, and *A. t.* ssp. *vaseyana*) and/or bitterbrush (*Purshia tridentata*). These shrubs usually provide significant cover in juniper stands. Low or stiff sagebrush (*Artemisia arbuscula* or *A. rigida*) is a dominant dwarf shrub in some juniper stands. Mountain big sagebrush appears most commonly with mountain mahogany and mountain mahogany mixed with juniper. Snowbank shrubland patches in mountain mahogany woodlands are composed of mountain big sagebrush with bitter cherry (*Prunus emarginata*), quaking aspen (*Populus tremuloides*), and Saskatoon serviceberry (*Amelanchier alnifolia*). Shorter shrubs such as mountain snowberry or creeping Oregon grape (*Mahonia repens*) can be dominant in the undergrowth. Rabbitbrush (*Chrysothamnus nauseosus* and *C. viscidiflorus*) increase with grazing.

Part of this woodland habitat lacks a shrub layer. Various native bunchgrasses dominate different aspects of this habitat. Sandberg bluegrass (*Poa sandbergii*), a short bunchgrass, is the dominant and most common grass throughout many juniper sites. Medium-tall bunchgrasses such as Idaho fescue (*Festuca idahoensis*), bluebunch wheatgrass (*Pseudoroegneria spicata*), needlegrasses (*Stipa occidentalis*, *S thurberiana*, *S. lemmonii*), and bottlebrush squirreltail (*Elymus elymoides*) can dominate undergrowth. Threadleaf sedge (*Carex filifolia*) and basin wildrye (*Leymus cinereus*) are found in lowlands, and Geyer's and Ross' sedges (*Carex geyeri*, *C. rossii*), pinegrass (*Calamagrostis rubescens*), and blue wildrye (*E. glaucus*) appear on mountain foothills. Sandy sites typically have needle and thread (*Hesperostipa comata*) and Indian ricegrass (*Oryzopsis hymenoides*). Cheatgrass (*Bromus tectorum*) or bulbous bluegrass (*Poa bulbosa*) often dominates overgrazed or disturbed sites. In good condition, this habitat may have mosses growing under the trees.

Other Classifications and Key References—This habitat is also called juniper steppe woodland (Kuchler 1964) and western juniper, Utah juniper, and pinyon pine/juniper (Scott *et al*. 2002). Other references describing this habitat include Dealy 1971, Downing 1983, Johnson and Clausnitzer 1992, and Tisdale 1986.

Natural Disturbance Regime—Both mountain mahogany and western juniper are fire intolerant. Under natural high-frequency fire regimes, both species formed savannas or occurred as isolated patches on fire-resistant sites in shrub-steppe or steppe habitat. Western juniper is considered a topoedaphic climax tree in a number of sagebrush–grassland, shrub-steppe, and drier conifer sites. The species is an increaser in many earlier seral communities in these zones and invades without fires. Most trees taller than 13 ft (4 m) can survive low-intensity fires. The historical fire regime of mountain mahogany communities varies with community type and structure. The fire-return interval for mountain mahogany (along the Salmon River in Idaho) was 13 to 22 years until the early 1900s but has increased ever since. Mountain mahogany can live to 1,350 years in western and central Nevada. Some old growth mountain mahogany stands avoid fire by growing on extremely rocky sites.

Succession and Stand Dynamics—Juniper invades shrub-steppe and steppe habitats and reduces undergrowth productivity. Although slow seed dispersal delays recovery time, western juniper can regain dominance in 30 to 50 years following fire. A fire-return interval of 30 to 50 years typically arrests juniper invasion. The successional role of curl-leaf mountain mahogany varies with community type. Mountain brush communities where curl-leaf mountain mahogany is either dominant or codominant are generally stable and successional rates are slow.

Effects of Management and Anthropogenic Impacts—Over the past 150 years, with fire suppression, overgrazing, and changing climatic factors, western juniper has increased its range into adjacent shrub-steppe, grassland, and savanna habitats. Increased density of juniper and reduced fine fuels from an interaction of grazing and shading result in high-severity fires that eliminate woody plants and promote herbaceous cover, primarily annual grasses. Diverse mosses and lichens occur on the ground in this type if it has not been too disturbed by grazing. Excessive grazing decreases bunchgrasses and increases exotic annual grasses, as well as various native and exotic forbs. Animals seeking shade under trees decrease or eliminate bunchgrasses and contribute to increasing cheatgrass cover.

Status and Trends—This habitat is dominated by fire-sensitive species; therefore, the range of western juniper and mountain mahogany has expanded because of an interaction of livestock grazing and fire suppression. Quigley and Arbelbide (1997) concluded that, in the Inland Pacific Northwest, juniper/sagebrush, juniper woodland, and mountain mahogany cover types are now significantly greater in extent than they were before 1900. Although this habitat type covers more area, its condition is generally degraded because of increased exotic plants and decreased native bunchgrasses. One-third of Pacific Northwest juniper and mountain mahogany community types listed in the National Vegetation Classification are considered imperiled or critically imperiled (Anderson *et al.* 1998).

6 Whitebark Pine

Geographic Distribution—Whitebark pine is a picturesque tree of the subalpine forest and tree line. Its distribution is split into two broad sections. Western populations of whitebark pine extend from about latitude 55 degrees N in western British Columbia, along the lower part of the Fraser River, south into Washington and along the Cascade Range, southward through the high mountains of Washington and Oregon into California. In northern California, whitebark pine is scattered in isolated populations, but farther south in the Sierra Nevada Range of central California, it is more continuous to its southern limit near Mount Whitney at about latitude 37 degrees N (Hitchcock *et al.* 1969, Cronquist *et al*. 1972, Bailey 1975). Eastern populations occur from about latitude 55 degrees N in central Alberta, Canada, and follow the northern Rocky Mountains southward into western Montana and central Idaho. Stands are extensive in northwestern Wyoming. Except for disjunct populations in northeastern Nevada (about latitude 41 degrees N), the southern and eastern limits of whitebark pine are the Wind River Mountains of Wyoming (Hitchcock *et al.* 1969, Cronquist *et al*. 1972, Bailey 1975). Whitebark pine does not occur south of the Wyoming basin. The distribution of whitebark pine is strongly influenced by the Clark's nutcracker (*Nucifraga columbiana*), a bird that is important for seed dispersal and seedling establishment (Lanner 1980, Steele *et al*. 1983).

Physical Setting—Slow-growing and long-lived, the whitebark pine is typically more than 100 years old before it produces cones. Whitebark pine's growth form ranges from a krummholz mat to a moderately tall, upright tree, but the tree is often short and heavily branched, with multiple stems. Whitebark pine typically grows with other high-mountain conifers but can form nearly pure stands in relatively dry mountain ranges (Arno and Hoff 1989). Where associated trees are capable of forming closed stands, whitebark pine can be a long-lived, dominant seral species if periodic disturbance, such as fire, removes its shade-tolerant competitors. On a broad range of dry, windy sites, however, whitebark pine is a climax tree because it is hardier and more durable than subalpine fir and other tree species (Arno and Hoff 1989). The sites where whitebark pine is seral tend to be moister and more productive than sites where the tree is climax (Arno 1986).

Landscape Setting—Whitebark pine grows on dry, rocky subalpine slopes and exposed ridges on high mountains between 5,900 and 9,950 ft (1,800 and 3,030 m). It is characteristic of tree line where it forms dense krummholz thickets. In Banff and Jasper National Parks at tree line (about 6,560 to 7,550 ft [2,000–2,300 m]), whitebark pines are dwarfed and isolated on dry, exposed sites. At the northern end of its range, the tree is a minor component of tree line. Whitebark pine is an important component of high-elevation forests in Idaho, Montana, and Wyoming between 5,900 and 10,500 ft (1,800 and 3,200 m). In high-elevation forests in the Cascade Range of southern Oregon and northern California between 8,000 and 9,500 ft (2,440 and 2,900 m), whitebark pine is a major component of tree line (Arno 1986, Arno and Hoff 1990). Whitebark pine occurs at elevations as low as 4,820 ft (1,470 m) in British Columbia and the Cascades of Washington. The lowest reported natural occurrence of whitebark pine is 3,600 ft (1,100 m) on Mt. Hood in Oregon. In the southern Sierra Nevada, it commonly occurs at elevations up to 11,500 ft (3,500m) (Arno 1986).

As mentioned earlier, sites where whitebark pine occurs as a climax are drier than those where it is seral. Whitebark pine is important in areas where the mean annual precipitation is 24 to 70 inches (600–1,800 mm) (Arno and Hoff 1990). The climate is characterized by cool summers and cold winters with deep snowpack. Trees have high frost resistance and low shade tolerance. They occur predominately on acidic substrates, although they have also been reported on calcareous ones. Most soils under whitebark pine stands are Inceptisols. The growth of whitebark pine in Montana and Wyoming is reported as good on sandy-loam and loam, fair on gravels and clay loams, and poor on clay (Forcella and Weaver 1977, Steele *et al*. 1983, Eggers 1986, Arno and Hoff 1990).

The whitebark pine habitat lies above the mixed montane conifer forest or lodgepole pine forest habitats and below the alpine grassland and shrubland habitats. Associated wetlands in subalpine parklands extend upward a short distance into the alpine zone. Primary land use is recreation, watershed protection, and grazing.

Structure—Whitebark pine habitat has a tree layer with typically between 10 and 30% canopy cover. Openings among trees are highly variable. The habitat appears either as parkland, that is, a mosaic of treeless openings and small patches of trees, often with closed canopies, or as woodlands or savanna-like stands of scattered trees. The ground layer can be composed of 1) low to matted dwarf shrubs 1 ft (0.3 m) tall that are evergreen or deciduous and often small-leaved; 2) sod grasses, bunchgrasses, or sedges; 3) forbs; or 4) moss- or lichen-covered soils. Herb- or shrub-dominated wetlands appear within the parkland areas and are considered part of this habitat. Wetlands can occur as deciduous shrub thickets up to 6.5 ft (2 m) tall, scattered tall shrubs, dwarf shrub thickets, or herbaceous plants shorter than 1.6 ft (0.5 m). In general, eastern Cascade Range and Rocky Mountain areas are parklands and woodlands typically dominated by grasses or sedges, with fewer heathers.

Composition—In western North America, whitebark pine is a dominant or codominant species in many high-elevation forests. In the Rocky Mountains, eastern Cascade Range, and Blue Mountains, it is a minor component in mixed stands of Engelmann spruce (*Picea engelmannii*) and subalpine fir (*Abies lasiocarpa*). It is found with mountain hemlock (*Tsuga mertensiana*) in the Cascade and British Columbia Coast ranges. In the upper subalpine forests of California, it is associated with subalpine fir, lodgepole pine (*Pinus contorta*), western white pine (*P. monticola*), foxtail pine (*P. balfouriana*), and limber pine (*P. flexilis*) (Arno 1980, Arno and Hoff 1990).

Drier areas are more woodland or savanna-like, often with low shrubs such as common juniper (*Juniperus communis*), kinnikinnick (*Arctostaphylos uva-ursi*), low whortleberries or grouseberries (*Vaccinium myrtillus* or *V. scoparium*), or common beargrass dominating the undergrowth. Wetland shrubs in the subalpine parkland habitat include bog-laurel (*Kalmia microphylla*), Booth's willow (*Salix boothii*), undergreen willow (*S. commutata*), Sierran willow (*S. eastwoodiae*), and blueberries (*Vaccinium uliginosum* or *V. deliciosum*).

Undergrowth in drier areas may be dominated by pinegrass (*Calamagrostis rubescens*), Geyer's sedge (*Carex geyeri*), Ross' sedge (*C. rossii*), smooth woodrush (*Luzula glabrata* var. *hitchcockii*), Drummond's rush (*Juncus drummondii*), or short fescues (*Festuca viridula*, *F. brachyphylla*, *F. saximontana*).

The remaining flora of this habitat is diverse and complex. The following herbaceous broadleaf plants are important indicators of differences in the habitat: American bistort (*Polygonum bistortoides*), American false hellebore (*Veratrum viride*), fringe leaf cinquefoil (*Potentilla flabellifolia*), marsh marigolds (*Caltha leptosepala*), avalanche lily (*Erythronium montanum*), partridgefoot (*Luetkea pectinata*), Sitka valerian (*Valeriana sitchensis*), subalpine lupine (*Lupinus arcticus* ssp. *subalpinus*), and alpine aster (*Aster alpigenus*). Showy sedge (*Carex spectabilis*) is also locally abundant (Cronquist *et al*. 1972, Dittberner and Olson 1983, Arno 1986).

Other Classifications and Key References—Quigley and Arbelbide (1997) called this habitat whitebark pine and whitebark pine–subalpine larch cover types. Kuchler (1964) included this habitat within the subalpine fir–mountain hemlock forest. Scott *et al*. (2002) classified the habitat as subalpine pine, subalpine fir/whitebark pine, and mixed whitebark pine forests (Kuramoto and Bliss 1970, Douglas and Bliss 1977, Arno 1979, Lillybridge *et al*. 1995).

Natural Disturbance Regime—Although fire is rare to infrequent in this habitat, it plays an important role, particularly in drier environments. Before 1900, whitebark pine woodland fire intervals varied from 50 to 300 years. Wind blasting by ice and snow crystals is a critical factor in these woodlands and establishes the higher limits of the habitat. Periodic shifts in climatic factors, such as drought, snowpack depth, or snow duration, either allow tree invasions into meadows and shrublands or eliminate or retard tree growth.

Succession and Stand Dynamics—In upper-elevation subalpine forests, whitebark pine is generally seral and competes with and is replaced by more shade-tolerant trees. Subalpine fir, a very shade-tolerant species, is the most abundant associate and most serious competitor of whitebark pine. Although whitebark pine is more shade tolerant than lodgepole pine and subalpine larch (*Larix lyallii*), it is less shade tolerant than Engelmann spruce and mountain hemlock (*Tsuga mertensiana*). Whitebark pine is the potential climax species on high, exposed tree line sites and exceptionally dry sites (Arno 1986, Eggers 1986, Tomback 1986, Arno and Hoff 1990). It sometimes acts as a pioneer species in the invasion of meadows and burned areas (Forcella and Weaver 1977, Fischer and Bruce 1983). On dry, wind-exposed sites, the regeneration of whitebark pine may require several decades, even though it is often the first tree to become established (Weaver and Dale 1974, Fischer and Clayton 1983, Arno and Hoff 1990). The fact that the Clark's nutcracker disperses seed allows whitebark pine to be more widespread as a seral species. The bird's dispersal of seeds throughout subalpine habitats is partly responsible for the status of whitebark pine as a pioneer and post-fire invader (Steele *et al*. 1983).

Effects of Management and Anthropogenic Impacts—Fire suppression has contributed to change in habitat structure and functions. For example, the current "average" whitebark pine stand will burn every 3,000 years or longer because of fire suppression. Blister rust, an introduced pathogen, is increasing whitebark pine mortality in these woodlands (Ahlenslager 1987). Even limited logging can have prolonged effects because of slow invasion rates of trees. This is particularly important on drier sites and in subalpine larch stands. During wet cycles, fire suppression can lead to tree islands coalescing and parklands converting to a more closed forest habitat. Parkland conditions can displace alpine conditions through tree invasions. Livestock use and heavy horse or foot traffic can trample and compact soil. Slow growth in this habitat prevents rapid recovery.

Status and Trends—Whitebark pine might be declining because of the effects of blister rust or fire suppression leading to conversion of parklands to more closed forest. Global climate warming will likely have an amplified effect throughout this habitat. Less than 10% of Pacific Northwest subalpine parkland community types listed in the National Vegetation Classification are considered imperiled (Anderson *et al*. 1998).

7 Aspen

Geographic Distribution—Quaking aspen (*Populus tremuloides*) is the most widely distributed tree in North America, but the habitat type is a minor one throughout eastern Washington, Oregon, and Idaho. It occurs from Newfoundland west to Alaska and south to Virginia, Missouri, Nebraska, and northern Mexico. A few scattered populations occur farther south in Mexico to Guanajuato (Little 1979). Distribution is patchy in the West, with trees confined to suitable sites. Aspen stands are much more common in the Rocky Mountain states. Density is greatest in Minnesota, Wisconsin, Michigan, Colorado, and Alaska; each of these states contains at least two million acres of commercial quaking aspen forest. Maine, Utah, and central Canada also have large acreages of quaking aspen (Jones and Schier 1985, Perala and Carpenter 1985).

Physical Setting—This habitat generally occurs on well-drained mountain slopes or canyon walls that have some moisture. Rockfalls, talus, or stony north slopes are often typical sites. This habitat may occur in steppes on moist microsites. It is not associated with streams, ponds, or wetlands. This habitat is found at elevations from 2,000 to 9,500 ft (610–2,896 m).

Landscape Setting—Aspen forms a "subalpine belt" above the western juniper and mountain mahogany woodland habitats and below montane shrub-steppe habitat. It can occur in seral stands in the lower mixed conifer forest and the ponderosa pine forest and woodland habitats. Primary land use is livestock grazing.

Structure—Deciduous trees, usually less than 48 ft (15 m) tall, dominate this woodland or forest habitat. The tree layer grows over a forb-, grass-, or low shrub-dominated undergrowth. Relatively simple two-tiered stands characterize the typical vertical structure of woody plants in this habitat. This habitat is composed of one to many clones of trees, with larger trees toward the center of each clone. Conifers invade and create mixed evergreen-deciduous woodland or forest habitats.

Composition—Quaking aspen is the characteristic and dominant tree in this habitat. It is the sole dominant in many stands, although scattered ponderosa pine (*Pinus ponderosa*) or Douglas-fir (*Pseudotsuga menziesii*) may be present. Snowberry (*Symphoricarpos oreophilus* and, less frequently, *S. albus*) is the most common dominant shrub. Tall shrubs such as Scouler's willow (*Salix scouleriana*) and Saskatoon serviceberry (*Amelanchier alnifolia*) may be abundant. On mountain or canyon slopes, antelope bitterbrush (*Purshia tridentata*), mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*), low sagebrush (*A. arbuscula*), and curl-leaf mountain mahogany (*Cercocarpus ledifolius*) often occur in and adjacent to this woodland habitat.

In some stands, pinegrass (*Calamagrostis rubescens*) may dominate the groundcover without shrubs. Other common grasses are Idaho fescue (*Festuca idahoensis*), California brome (*Bromus carinatus*), or blue wildrye (*Elymus glaucus*). Characteristic tall forbs include horsemint (*Agastache* spp.), aster (*Aster* spp.), senecio (*Senecio* spp.), and coneflower (*Rudbeckia* spp.). Low forbs include meadow-rue (*Thalictrum* spp.), bedstraw (*Galium* spp.), sweetcicely (*Osmorhiza* spp.), and valerian (*Valeriana* spp.).

Other Classifications and Key References—This habitat is called aspen by the Society of American Foresters and aspen woodland by the Society of Range Management. The Oregon Gap II Project (Kiilsgaard 1999) cover type that would represent this type is aspen groves. Other references describing this habitat include Franklin and Dyrness 1973, Williams and Lillybridge 1983, Agee 1994, Howard 1996, Mueggler 1988, and Ritter 2000.

Natural Disturbance Regime—Fire plays an important role in maintenance of this habitat. Quaking aspen will colonize sites after fire or other stand disturbances through root sprouting. Research on fire scars in aspen stands in central Utah (Howard 1996) indicated that most fires occurred before 1885 and concluded that the natural fire-return interval was 7 to 10 years. Ungulate browsing plays a variable role in aspen habitat: ungulates may slow tree regeneration by consuming aspen sprouts on some sites and may have little influence in other stands.

Succession and Stand Dynamics—There is no generalized successional pattern across the range of this habitat. Aspen sprouts after fire and spreads vegetatively into large clonal or multiclonal stands. Because aspen is shade intolerant and cannot reproduce under its own canopy, conifers can invade most aspen habitat. In central Utah, quaking aspen was invaded by conifers in 75 to 140 years. Apparently, some aspen habitat is not invaded by conifers, but eventually clones deteriorate and shrubs, grasses, and/or forbs grow in.

This transition to grasses and forbs is more likely on dry sites.

Effects of Management and Anthropogenic Impacts—Domestic sheep reportedly consume four times more aspen sprouts than cattle do. Heavy livestock browsing can adversely impact aspen growth and regeneration. With fire suppression and alteration of fine fuels, fire rejuvenation of aspen habitat has been greatly reduced since about 1900. Conifers now dominate many seral aspen stands, and extensive stands of young aspen are uncommon.

Status and Trends—With fire suppression and change in fire regimes, the aspen forest habitat is less common than it was before 1900. None of the five Pacific Northwest upland quaking aspen community types in the National Vegetation Classification is considered imperiled (Anderson *et al.* 1998).

8 Mountain Brush

Geographic Distribution—This habitat occurs as a patchily distributed resource primarily on steep canyon slopes in the margins of the Columbia River basin in Idaho.

Physical Setting—This habitat develops in hot dry climates in the Pacific Northwest. Annual precipitation totals 12 to 20 inches (31–51 cm); only 10% falls in the hottest months (July through September). Mountain shrub habitat occurs as a transition community between sagebrush steppe and conifer communities. Mountain shrub is found at moderately high elevations, often associated with Douglas-fir and aspen communities, on sites that are more mesic than sagebrush steppe but drier than aspen. Mountain shrub is usually found on north and east slopes that tend to be cooler and moister than south and west aspects.

Landscape Setting—This habitat is generally found in steeper aspects within a mosaic of shrub-steppe, aspen, and pine/fir forest habitats. This habitat can develop near talus slopes, at the heads of dry drainages, and on toeslopes in moist shrub-steppe and steppe zones. At lower-elevation sites, these are more often in a mix with perennial grasses, dry rocky grasslands, and low-elevation riparian habitats. The primary surrounding land use is livestock grazing. Mountain brush is widely regarded as important to wildlife for its food and cover values, as well as providing integral components of watershed stability and species diversity (Lanner1983, Stauffer and Peterson 1985, Steele and Geier-Hayes 1995).

Structure—The mountain brush habitat is generally a mix of tall (5 ft [1.5 m]) to medium (1.6 ft [0.5 m]) deciduous shrublands in a mosaic with bunchgrass or annual grasslands. Shrub canopies are almost always closed (>60% cover), forming a thicket of interwoven stems and branches. Shrub layers can be one or two tiered, but they are often so dense that they restrict the herbaceous layer to shade-tolerant rhizomatous species.

Composition—Mountain brush is a highly diverse community with chokecherry (*Prunus virginiana*), serviceberry (*Amelanchier alnifolia*), currant (*Ribes* sp.), mountain snowberry (*Symphoricarpos oreophilus*), buckbrush (*Ceanothus cuneatus*), mountain mahogany, big tooth maple (*Acer grandidentatum*), antelope bitterbrush (*Purshia tridentata*), and elderberry (*Sambucus racemosa*), often intermingled with mountain big sagebrush. The herbaceous understory is typically composed of perennial grasses such as Idaho fescue (*Festuca idahoensis*), bluebunch wheatgrass (*Pseudoroegneria spicata*), and Sandberg bluegrass (*Poa secunda*). Perennial forbs are also important understory components and may include nodding microseris (*Microseris* *nutans*), arrowleaf balsamroot (*Balsamorhiza sagittata*), narrow-leaf collomia, (*Collomia linearis*), blue-eyed Mary (*Collinsia verna*), pink microsteris (*Microsteris gracilis*), Indian paintbrush, (*Castilleja* sp.), owl-clover (*Orthocarpus tenuifolius*), buckwheat (*Fagopyrum esculentum*), and tapertip hawksbeard (*Crepis acuminata*).

Other Classifications and Key References—This habitat is called mountain brush (Shiflet 1994). The Oregon Gap II Project (Kiilsgaard, C. 1999) represents this type as eastside big sagebrush shrubland. Scott *et al*. (2002) classified this habitat as non-forested lands–grasslands. Other references describing this habitat are Daubenmire (1970), Tisdale (1986), and Johnson and Simon (1987).

Natural Disturbance Regime—Stand-replacing fires occur from 25 to 100 years (63-year midrange) in mountain shrub (Loop and Gruell 1973), though fire-return intervals may vary widely with changes in elevation, aspect, site moisture, and associated forest or woodland communities. Fuel loadings vary among communities. All species of mountain shrubs resprout after fire, except for mountain big sagebrush. Mountain shrub communities generally recover rapidly following wildland fire and are considered to be fire tolerant. Mountain shrub is classified as Fire Regime–V (Hardy *et al*. 2001).

Succession and Stand Dynamics—Many of the major shrubs sprout following fire and are maintained with moderate fire frequency. Most thickets will increase in size without fire. This habitat has increased primarily in moist steppe and shrub-steppe habitat with fire suppression and restricted grazing. Prolonged fire suppression may lead to invasions by tree species. Apparently some representatives of this habitat potentially support pine/fir forests after a long, fire-free period.

Effects of Management and Anthropogenic Impacts—Livestock grazing in shrub-steppe habitat changes the surrounding fine-fuel matrix for fire. That, combined with fire suppression, leads to a change in habitat patch size, structure, and composition. In response to fire suppression, shrub thickets on northerly aspects near lower tree line tend to increase in patch size and height and be invaded by tree species. With heavy livestock grazing, shrubs are browsed, broken, and trampled, which eventually creates a more open shrubland with a more abundant herbaceous layer.

Status and Trends—The mountain brush habitat is restricted in range and probably has decreased locally in the Upper Snake province.

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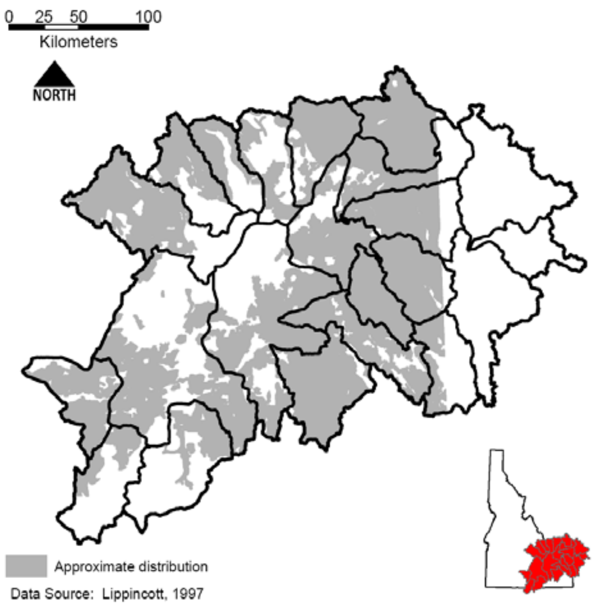
APPENDIX 2-4—TERRESTRIAL FOCAL SPECIES DESCRIPTIONS

1 Riparian/Herbaceous Wetlands

1.1 Western Toad (*Bufo boreas*)



A currently accepted subspecies of the western toad that occurs in Idaho is the western toad (*Bufo boreas* ssp. *boreas*). This toad also occurs in western British Colombia and southern Alaska and southward to Washington, Oregon, western Montana, western Wyoming, northern California, Nevada, western Utah, and western Colorado (Stebbins 1951, Schmidt 1953). Amphibians generally seem to be more sensitive to environmental changes than other taxonomic groups are. Western toads repeatedly use individual stumps or logs, a habit that may be important for conservation and recovery programs to consider.

The western toad is found in the Rocky Mountains in aspen (*Populus* spp.) groves and riparian forests (Kricher 1993). In Colorado, the largest populations are typically found in areas characterized by willows (*Salix* spp.), bog birch (*Betula glandulosa*), and shrubby cinquefoil (*Potentilla fruticosa*) (USFWS 1994). In the Pacific Northwest, the western toad occurs in mountain meadows and less commonly in Douglas-fir forests (*Pseudotsuga menziesii*) (Kricher 1993). Western toads have been collected from sedge meadows near a pond occurring in a creosotebush (*Larrea tridentata*) community and from aspen (*Populus* spp.)-willow groves within big sagebrush (*Artemisia tridentata*)-grassland (Stebbins 1951).

Western toads are widespread throughout the mountainous areas of northwestern North America, ranging from sea level to elevations near or above regional tree line, or 10,000 feet (305–3,050 m) in elevation (Stebbins 1951, Verner and Boss 1980). The toad is uncommon at the higher elevations (Verner and Boss 1980). Western toads occupy desert streams and springs, grasslands, and mountain meadows; they are less common in heavily wooded regions. They are usually found in or near ponds, lakes (including saline lakes), reservoirs, rivers, and streams (Stebbins 1951, Stebbins 1985).

Western toads are active from January to October, depending on latitude and elevation (Stebbins 1985). At low elevations, western toads are active at night; at high elevations and in the northern parts of their range, they are diurnal (Stebbins 1985). Diurnal and nocturnal activities are often related to seasonal changes in temperature; most western toads are diurnal during spring and fall but nocturnal during the warmer summer months (USFWS 1994).

Body temperature of western toads is closely correlated with the substrate temperature. Basking behavior and conduction from a substrate are primary means of increasing body temperature, while evaporation and conduction of heat to a cooler medium lead to cooling. To avoid evaporative conditions, the frogs usually spend the daylight hours on the forest floor in the soil under rocks, logs, stumps, or other surface objects or in rodent burrows (Stebbins 1951, Kahn 1960, Porter 1972, Stebbins 1985, Kricher 1993). Individuals have been observed to use the same retreat repeatedly. In locations where there is little or no hiding cover, western toads may spend most of the day in water (Stebbins 1951). Under more humid conditions, western toads may become active during the day (Porter 1972).

In central Oregon, the minimum breeding age for male western toads is 3 years, and probably 4 or 5 years for females (Olson 1992). Male western toads breed every year, while females breed at less regular intervals, depending on individual condition and previous years' breeding effort (Olson 1992). Sex ratios differ according to habitat type: males are more numerous in wet areas; females, more numerous in dry habitats (USFWS 1994).

Western toads require open water for breeding (Verner and Boss 1980). All breeding members of a local population tend to lay their eggs in the same location, which is used repeatedly from year to year. For example, at one site on a permanent lake in the Cascade Range in Oregon, western toads returned each year to the same submerged willow clumps (Olson 1992).

Eggs are laid in open water from February to July, with peak activity occurring in April. Timing of egg-laying activity varies with elevation and weather conditions (Verner and Boss 1980). Eggs are usually laid in late May or early June (USFWS 1994). They are laid in gelatinous strings of 13 to 52 eggs per inch, in masses of up to 16,500 per clutch (Stebbins 1951, Kahn 1960). Egg development rate is partially dependent on temperature; hatching times vary (Porter 1972). Eggs are usually laid in shallow water (not deeper than 12 inches [30 cm] but usually at least 6 inches [5 cm] deep (Kahn 1960, Olson 1992). The warmth of shallow water increases the rate at which development occurs; shallow water and vegetative matter may contribute to protecting eggs from predation by fish (Olson 1992). Woody debris or submerged vegetation is also used to protect egg masses (Kahn 1960, Olson 1992).

Metamorphosis is usually completed within 3 months of egg laying. The time required for metamorphosis is given as 30 to 45 days for the western toad (Stebbins 1951). Female western toads at least 10 to 11 years of age have been reported (Olson 1992). In Colorado, western toads probably attain a maximum age of at least 9 years (USFWS 1994).

Western toads wait for their prey on the surface of the ground or in shallow burrows dug by other animals. Their diet consists largely of bees, beetles, ants, and arachnids. Other foods include crayfish, sowbugs, grasshoppers, trichopterans, lepidopterans, and dipterans (Stebbins 1951, Verner and Boss 1980).

Tadpoles are preyed upon by fish, herptiles, birds, and mammals (Porter 1972). Toads in general tend to walk or hop rather than jump (like frogs). Their slow movement makes them vulnerable to predators; however, the western toad (like other toads) produces skin toxins that are avoided by many predator species. The nocturnal habit may also help reduce predation (Kricher 1993). Adult western toads are preyed upon by common ravens (*Corvus corvax*) and probably also by other birds, herptiles, and mammals (Olson 1992, Porter 1972). A badger (*Taxidea taxus*) was recorded as having consumed five adult *Bufo* (probably western toad, which was the only *Bufo* species in the area) in Wyoming (Martin 1973).

Mortality of western toads is greatest during the larval and juvenile stages but is slight thereafter. Most mortality can be attributed to unseasonable weather and predation on juvenile toads. There is very little predation on adult toads, and mortality of adults is low (USFWS 1994). Western toads are also taken by people for the pet trade (Martin 1992).

1.2 Yellow-billed Cuckoo (*Coccyzus americanus*)

The yellow-billed cuckoo is distributed throughout much of the mideastern United States, southeastern Canada, the Greater Antilles, and Mexico. The species winters primarily in South America east of the Andes Mountains. There are also reports of the species west of the Andes in northern Colombia (Hilty and Brown 1986).

The species' range boundaries are confused by recurrent observations of nonbreeding individuals away from breeding sites. For instance, there are several reports of vagrants in Canadian prairie provinces in July (Koes and Taylor 1996) and in Alaska (Tobish and Isleib 1992). The species may also wander north or east in the fall before migrating south. Some individuals have also been observed in Britain, Ireland, and Western Europe, and the birds were found either dead or near death (Crmap 1985). These birds became disoriented in frontal zones north of Bermuda, and then were carried east (Cramp 1985).

The yellow-billed cuckoo prefers open woodlands with clearings and low, dense, scrubby vegetation; it is often associated with waterways. Generally, the species is absent from heavily forested areas and large urban areas (Eaton 1988). In the central United States and Canada, the bird occupies woodlands, abandoned farmland, overgrown fruit orchards, successional shrubland, and dense thickets along streams and marshes (Johnsgard 1979, Peck and James 1983, Eaton 1988, Jauvin 1996). It is also found in willow (*Salix* spp.)-dogwood (*Cornus* spp.) shrub wetlands. The yellow-billed cuckoo is primarily solitary during the breeding season, observed either alone or in breeding pairs (Oberholser 1974). The bird gathers in large flocks during migration (Hilty and Brown 1986).

There are reports of the bird breeding in southeastern Idaho (Dobkin 1994). Age at first breeding is believed to be at about one year of age. Females lay between 1 and 5 eggs, with 2 to 3 being the usual. Sets of 6 or more eggs may be attributed to more than one female laying eggs in a single nest (Nolan and Thompson 1975). The number of broods per season is not confirmed, though the species is believed to have a single brood, with nesting timed to coincide with temporary local abundance of food (Nolan and Thompson 1975).

The yellow-billed cuckoo is known to parasitize at least 11 other bird species: it lays its eggs in the nests of other species such as the American robin. The yellow-billed cuckoo does not randomly lay eggs in nests of other birds but selects hosts with similarly colored eggs (Hughes 1997).

There is little information on the life span and survivorship of the yellow-billed cuckoo because so very few banded birds have been recovered. Three banded birds were captured at 4 years of age (Canadian Wildlife Service, cited in.

The yellow-billed cuckoo eats primarily large insects like caterpillars, katydids, cicadas, grasshoppers, and crickets (Nolan and Thompson 1975, Laymon 1980). Occasionally, the bird eats small frogs, and arboreal lizards (Voous 1955, Hamilton and Hamilton 1965). In winter, the cuckoo more frequently eats fruit and seeds than it does in summer (Rappole *et al*.1983). The bird forages in open areas, woodlands, orchards, and adjacent streams. The majority of food items are collected from riparian habitats (Laymon 1980).

Eggs and nestlings may be taken by avian predators, mammals, or snakes (Nolan 1963, Potter 1980). Raptors may be an important cause of adult mortality both along the migration route and upon arrival in wintering grounds following migration.

1.3 American Beaver (*Castor canadensis*)

The American beaver inhabits riparian areas of mixed coniferous-deciduous forests and deciduous forests containing abundant beaver foods and lodge-building material such as quaking aspen (*Populus tremuloides*), willows (*Salix* spp.), alders (*Alnus* spp.), redosier dogwood (*Cornus sericea*), and cottonwoods (*Populus* spp.) (Patric and Webb 1953, Allen 1983). Suitable habitat for beavers must contain all of the following: stable aquatic habitat providing adequate water; a channel gradient of less than 15%; and quality food species in sufficient quantity (Allen 1983). Through tree-harvesting activity, beavers can usually control water depth and stability on small streams, ponds, and lakes and can also have an effect on natural succession.

Large lakes or reservoirs (8 ha in surface area) with irregular shorelines provide optimum habitat for beavers. Lakes and reservoirs that have extreme annual or seasonal fluctuations in the water level are generally unsuitable habitat for beavers (Allen 1983, Smith and Peterson 1991). Intermittent streams or streams that have major fluctuations in discharge have little year-round value as beaver habitat (Allen 1983). Food availability is another factor determining suitable habitat for beavers (Harris 1991). Beavers often occupy marshes, ponds, and lakes when an adequate supply of food is available. They generally forage no more than about 90 m from water, though foraging distances of up to 200 m have been reported (Allen 1983).

In Idaho, beavers breed between mid-January and early June (Lippincott 1997). Beavers are generally monogamous, although males will mate with other females (Van Gelden 1982, Merritt 1987). Only the dominant female of a beaver colony breeds, producing one litter a year (Van Deelen 1991). The gestation period is four months, with the average litter size varying between two and three kits (Rue 1967, Van Gelden 1982, Zeveloff 1988, Van Deelen 1991). Kits are weaned at two to three months and can swim by one week of age (Van Gelden 1982, Zeveloff 1988). Beavers become sexually mature between ages two and three (Lawrence 1954, Wilkinson 1962). They live up to 11 years in the wild and between 15 and 21 years in captivity (Rue 1967, Merritt 1987).

Beavers are active throughout the year and usually nocturnal. They live in colonies (average five beavers per colony) that consist of three age classes: adults, kits, and yearlings that were born the previous spring (Lawrence 1954). After young beavers reach their second or third year, they are forced to leave the family group (Lawrence 1954, Merritt 1987, Zeveloff 1988). Dispersal may be delayed in areas with high beaver densities. Subadults generally leave the natal colony in late winter or early spring (Van Deelen 1991). Subadult beavers have been reported to migrate as far as 236 km, although average migration distances range from 8 to 16 km (Allen 1983). Adult beavers are nonmigratory (Allen 1983).

Beavers are herbivores. During late spring and summer, their diet consists mainly of fresh herbaceous matter (Allen 1983, Lawrence 1954). Beavers appear to prefer herbaceous vegetation to woody vegetation during all seasons if it is available. Woody vegetation may be consumed during any season, although its highest utilization occurs from late fall through early spring when herbaceous vegetation is not available. The majority of the branches and stems of woody vegetation are cached for later use during winter (Allen 1983). Trees and shrubs closest to the water's edge are generally used first (Allen 1983).

Winter is a critical period, especially for colonies on streams because they must subsist solely on their winter food caches. In contrast with stream colonies, those on lakes are not solely dependent on their stores of woody vegetation; they can augment their winter diet of bark with aquatic plants (Lawrence 1954).

Aquatic vegetation such as duckweed (*Lemma* spp.), pondweed (*Potamogeton* spp.), and waterweed (*Elodea* spp.) are preferred foods when available (Allen 1983). The thick, fleshy rhizomes of water lilies (*Nymphaea* spp. and *Nuphar* spp.) may be used as a food source throughout the year. If present in sufficient amounts, water lily rhizomes may provide an adequate winter food source, resulting in little or no tree cutting or food caching of woody materials (Allen 1983, Lawrence 1954). Other important winter foods of beavers living on lakes include the rhizomes of sedges and the rootstocks of mat-forming shrubs (Lawrence 1954).

Aspen and willows are considered preferred beaver foods; however, these species are generally riparian species and so may be more available for beaver foraging but not necessarily preferred over all other deciduous tree species. Beavers have been reported to subsist in some areas by feeding on conifer trees, but these trees are a poor-quality food source (Allen 1983).

The lodge is the major source of escape, resting, thermal, and reproductive cover for beavers. Beavers usually construct lodges so that the structure is surrounded by water or located against a bank. Water protects the lodge from predators and provides concealment for beavers when traveling to and from food-gathering areas and caches (Allen 1983). On lakes and ponds, lodges are frequently situated in areas that provide shelter from wind, waves, and ice (Allen 1983). Damming large streams that have swift, turbulent waters creates calm pools for feeding and resting (Harris 1991).

Beavers have few natural predators; however, in certain areas, they may face predation pressure from wolves (*Canis lupus*), coyotes (*Canis latrans*), lynx (*Lynx canadensis*), fishers (*Martes pennanti*), wolverines (*Gulo gulo*), and occasionally bears (*Ursus* spp.). Minks (*Mustela vison*), otters (*Lutra canadensis*), hawks, and owls periodically prey on kits (Rue 1967, Merritt 1987). Humans kill beavers for their fur (Lawrence 1954, Merritt 1987).

However, beavers will live near people if all habitat requirements are met (Rue 1967). Railways, roads, and land clearing adjacent to waterways may affect beaver habitat suitability. Transplants of beaver may be successful on strip-mined land or in new impoundments where water conditions are relatively stable. Highly acidic waters, which often occur in strip-mined areas, are acceptable for beaver if suitable foods are present (Allen 1983).

Beaver activity can have a significant influence on stream and riparian habitats (Munther 1981, Barnes and Dibble 1988, Johnston and Naiman 1990, Van Deelen 1991). Through tree-harvesting activity, beavers can affect natural succession. Other than humans, beavers are the only mammals in North America that can fell mature trees; therefore, their ability to decrease forest biomass is much greater than that of other herbivores (Allen 1983). In addition, beaver ponds conserve spring runoff, thus ensuring more constant stream flow, diminishing floods, conserving soil, and helping maintain the water table (Hazard 1982).

Beaver activity can be beneficial to some wildlife species (Johnson 1989, Van Deelen 1991). Waterfowl often benefit from the increased edge, diversity, and invertebrate communities created by beaver activity (Van Deelen 1991). Occupied beaver-influenced sites produce more waterfowl because of improved water stability and increased brood-rearing cover; waterfowl production declines when beavers leave an area. Great blue herons (*Ardea herodias*), ospreys (*Pandion halietus*), bald eagles (*Haliaeetus leucocephalus*), kingfishers (*Ceryle alcyon*), and many species of songbirds also benefit from beaver activity. Otters, raccoons (*Procyon lotor*), mink, and muskrat (*Ondatra zibithica*) thrive on the increased foraging areas produced by beaver activity. Berry-producing shrubs and brush in areas cut by beavers attract white-tailed deer (*Odocoileus virginianus*) and black bear (*Ursus americanus*) (Van Deelen 1991).

Beaver activity can also improve fish habitat. Production of three trout species (*Salmo* spp. and *Salvelinus fontinalis*) in a stream in the Sierra Nevada increased due to a higher standing crop of invertebrates in beaver ponds (Gard 1961). Smallmouth bass (*Micropterus dolomieuis*) and northern pike (*Esok lucius*) also benefit from beaver impoundments (Van Deelen 1991). In some instances, beaver ponds have provided up to six times more salmonids (by total weight) per acre than adjacent stream habitat without beaver ponds has provided (Munther 1981). In areas of marginal trout habitat, however, beaver activity can reduce trout production. Beaver-caused loss of streamside shade and diminished water velocity can result in lethal water temperatures (Van Deelen 1991).

The amount of influence that cattle have on riparian environment can be reduced by beaver activity in many valley bottoms. If beavers are thoroughly established in willow habitats of wide valleys prior to cattle being introduced, the immediate effect of cattle on the stream is often minor (Munther 1981).

Beaver activity can also have detrimental effects. Beaver-caused flooding often kills valuable lowland timber (Van Deelen 1991). Human–beaver conflicts occur when beavers flood roadways and agricultural lands or dam culverts and irrigation systems. Also, beavers have potential to increase waterborne pathogens (including *Giardia lamblia*) downstream of their activity (Van Deelen 1991).

Information on the direct effects that fire has on beavers was not found in the literature; however, beavers can probably easily escape fire (Tesky 1993). Since lodges are typically built over water, they are probably at little risk of being destroyed by fire. Fire occurring in riparian areas often benefits beaver populations (Kelleyhouse 1979). Beavers are adapted to the early stages of forest succession. Quaking aspen, willows, alders, and redosier dogwood—prime beaver food trees—all sprout vigorously after fire. As succession progresses, these trees become too large for beavers to use or are replaced by climax trees (Wright and Bailey 1982). Recurring fires within parts of boreal forests have allowed aspen and willow to replace coniferous forests. This change favors beaver populations since willow and aspen are important food sources.

2 Open Water

2.1 Trumpeter Swan (*Cygnus buccinator*)

The trumpeter swan is listed as a species of special concern in Idaho (Category A, Draft List) and Montana and as a Priority 1 species in Wyoming. Region 1 of the U.S. Forest Service lists the trumpeter swan as a sensitive species on the Beaverhead, Gallatin, and Custer National Forests in Montana. Region 4 (Draft List) also lists the swan as a sensitive species (Clark *et al*. 1989, Reel *et al*. 1989, Finch 1992). The swan is listed as vulnerable in Alberta, British Columbia, Saskatchewan, and Yukon Territory in Canada (CSEWC 1992).

Trumpeter swans were once abundant and widespread in North America. By 1920, the commercial swanskin trade, coupled with sport hunting and habitat destruction, reduced the species to near extinction. The trumpeter swan breeding range extended from Alaska eastward to Ontario and south to Oregon, the Rocky Mountains, Nebraska, and northern Missouri (Shea 1979). Now, only two major populations remain (Palmer 1976, Shea 1979, Bellrose 1980). The Pacific population of trumpeter swans breeds in Alaska and British Columbia and winters along the Pacific Coast from Alaska to northern Oregon (Clark *et al*. 1989 (Shea 1979). The mid-continental population nests in Alberta, British Columbia, the Yukon Territory, Northwest Territories, Saskatchewan, and the Greater Yellowstone region (Shea 1979, Clark *et al*. 1989). Over-hunting of trumpeter swans destroyed most of the species' traditional migration patterns to southerly winter habitats. As a result, virtually all mid-continental trumpeter swans, regardless of their summer range, now winter in the Greater Yellowstone Ecosystem (Clark *et al*. 1989).

Trumpeter swans are generally found in wetland areas among aquatic and tall emergent vegetation as the vegetation provides shelter and cover (Hansen 1971). Plants found in most trumpeter swan habitats include willows (*Salix* spp.), alders (*Alnus* spp.), cottonwoods (*Populus* spp.), water milfoil *(Myriophyllum exalbescens*), arrowhead (*Sagittaria latifolia*), and pondweeds (*Potamogeton* spp.) (Banko1960, Hansen et al. 1971). Adults may remove vegetation around the nest until the nest is surrounded by open water. This strategy provides good visibility and protection from land predators (Anon. 1992). Nests are built in water 1 to 3 feet deep (Bellrose 1980), often on a muskrat house, beaver lodge, or small island (Reel *et al*. 1989). Occasionally, a nest is located on or near the shoreline of a small inlet in a large lake (Hansen et al. 1971). During winter, trumpeter swans prefer open sites with few trees or shrubs to obscure their vision while feeding (Clark *et al*. 1989). Winter habitat must provide extensive beds of aquatic plants and water that remains ice-free.

Trumpeter swans most often form pair bonds when they are 2 or 3 years old and first nest when they are 4 or 5 years old. Most pairs remain together year-round and bond for life (Clark *et al*. 1989, Reel *et al*. 1989, Anon. 1992). Egg laying normally begins in late April or early May and is completed about mid-May (Palmer 1976, Bellrose 1980). In Alberta, eggs are laid in mid-May (Anon. 1992). Each breeding pair uses only one nest, and the female lays 5 to 6 eggs (Palmer 1976, Madge and Burn 1988, Anon. 1992). If the eggs are destroyed, the pair probably will not renest (Anon. 1992). The incubation period is 33 to 37 days (Banko1960, Bellrose 1980, Reel *et al*. 1989).

Trumpeter swan cygnets grow rapidly (Bellrose 1980). They are fully feathered in 9 to 10 weeks but are unable to fly until 13 to 15 weeks in Alaska and 14 to 17 weeks in Montana (Bellrose 1980, Palmer 1976, respectively). Cygnets remain with their parents throughout their first winter. They separate from the parents the following spring, but siblings may remain together into their third year. Family bonds are strong; subadult siblings may rejoin parents after nesting ends or in subsequent winters (Clark *et al*. 1989). Trumpeter swans may live up to 35 years in captivity but usually do not live more than 12 years in the wild (Anon. 1992).

Nonbreeding subadults molt first, and it is rare for both members of a breeding pair to be flightless at the same time. The male of the pair usually molts first. Some paired birds begin to molt as early as nonbreeders do. Many, however, delay a month or longer. Some trumpeter swans are flightless until early September in Alaska and until October in Montana. Trumpeter swans are normally flightless for about 30 days (Bellrose 1980).

Trumpeter swans eat the roots, stems, leaves, and/or seeds of a variety of aquatic vegetation, and they occasionally eat insects (Anon. 1992). Initially, young cygnets eat large aquatic insects and snails. Cygnets feed on the water's surface and often depend on the adults to stir up the water around them.

Within 2 to 3 weeks, cygnets start to eat aquatic plants (Anon. 1992).

Trumpeter swans feed on the following: the tubers of duck-potato (*Sagittaria* spp.) and sago pondweed (*Stuckenia pectinatus*); the stems and leaves of sago and other pondweeds (*Potamogeton* spp.), water milfoil (*Myriophyllum verticullatum*), muskgrass (*Chara* spp.), waterweed (*Elodea canadensis*), and duckweed (*Lemna triscula*); the seeds of yellow pond lily (*Nuphar polysepala*), water shield (*Bransenia schreber*), smartweed (*Polygonum* spp.), sedges (*Carex* spp.), and spikerush (*Eleocharis* spp.); and the stems and roots of grasses and sedges (Banko1960, Palmer 1976, Bellrose 1980, Anon. 1992).

After they reach flying age, trumpeter swans have few natural enemies, except for humans. Coyotes (*Canis lutrans*), river otters (*Lutra canadensis*), minks (*Mustela vison*), and golden eagles (*Aquila chrysaetos*) have been blamed for cygnet deaths in Yellowstone National Park and Red Rock Lakes National Wildlife Refuge (Shea 1979). The following species also occur in trumpeter swan habitat and could potentially prey on trumpeter swans: the black bear (*Ursus americanus*), lynx (*Lynx canadensis*), bald eagle (*Haliaeetus leucocephalus*), great horned owl (*Bubo virginianus*), mountain lion (*Felis concolor*), bobcat (*Lynx rufus*), striped skunk (*Mephitis mephitis*), red fox (*Vulpes vulpes*), and raccoon (*Procyon lotor)*, as well as gulls (*Larus* spp.) (Shea 1979).

Trumpeter swans are sensitive to human activities on their breeding grounds. Intrusions by people at nesting wetlands have caused temporary and permanent nest abandonment, as well as movements from breeding and staging areas (Anon. 1992). Trumpeter swans will not nest on lakes that have been intensively developed for recreation. The swans are most sensitive to disturbance from mid-April to mid-June (Anon. 1992). Cygnet survival is associated with spring weather and favorable water levels. It is extremely important to properly manage water levels so that nest flooding is avoided and growth of aquatic vegetation is encouraged through nutrient cycling (Reel *et al*. 1989).

2.2 Western Grebe (*Aechmophorus occidentalis*)

The western grebe breeds in Idaho and overwinters primarily on the Pacific Coast, from southern British Columbia to southern Baja California and Sinaloa, Mexico. The species breeds on freshwater lakes and marshes that have extensive areas of open water bordered by emergent vegetation. Breeding areas contain open water of at least several square kilometers (Storer and Nuechterlein 1992).

The species migrates at night, probably in flocks (Nuechterlein and Storer 1982). Many birds from the northern populations move west to the Pacific Coast from early September to early November, with peaks migrations recorded in October. Over the winter, western grebes prefer to hunt on salt or brackish bays, estuaries, or sheltered seacoasts and are infrequently seen on freshwater lakes or rivers. The birds fly east from the Pacific Coast to the interior breeding areas from late April to early May.

Western grebes are monogamous, and the pair bond is maintained at least until the chicks are several weeks old, but it is unknown whether pairs reunite in subsequent years (Storer and Nuechterlein 1992). Unpaired males outnumber females in late-courting groups, suggesting a male-biased sex ratio. Western grebes display two courtship ceremonies that are a series of different behaviors such as rushing, weed dancing, preening, and elaborate neck stretching (Nuechterlein and Storer 1982).

The western grebe is highly social during the breeding period, with nesting occurring in colonies of up to several hundred or thousand individuals on one lake. The colonies are often in areas flooded with emergent vegetation. Beds of extremely thick submergent vegetation such as water milfoil (*Myriophyllum exalbescens*) and pondweed (*Potamogeton* spp.) are also used. Nests are rarely less than 6 feet (2 m) apart (Nuechterlein 1975).

Birds probably can breed in their first year, although small groups of nonbreeding birds are often observed (Storer and Nuechterlein 1992). Normally, one brood is raised per year. The mean clutch size is between 2 and 3 chicks, but clutch size tends to decrease the later in the season the eggs are laid. The number of clutches per season is normally one, but replacement clutches are common. The first chicks hatch in 22 to 24 days (Lindvall and Low 1982). Both members of the pair are usually at the nest and defend it vigorously against other members of the nesting colony. Parental care tends to cease after 8 weeks. Western grebes are known to live up to 14 years, but most banded birds have been recovered at minimum ages of between 6 and 7 years (Eichhorst 1992).

The main food items taken by western grebes are fish, which are reported to compose 81 to 100% of the diet (Wetmore 1924, Lawrence 1950).

The western grebe consumes a wide variety of fishes (Palmer 1962). Other animals eaten by the western grebe are salamanders (Ambystoma), crustaceans, polychaete worms, and insects (grasshoppers and a variety of aquatic forms).

Predators of the western grebe include the bald eagle (*Haliaeetus leucocephalus*) and mink (*Mustela vison*). Raccoons will take nesting adults and eggs. Large gulls (*Larus* spp.) prey on eggs and chicks if humans disturb a nesting colony. Eggs are consumed by common ravens (*Corvus corax*) or pecked and eaten by coots and Forster’s terns, usually after human interference. Chicks are also vulnerable to predation by bass (*Micropterus* spp.) and pike (*Esox* spp.).

The major cause of nest and egg losses for this species is wave action during windstorms. Large numbers of migrant birds have been frozen into a lake during a quick freeze-up (Nero 1960). Also, adults are awkward on land and around nests, and newly hatched chicks are frequently found dead from being trampled in the nest.

2.3 American White Pelican (*Pelecanus erythrorhynchos*)

The American white pelican occurs mainly in western and southern portions of North America. A huge white bird with black-tipped wings, it has an enormous flattened bill with a bright yellow-orange pouch for feeding. The white pelican can reach a height of 55 to 70 inches (14–18 cm), weigh between 13 and 21 pounds (5–8 kg), and have a wingspan of up to 10 feet (3 m). During the breeding season, a short, yellowish crest appears on the back of the head, and a horny plate appears on the upper mandible of the male. This pelican is gregarious, usually traveling in flocks and nesting in colonies.

In Idaho, the white pelican breeds at Minidoka National Wildlife Refuge, at Blackfoot Reservoir, and on the Snake River near Glenns Ferry. The species annually migrates south to where the minimum temperature stays above 39 °F (4 °C). The winter range of the white pelican includes the Pacific Coast from central California and southern Arizona south to Baja California, western Mexico, and Nicaragua. Some birds remain year-round in central Durango, Mexico (Knoder *et al*. 1980).

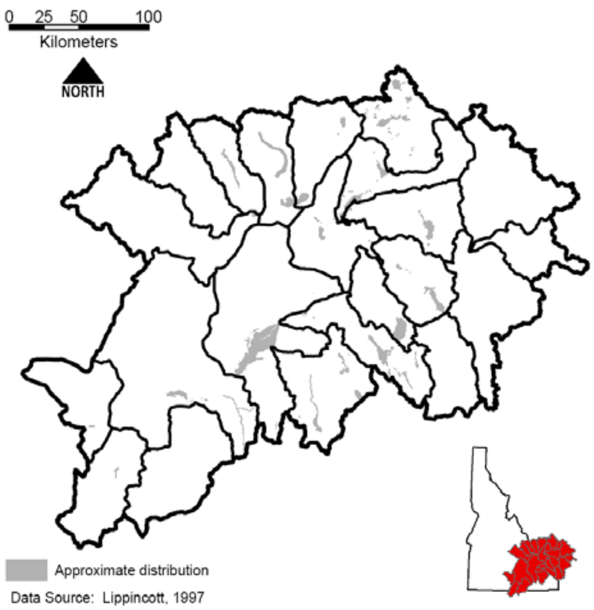
White pelicans first breed at 3 years, and they probably breed annually thereafter (Evans and Knopf 1993). Females lay only one clutch per season of between 1 and 3 eggs. Reduced clutches are common in this species due to egg loss (Evans and Knopf 1993, Knopf 1979). Upon hatching, the young are totally dependent on their parents for food, warmth, and protection. By about 3 weeks of age, they become more mobile. Generally, if there are two hatchlings, only one of the two young survives, the other being harassed or expelled from the nest by its older nest mate (Evans and Knopf 1993). After fledging, 41% mortality occurs in the first year, 16% in the second year (Strait and Sloan 1974). The maximum reported life span for a white pelican, based on 4,344 bird-band returns, is 26.4 years (Clapp *et al*. 1982).

Throughout their range, white pelicans eat small, schooling fish. The pelicans do not dive for food but cooperate to surround fish in shallow water, where the birds then scoop the fish into their pouches. Pelican also take larger sluggish bottom feeders, salamanders, and crayfish (Evans and Knopf 1993).

Mammalian predators include the red fox (*Vulpes vulpes*) and coyote (*Canis latrans*). (Thompson *et al*. 1979). Avian predators include large white-headed gulls (*Larus* spp.), ravens (*Corvus corax*), great horned owls (*Bubo virginianus*), and bald eagles (*Haliaeetus leucocephalus*). Gulls and ravens tend to take eggs (Thompson *et al*. 1979), while great horned owls and eagles take young.

In recent decades, the number of pelicans has declined because of the pesticides, human disturbance, and draining of wetlands.

2.4 American Avocet (*Recurvirostra americana*)



The American avocet is a large shorebird with long bluish legs, a long, thin bill that curves upward, and a black-and-white chevron pattern on its back. The bird is between 17 and 18.5 inches (43–47 cm) long, including a 3.25- to 3.75-inch (8.2–9.5 cm) bill; the bird weighs between 9.7 and 12.4 ounces (275–350 g). The plumage on the avocet’s head and neck becomes a cinnamon color in early spring when the birds begin to form mating pairs and migrate to breeding areas.

The American avocet migrates north to the wetlands of the arid western United States from March to May and returns to the southern winter ranges from July to October. Large numbers of the species breed at the marshes of the Great Salt Lake, Utah, and the Tulare Basin, California. The avocet also breeds in the Upper Snake province, arriving between April and May. After the breeding season is over, the birds migrate to parts of California and southern Texas, southward through Mexico to Central America.

Upon arriving at the breeding grounds, the mated pair copulates several times. Most avocets breed at 2 years, but some breed in their first year. Females lay between 3 and 4 eggs, with 4 being the usual (Robinson *et al*. 1997). Both parents incubate the eggs for about 23 to 25 days (Gibson 1971, Hamilton 1975). Chicks stay in the nest no more than 24 hours after the last chick hatches (Robinson *et al*. 1997). In dense nesting areas, chicks sometimes move from nest to nest and are brooded by different adults. Broods are led to nursery areas of shallow water that have vegetation that can be used for cover. The young become independent in about 6 weeks. American avocets are known to live for at least 9 years (Robinson *et al*. 1997).

The avocet feeds by thrusting its bill underwater and swinging it from side to side along the bottom to stir up aquatic insects (Hamilton 1975). It also eats crustaceans and other aquatic animals, as well as plants, that it happens to stir up or that it finds at the surface of the pond or marsh.

The avocet eats primarily aquatic invertebrates and also takes terrestrial invertebrates, small fish, and seeds. In freshwater wetlands, the avocet will eat water boatmen (Hemiptera, Corixidae), adult and larval beetles (Coleoptera), fly larvae (Diptera), midges (Chironomidae), and, in more saline wetlands, brine flies (Wetmore 1925). The avocet will also eat seeds of marsh or aquatic plants, specially sago pondweed (*Stuckenia pectinatus*), salt grass (*Distichlis spicata*), and bulrushes (Robinson *et al*. 1997). In permanent shallow lakes and inland sloughs, the avocet will eat amphipods (*Gammarus lacustris* and *Hyalella azteca*) (Edwards and Bush 1989). Other foods identified from avocet stomachs include terrestrial insects such as grasshoppers (Orthoptera), caterpillars (Lepidoptera), beetles (Coleoptera), true bugs (Hemiptera), flies (Diptera) and ants, bees and wasps

(Hymenoptera), and spiders (Araneae); small minnows (Cyprinidae); and a small salamander (Salamandridae) (Wetmore 1925).

Predators of adult avocets include the peregrine falcon (*Falco peregrinus*), prairie falcon (*F. mexicanus*), great horned owl (*Bubo virginianus*), and northern harrier (*Circus cyaneus*) (Porter and White 1973, Evans 1988). Falcons and harriers, as well as mink (*Mustela vison*), are known to prey on the young. Predators of avocet eggs include gulls, ravens (*Corvus corax*), badgers (*Taxidea taxus*), striped skunks (*Mephitis mephitis*), long-tailed weasels (*M. frenata*), coyotes (*Canis latrans*), raccoons (*Procyon lotor*), red fox, and gopher snakes (*Pituophis melanoleucus*) (Gibson 1971, Grover and Knopf 1982, Sidle and Arnold 1982, Alberico 1993).

2.5 Common Loon (*Gavia immer*)

The common loon breeds on freshwater lakes, predominately in the broadband of boreal and mixed forest across North America (Barr 1973, 1996). The common loon is very striking, with a black-and-white checkered back, glossy black head, and white "necklace" around the throat. Males and females look the same, though males are generally larger. Adults are large-bodied, weighing from 2.5 to over 6.1 kg and measuring between 66 and 91 cm long (McIntyre and Barr 1997).

Although they are thought of as solitary birds, loons sometime gather into small groups in the summer. In September, group feeding is quite common as loons gather on larger lakes during migration. Loons are usually found in groups on their ocean wintering grounds.

In spring, loons arrive on northern lakes as soon as the ice thaws. After a loon starts to breed, it attempts to breed every year thereafter. Loons are solitary nesters. Small lakes, generally covering between 5 and 50 hectares, can accommodate one pair of nesting loons (Kerekes *et al*. 1994). Larger lakes may have more than one pair of breeding loons, with each pair occupying a bay or section of the lake (Yonge 1981). Some loons may nest on lakes that cover less than 7 hectares and use other nonterritorial lakes for foraging (McIntyre 1975).

There is no data on age at first breeding, but it is thought that the common loon first breeds at 4 years, or as late as 7 years (McIntyre and Barr 1997). The oldest banded bird recovered was almost 8 years old (Clapp *et al*. 1982). One loon was recorded to return to breeding grounds for 9 years. There is no data on survivorship, but it is assumed that the life span of the common loon is similar to that of the Arctic loon (*Gavia arctica*), 25 to 30 years (Nilsson 1977).

Banding studies have shown that loons sometimes switch mates after a failed nesting attempt and even between nesting attempts in the same season (Evers 1993). Loons build their nests close to the water, with the best sites being completely surrounded by water, such as on an island, muskrat house, half-submerged log, or sedge mat (Olson and

Marshall 1952, Palmer 1962, Vermeer 1973, Alvo 1981, McIntyre 1988). The same sites are often used from year to year (McIntyre 1974). Usually one or two eggs are laid in late June.

Both the male and female help with nest building and incubation, which usually lasts 27 to 31 days (Yonge 1981). If the eggs are lost, the pair may renest, often in the same general location (McIntyre 1975). Chicks are fed exclusively by their parents for the first few weeks of life, and up until the chicks are 8 weeks old, the adults are with them most of the time (McIntyre and Barr 1997). After this time, the chicks begin to dive for some of their own food, and by 11 or 12 weeks of age, the chicks are providing almost all of their own food and may be able to fly (McIntyre and Barr 1997).

Early in their life, chicks are fed small food items including snails, small fish, crayfish, minnows, and some aquatic vegetation. As they grow, they are fed more fish. Adult common loons eat primarily live fish, other aquatic vertebrates, and some invertebrates and occasionally eat vegetation (Barr 1996).

The loon's skeleton and muscular systems are designed for swimming and diving. The legs are placed far back on the body, allowing for excellent movement in water but making the birds ungainly on land. The loon's head can be held directly in line with the neck during diving to reduce drag, and the legs have powerful muscles for swimming (Wilcox 1952). Many bones of the loon's body are solid, rather than hollow like those of other birds. These heavy bones make loons less buoyant and help them dive (McIntyre and Barr 1997). The loon's large webbed feet, not their wings, provide propulsion underwater.

Adult common loons have few known predators on breeding grounds, primarily due to careful nest site selection. Placing nests on islands and floating artificial structures, rather than on natural shoreline, results in increased nest success (McIntyre and Mathisen 1977). Still, some predators manage to raid nest sites; such predators include American crows (*Corvus brachyrynchos*), ravens (*Corvus corax*), gulls (*Larus* spp.), striped skunks (*Mephitis mephitis*), raccoons (*Procyon lotor*), mink (*Mustela vison*), and weasels (*Mustela* spp.). Young chicks are taken by northern pike (*Esox lucius*), muskellunge (*E. masquinongy*), snapping turtles, bald eagles, and gulls (Yonge 1981).

3 Shrub-steppe

3.1 Sagebrush (*Artemisia* spp.)

3.1.1 Wyoming Big Sagebrush (*Artemisia tridentata* ssp. *wyomingensis*)

Wyoming big sagebrush-steppe communities are prevalent in the West (Howard 1999). There are two other widely distributed subspecies of big sagebrush: basin big sagebrush (*A. tridentata* ssp. *tridentata*) and mountain big sagebrush (*A. tridentata* ssp. *vaseyana*) (Beetle and Young 1970, Hickman 1993, Kartesz 1994). It is impossible to distinguish Wyoming big sagebrush from basin or mountain big sagebrush without molecular analysis (Beetle and Alvin 1965, Weber 1987).

Wyoming big sagebrush is a native shrub (Balliette *et al*. 1986, Dorn 1988, Hickman 1993, Cronquist *et al*. 1994). It is the most drought tolerant of the three major big sagebrush subspecies (Meyer and Monsen 1993). Plants are generally 46 to 76 cm tall, with rounded, uneven crowns. The main stem is usually branched at or near ground level into two or more substems (Schlatterer 1973, Beetle and Johnson 1982). Wyoming big sagebrush is technically an evergreen but semi deciduous in habit. It develops two types of leaves: large ephemeral leaves and smaller, perennial leaves produced from ephemeral leaf axes (Miller and Shultz 1987). The inflorescence is an open, many-flowered spike (Beetle and Johnson 1982). The fruit is a small, easily shattered achene (Shaw and Monsen 1990).

The root system is deep and well developed, with many laterals and one or more taproots. The majority of roots (about 35% of the total root system) are in the upper first foot (30.5 cm) of soil. Some roots may penetrate as far as 6 feet (1.8 m) (Fernandez and Caldwell 1975, Leaf 1975, Sturges 1977). Roots are infected with the vesicular-arbuscular mycorrhizae (VAM) (*Glomus microcarpus* and *Gigaspora* spp.) (Doerr *et al*. 1971, Bethlenfalvay and Dakessian 1984, Hurley and Wicklow-Howard 1986).

Wyoming big sagebrush reproduces from seed; it does not sprout or layer (Beetle and Young 1965, Schlatterer 1973, McArthur *et al*. 1977). Pollination is mostly by outcrossing, but plants can also self-pollinate (Freeman *et al*. 1991). Wyoming big sagebrush is also a long-lived species. Maximum life span may exceed 150 years (Ferguson 1964).

Wyoming big sagebrush is most common on foothills, undulating terraces, slopes, and plateaus but also occurs in basins and valley bottoms (Francis 1983, Tiedeman *et al*. 1987, Dorn 1988, Hodgkinson 1989, Cronquist *et al*. 1994). Aspect varies, but shrubs are most common on south- to west-facing slopes (Tweit and Houston 1980, Tiedeman *et al*. 1987, Burke *et al*. 1989). The plant occurs on frigid, mesic, and xeric soils of silty, clayey, skeletal, and mixed textures (Passey *et al*. 1982, Francis 1983, Winward 1983, Holland 1986, Hodgkinson 1989). In the Snake River Plain of southern Idaho, Wyoming big sagebrush communities occur on sites that receive more than 8 inches (20 cm) of annual precipitation. Where the ranges of Wyoming and mountain big sagebrush overlap, Wyoming big sagebrush generally occurs where precipitation is less than 12 inches (30 cm), whereas mountain big sagebrush occurs on wetter sites (Hironaka *et al*. 1983, Hironaka 1986, Bunting *et al*. 1993). In the southern Rocky Mountains, Wyoming big sagebrush occurs on low- to mid-elevation sites that receive precipitation mainly as rain, whereas mountain big sagebrush occurs above 6,900 feet (2,100 m), where most precipitation is snow (Leaf 1975).

Wyoming big sagebrush communities are common in southern Idaho (Kaltenecker and Wicklow-Howard 1994). The sagebrush occurs in pinyon-juniper (*Pinus-Juniperus* spp.) woodlands and ponderosa pine (*P. ponderosa*) forests, often as a dominant shrub (Tausch and Tueller 1990, Eddleman *et al*. 1994, Rose and Eddleman 1994, West *et al*. 1998). On the Snake River Plain, community associates include budsage (*Artemisia spinescens*), shadscale (*Atriplex confertifolia*), littleleaf horsebrush (*Tetradymia glabrata*), green rabbitbrush (*Chrysothamnus viscidiflorus*), winterfat (*Krascheninnikovia lanata*), Indian ricegrass (*Achnatherum hymenoides*), bottlebrush squirreltail (*Elymus elymoides*), Sandberg bluegrass (*Poa secunda*), and cheatgrass (*Bromus tectorum*) (Bunting *et al*. 1993). Soil crusts of cyanobacteria, lichens, and mosses including twisted moss (*Tortula ruralis*), fire moss (*Ceratodaon purpureus*), silvergreen bryum moss (*Bryum argenteum*), and funaria moss (*Funaria hygrometrica*) may be well represented.

Wyoming big sagebrush is preferred browse for wild ungulates (Peek *et al*. 1979, Welch and McArthur 1986, Shaw and Monsen 1990, Bray *et al*. 1991), and Wyoming big sagebrush communities are important winter ranges for big game (McArthur *et al*. 1977, Tweit and Houston 1980, Mueggler and

Stewart 1981, Hironaka *et al*. 1983). Pronghorn usually browse Wyoming big sagebrush heavily (Allen *et al*. 1984). On the Idaho National Engineering and Environmental Laboratory, for example, the shrub comprised 90% of the diet of pronghorn from fall through spring. Lagomorphs may browse Wyoming big sagebrush heavily in winter (Gates and Eng 1984). Wyoming big sagebrush is a crucial food item for the sage-grouse and part of the bird's critical habitat (Tweit and Houston 1980, Clifton 1981, Autenrieth *et al*. 1982, Welch *et al.* 1991, Fischer *et al*. 1993, Fischer *et al.* 1996).

Wyoming big sagebrush is a mid to late seral species (Eddleman and Doescher 1978, Francis 1983). It may take a decade or longer for Wyoming big sagebrush reestablishment after a stand-replacing event such as fire (Sturges 1994). Prior to reestablishment of Wyoming big sagebrush, disturbed Wyoming big sagebrush communities are mostly populated with associated grasses. For instance, cheatgrass dominates many Wyoming big sagebrush stands in southern Idaho, northern Nevada, and eastern Oregon.

Fire is the principal means of renewal for decadent stands of Wyoming big sagebrush (Blank *et al.* 1994). After fire, Wyoming big sagebrush establishes from the seedbank (Beetle and Young 1965, Schlatterer 1973, McArthur *et al.* 1977), from seed produced by remnant plants that escaped fire (Bushey 1987), and from plants adjacent to the burn that seed in (Clifton 1981, Bushey 1987). Fires in Wyoming big sagebrush are usually not continuous, and remnant plants are the principal means of post-fire reproduction (Bushey 1987). Fire does not stimulate germination of soil-stored Wyoming big sagebrush seed, but neither does fire inhibit its germination (Chaplin and Winward 1982).

Interestingly, Native Americans made tea from big sagebrush leaves. They used the tea as a tonic and an antiseptic for treating colds, diarrhea, and sore eyes and as a rinse to ward off ticks. Big sagebrush seeds were eaten raw or made into meal (Mozingo 1987). The wood is extremely aromatic when burned, and the wood smoke was used to mask the effects of an encounter with a skunk (Elmore 1976).

3.1.2 Mountain Big Sagebrush (*Artemisia tridentata* var. *vaseyana*)

Mountain big sagebrush is a long-lived (50+ years), woody, aromatic, native, evergreen shrub (Beetle and Johnson 1982, Blank *et al.* 1994). Shrubs often appear flat topped from a distance because of the nearly equal height of flowering stalks (Lackschewitz 1991). The fruit is a small, easily shattered achene that falls or is blown near the parent plant (Young and Evans 1989, Shaw and Monsen 1990). Root length of mature plants is about 2 m (6.5 feet) (Richards and Caldwell 1987). Mountain big sagebrush roots are colonized by fungi that form symbiotic vesicular-arbuscular mycorrhizae (Caldwell *et al.* 1985, Trent *et al.* 1994). Aboveground, the plant is host to an unidentified, pathogenic snow-mold fungus that decreases shrub cover and productivity (Hess *et al*. 1985, Nelson and Sturges 1986).

Mountain big sagebrush usually flowers in late summer and fall, but some strains may flower as early as July (Johnson 2000). Seed matures from September through October (McArthur *et al*. 1979). Mature seeds fall or are blown from inflorescences during autumn and winter, and emergence occurs in winter or spring (McDonough and Harniss 1974, Young and Evans 1989, Meyer and Monsen 1991). Seeds are short-lived (less that 5 years in warehouse) and probably do not form a persistent seed bank (Young and Evans 1989, Meyer *et al*. 1990). Mountain big sagebrush can reproduce vegetatively by layering

(Beetle and Young 1965, McArthur *et al*. 1979, Harvey 1981, Beetle and Johnson 1982). It does not resprout when aboveground tissues are killed by fire or other means (Blaisdell 1953, Blaisdell *et al*. 1982).

In the Intermountain West, mountain big sagebrush usually occurs in the upper elevational range of the big sagebrush zone in montane valleys and on foothills, slopes, and high ridges (Beetle 1960, Beetle 1961, McArthur *et al*. 1979, Winward 1980, Blaisdell *et al*. 1982). In northerly parts of its range, this species occurs in mountain valleys and on mountain slopes and ridges as high as 9,850 feet (3,000 m) (McArthur *et al*. 1979). In Idaho, it has been reported as low as 2,500 feet (780 m). Soils are moderately deep, well drained, slightly acidic to slightly alkaline and characterized by late-melting winter snow cover and summer moisture (Beetle 1961, West *et al.* 1978, McArthur *et al*. 1979, Blaisdell *et al*. 1982, Tueller and Eckert 1987, Burke 1989, Burke *et al*. 1989). This shrub grows in full sun but tolerates shade, often occurring in association with mature conifers (West *et al*. 1978, Noste and Bushey 1987).

Mountain big sagebrush occurs over a range of habitats from montane parklands to warm desert fringes in western North America, often as a dominant in shrublands or codominant in savannah (Johnson 2000). This species is a common component of shrub patches in arid grasslands (Mueggler and Campbell 1982, Marlow *et al*. 1987, Vaitkus and Eddleman 1991, Johnson *et al*. 1994, Rose and Eddleman 1994). It occurs widely throughout Great Basin pinyon-juniper woodlands dominated by true pinyon (*Pinus edulis*), singleleaf pinyon (*P. monophylla*), and Utah juniper (*Juniperus osteosperma*) (Tueller *et al*. 1979). Mountain big sagebrush has been reported in association with numerous other tree species, including quaking aspen (*Populus tremuloides*) (Mueggler and Campbell 1982, Mueggler 1985, Burke *et al*. 1989, Chambers 1989), ponderosa pine (*P. ponderosa*) (Peek *et al*. 1979, Harvey 1981, Johnson *et al*. 1994, Rose and Eddleman 1994), lodgepole pine (*P. contorta*) (Beetle 1961, Chambers 1989), Douglas-fir (*Pseudotsuga menziesii*) (Pfister *et al*. 1977, Harvey 1981), limber pine (*P. flexilis*) (Beetle 1961, Plummer 1976, Pfister *et al*. 1977, Harvey 1981), subalpine fir (*Abies lasiocarpa*) (McLean 1970), and whitebark pine (*P. albicaulis*) (Beetle 1961, Mumma 1990). Mountain big sagebrush may also occur in association with white fir (*A. concolor*) and Engelmann spruce (*Picea engelmannii*).

Common plant associates in Idaho and Montana include Woods' rose (*Rosa woodsii*), mountain snowberry (*Symphoricarpos oreophilus*), green rabbitbrush (*Chrysothamnus viscidiflorus*), antelope bitterbrush (*Purshia tridentata*), and Rocky Mountain juniper. Associated grasses and forbs include Kentucky bluegrass (*Poa pratensis*), bluebunch wheatgrass (*Pseudoroegneria spicata*), Idaho fescue (*Festuca idahoensis*), cheatgrass (*Bromus tectorum*), prairie Junegrass (*Koeleria macrantha*), green needlegrass (*Nassella viridula),* needle and thread (*Hesperostipa comata*), Sandberg bluegrass (*Poa secunda*), and bottlebrush squirreltail (*Elymus elymoides*) (Winward 1970, Marlow *et al*. 1987, Kaltenecker and Wicklow-Howard 1994, Monsen and Anderson 1995).

Publications listing mountain big sagebrush as a dominant, codominant, or indicator species include the following: *Sagebrush-Grass Habitat Types of Southern Idaho* (Hironaka *et al*. 1983), *Aspen Community Types on the Caribou and Targhee National Forests in Southeastern Idaho* (Mueggler and Campbell 1982), *Grassland and Shrubland Habitat Types of the Shoshone National Forest* (Tweit and Houston 1980), *Taxonomic and*

Ecological Relationships of the Big Sagebrush Complex in Idaho (Winward 1970), and *Sagebrush Steppe* (Young *et al*. 1977).

The ecology of mountain big sagebrush in the West has been altered by postsettlement increases or decreases in historical fire intervals, livestock grazing, widespread invasion by exotic annuals, and perhaps climate change (Burkhardt and Tisdale 1976, Blaisdell *et al*. 1982, West 1988, Miller and Rose 1998). Historical abundance of big sagebrush has been disputed. According to reviews (Beetle and Johnson 1982, West 1988) and a comparative examination of 20 historical photos from three states (Kuchler 1964), big sagebrush was abundant and codominant with perennial bunchgrasses in presettlement times. Sagebrush species do not appear to have increased their range on a large scale, but reviewers agree that big sagebrush has increased in density in many places in response to excessive grazing and altered fire regimes. Mountain big sagebrush is readily killed by fire and requires at least 15 years to recover after fire (Bunting *et al*. 1987).

In the juniper woodlands of southern Idaho, western juniper has invaded large areas of mountain big sagebrush shrubland. Burkhardt and Tisdale (1969, 1976) reviewed possible causes, including destruction of grassland via livestock grazing, increased seed dispersal by sheep, climate change, and a reduction of the historic fire-return interval. In field sites, they examined seed dispersal mechanisms, fire history, and juniper seedling establishment and concluded that succession of sagebrush-grass shrublands to juniper woodlands is directly related to cessation of periodic fires. In the same region, Hironoka *et al*. (1983) identified 10 climax habitat types dominated by mountain big sagebrush.

There has been extensive documentation that many wild animals rely on the big sagebrush ecosystem for both food and cover (McGee 1979, Nagy 1979, Peek *et al*. 1979, Blaisdell *et al*. 1982, Hironaka *et al*. 1983, Noste and Bushey 1987, Wambolt *et al*. 1994, Welch *et al*. 1996). Wildlife researchers have argued that neither the importance of sagebrush as forage nor the effects of foraging on sagebrush are fully appreciated (Wambolt 1995, 1996; Welch and Wagstaff 1992).

Historically, Native Americans used big sagebrush leaves and branches for medicinal teas and used the leaves as a fumigant. Bark was woven into mats, bags, and clothing (Parish *et al*. 1996).

3.1.3 Black Sagebrush (*Artemisia nova*)

A native evergreen shrub, black sagebrush is small, spreading, and aromatic. Heights usually range from 6 to 18 inches (15–45 cm) but occasionally reach up to 30 inches (76 cm) on productive sites (McArthur and Stevens 1986). Although plants may have an upright habit, the branches are typically decumbent and arise from a spreading base. Black sagebrush has a shallower, more fibrous root system than big sagebrush does (Kleinman 1976). As a result, annual growth depends largely on soil moisture content near the ground surface.

Growth is initiated in April, with new leaves being produced from May throughout most of the summer (Beetle 1960). Flower heads first appear in July, but blooming does not occur until September; flowers may be numerous one year and particularly sparse in another (McMurray 1986). Seed dispersal takes place in October (McMurray 1986). Late spring leaves and summer leaves persist through the winter (McMurray 1986).

Black sagebrush is a significant browse species within the Intermountain region (McMurray 1986). It is especially important on low-elevation winter ranges in the southern Great Basin where extended snow-free periods allow animals to access plants throughout most of the winter (Johnson 1978). In these areas, black sagebrush is heavily utilized by pronghorn and mule deer (Beale and Smith 1970, McAdoo and Klebenow 1979, Clary and Beale 1983) and highly preferred by domestic sheep (Clary 1986). Stands are often contiguous with salt desert communities in the southern Great Basin. Relative to the surrounding vegetation, good-condition winter ranges are productive and also offer a good selection of associated species. Many of these ranges have been seriously depleted by past overgrazing (McMurray 1986).

Black sagebrush is highly nutritious winter forage. Although not as productive as many other forage species, black sagebrush has winter nutritive quality that is second only to that of big sagebrush (Cook and Stoddart 1953, Behan and Welch 1986). However, black sagebrush may be lethal to domestic sheep if it comprises the bulk of their diet for even a short time (McMurray 1986). This situation is most likely to occur when animals are concentrated on winter ranges (Johnson 1978). On spring and transitional ranges, black sagebrush is thought to cause abortion in sheep. Recent studies have shown that it is a preconditioning plant responsible for horsebrush-related photosensitization in sheep (Johnson 1978).

Black sagebrush regenerates almost exclusively from seed (Beetle 1960), spreading aggressively on favorable sites, and is a good conservation plant for dry, shallow, stony soils and mine spoils. Mature, self-perpetuating stands of black sagebrush are considered to be indicators of climax conditions. Seedlings are present during early seral stages, and plants coexist with later-arriving species (McMurray 1986). Long-established black sagebrush stands in Nevada have recently undergone invasion by both Utah juniper (*Juniperus osteosperma*) and singleleaf pinyon (*Pinus monophylla*). This invasion, which accelerated around 1921, has been attributed to the combined effects of overgrazing, fire suppression, and climatic change (Blackburn and Tueller 1970).

Black sagebrush is considered a climax species and has been used as an indicator in a number of habitat-typing systems within the sagebrush-grass region (McMurray 1986). It also occurs as an understory dominant within forested communities. Forested habitat types using black sagebrush as an indicator have been identified within ponderosa pine and juniper series and pinyon-juniper (*Pinus-Juniperus* spp.) series (Alexander 1985).

Historically, fire has had little or no influence in communities dominated by black sagebrush (Winward 1985). When exposed to fire, plants are easily killed and do not sprout (Wright *et al*. 1979, Volland and Dell 1981). Use of prescribed burning is not usually feasible where black sagebrush forms dense stands. Since plants are nonsprouters, fire is not recommended on winter ranges where this species constitutes an important forage plant (McMurray 1986).

3.2 Northern Sagebrush Lizard (*Sceloporus graciosus graciosus*)

A member of the spiny lizard family, the northern sagebrush lizard is about 5 to 6 inches (12–15 cm) long. It is grayish-green to brown, with some darker spots and crossbars and faint, light-colored dorsolateral stripes. Sides are reddish-orange behind the forelegs. Males have light blue mottling (not patches) on their throat and darker blue belly patches. Females have pinkish-orange on their sides and neck (Behler and King 1979).

The northern sagebrush lizard ranges from Montana southward to northwestern New Mexico and west to Washington, Oregon, California, and Baja California (Nussbaum *et al*. 1983). The species is also present in North Dakota. The northern sagebrush lizard is often found in pinyon-juniper woodlands and sagebrush flats.

The lizard is a ground-dweller, appearing to prefer sagebrush and gravelly soils or fine-sand dunes. Home range size averaged about 4,300 to 6,450 square feet (400–600 m^2) in Utah. M'Closkey *et al*. (1997) found that areas experimentally depopulated of this species were quickly recolonized from surrounding areas. The sagebrush lizard is never far from shelter such as stony piles, crevices, or animal burrows. The species is found in elevations from sea level to about 10,500 ft (3,200 m) (Stebbins 1985).

The species produces a single clutch of 1 to 8 eggs, which are laid between June and July (Tinkle *et al*. 1993). Eggs hatch in 45 to 75 days (Tinkle *et al*. 1993). In Colorado and Utah, most adult females produce 2 clutches annually. Sagebrush lizards are sexually mature in their first (southern portion of range) or second (northern) year. In southern Utah, most females produce their first clutch at an age of about 22 to 24 months (some matured in about one year under uncommon optimal conditions). In southern Utah and west-central California, annual survival rate averaged roughly 50 to 60% in adults and less than 30% in juveniles and eggs (Tinkle *et al*. 1993). The southern Utah population appeared to be substantially resource limited.

The northern sagebrush lizard eats insects such as beetles, flies, ants, caterpillars, spiders, ticks, mites, and aphids. The species is diurnal and becomes inactive in cold winter weather; duration of the inactive period varies with local climate. In southern Utah, the lizard is active mainly from early April to mid-September (Tinkle *et al*. 1993).

Predators of sagebrush lizards include striped whipsnakes (*Masticophis taeniatus*), night snakes (*Hypsiglena* spp.), and a variety of predatory birds.

3.3 Greater Sage-Grouse (*Centrocercus urophasianus*)

The greater sage grouse historically inhabited much of the sagebrush-dominated regions of North America. The species is renowned for its spectacular breeding displays, during which large numbers of males congregate to perform a strutting display (Johnsgard 1973). Today, sage-grouse populations are declining throughout most of their range, mostly due to habitat loss and degradation (Hays *et al*. 1998).

Sage-grouse are relatively large, with the males being larger than the females. Males weigh 3.75 to 6.4 pounds (1.7–2.9 kg) and are 26 to 30 inches (65–75 cm) long; females weigh 2.2 to 4 pounds (1.0–1.8 kg) and are 19.7 to 23.6 inches (50–60 cm) long (Schroeder *et al.* 1999). Both sexes have narrow, pointed tails; feathering to the base of the toes; a variegated pattern of grayish brown, buffy, and black on the upper parts of the body; and a black belly (Johnsgard 1973). Males are more colorful than females and have a black throat and bib; scaly, white foreneck plumage; and a large, white ruff on the breast (Dunn *et al*. 1987). Males also exhibit two large, frontally directed air sacs of olive-green skin and yellow superciliary combs that enlarge during breeding display (Johnsgard 1973, Udvardy 1977). Sage-grouse are thought to live up to 10 years in the wild, but in one study, the average life span of sage-grouse in both hunted and protected populations was 1 to 1.5 years (Elman 1974); in another study, sage-grouse 3 to 4 years of age were considered old (Wallestad 1975).

Female sage grouse are sexually mature their first fall and nest the following spring (Patterson 1952). Males are sexually mature the spring following their first winter. Yearling males engage in display and breeding but devote less time and energy to courtship activities than adults do (Wiley 1974).

In early April, male and female sage-grouse gather for displaying and mating at specific locations, called leks. At the beginning of the breeding season, male sage-grouse establish small territories on the lek. The males occupying territories near the center of the lek may be more successful at mating (Davis 1978). After mating, sage-grouse hens leave the lek to nest. Most hens build nests under shrubs (Jarvis 1974, Wallestad and Pyrah 1974, Roberson 1984), specifically in areas with medium-high shrub cover and residual grass (i.e., dry grass from the previous growing season) (Schoenberg 1982, Gregg 1991, Sime 1991). Hens incubate 7 to 15 eggs for about 25 to 27 days (Connelly *et al*. 1991). After hatching, chicks wait until they are dry before they leave the nest. Sage-grouse hens attempt to raise one brood in a season (Girard 1937). The chicks feed themselves, but hens spend considerable time keeping chicks warm and guarding them for the first four to five weeks (Patterson 1952).

Sage-grouse usually roost on the ground from evening until early morning, feed and rest during the afternoon, and return to their roosting site at night (Johnsgard 1973). Sage-grouse use shrub stands with medium to very high shrub cover primarily for foraging and loafing (Autenrieth 1981, Emmons and Braun 1984, Roberson 1984).

Sagebrush, grasses, forbs, and insects comprise the annual diet of sage-grouse. Sagebrush comprises 60 to 80% of the yearly diet of adult sage-grouse (Patterson 1952, Wallestad *et al*. 1975, Remington and Braun 1985) and as much as 95 to 100% of the winter diet (Roberson 1984). Forbs may constitute 50% of the diet of juveniles up to 11 weeks of age (Klebenow and Gray 1968, Peterson 1970). Forbs also appear to be important to nesting hens in the pre-laying period (Barnett and Crawford 1993). Insects make up 50% of the diet during the first and second week of life (Patterson 1952, Klebenow and Gray 1968, Peterson 1970). Chicks younger than 3 weeks old require insects for survival and chicks older than 3 weeks have reduced growth rates when insects were removed from the diet.

Some researchers consider water a key component of sage-grouse habitat (Carr 1967, Savage 1969, Call and Maser 1985). Others have found no evidence that sage-grouse prefer sites close to water (Wallestad 1975, Autenrieth 1981, Cadwell *et al*. 1994). Sage-grouse need to consume water, but they typically obtain enough water by consuming vegetation that stores water, such as succulent forbs. Sage-grouse may concentrate in late summer and fall where water or succulent forbs are available. Water sources include streams, springs, water holes, and cattle troughs. Where water is available, sage-grouse normally visit water sites in the morning and evening. Sage-grouse that occupy areas with little precipitation may migrate to areas containing water during summer and fall. Chicks require water soon after hatching (Girard 1937), so hens with broods often migrate to areas containing water. Petersen (1980) found that hens with broods remained in upland habitat until succulent forbs disappeared; then they moved to wet meadows in late summer.

Sources of mortality of sage-grouse include predation, weather, accidents, disease and parasitism, and environmental hazards such as pesticides. These natural and human-influenced factors become more important management issues with small populations. Blus *et al*. (1989), for instance, found organophosphorus insecticides (dimethoate or methamidophos) directly responsible for the death of sage-grouse that occupied or were near sprayed alfalfa or potato fields in southeastern Idaho. Predation is a limiting factor throughout the annual sage-grouse cycle, but its severity depends on habitat quality. Raptors and crows are the primary predators of sage-grouse (Patterson 1952, Lumsden 1968, Wiley 1973), while coyotes (*Canis latrans*), bobcats (*Lynx rufus*), minks (*Mustela vison*), badgers (*Taxidea taxus*), and ground squirrels (*Spermophilus* spp.) are the most important ground predators. Weather can influence nesting success and survival of young chicks (Dalke *et al*. 1963, Autenreith 1981). Diseases and parasites do not appear to be a significant source of mortality (Girard 1937, Batterson and Morse 1948).

3.4 Sage Sparrow (*Amphispiza belli*)

The sage sparrow breeds from the northern edges of the Great Basin sagebrush expanses in shrub-steppe habitats west of the Rocky Mountains southward to Baja California in the chaparral and sagebrush scrub. There are five subspecies of sage sparrow; *A. belli nevadensis* breeds in Idaho and migrates to the southwestern United States and south to portions of northwestern Mexico for the winter.

The sage sparrow nests in saltbush and rabbitbrush. Most nests are found within or under shrubs (Green 1981, Petersen and Best

1985). The sparrow tends to choose shrubs that are clumped with others and about 26 inches (66 cm) high (Reynolds 1981). Most nests are placed in the densest portion of nest-site vegetation (Petersen and Best 1985). Sage sparrows also show strong breeding site fidelity (Petersen and Best 1987).

Females lay between 1 and 4 eggs, with 3 being the usual (Reynolds 1981). Successful nests averaged 1.3 fledglings/nest (Reynolds 1981). Most *A. belli nevadensis* raise 2 or 3 clutches per season (Martin and Carlson 1998). Both parents feed the young. The sage sparrow male is expected to live for at least 3 years; the female, 2 years. One *A. belli nevadensis* individual was recovered at 6 years old (Wiens 1985).

The sage sparrow's diet varies depending on the season. The species heavily consumes seeds, including grasses, in April and again in July and August (Rotenberry 1980). During May and June, breeding adults take a wide variety of arthropods, primarily beetles (Coleoptera), grasshoppers and crickets (Orthoptera), and butterfly and moth larvae (Lepidoptera) (Wiens and Rotenberry 1979, Rottenberry 1980). Larger prey items are consumed early in the breeding season (April), and prey gradually decline in size to August (Rotenberry 1980). The sage sparrow consumes 44% animal and 56% seed and plant materials in fall, switching to 13% animal and 87% seed and plant material in winter.

Predators of the sage sparrow eggs and young include the Townsend's ground squirrel (*Spermophilus townsendii*), loggerhead strike, and common raven (*Corvus corax*) (Reynolds 1981, Rotenberry and Wiens 1989). Sage sparrow bones are found in great horned owl (*Bubo virginianus*) pellets (Bond 1940).

4 Pine/Fir Forest (Dry, Mature)

4.1 Great Gray Owl (*Strix nebulosa*)

The great gray owl is a large gray owl with a distinctively large facial disk of light gray with darker gray or brown concentric rings. The owl has a black chin with white along the sides that runs into the bottom white border of the facial disk. The iris of the eye is lemon yellow, and the bill is bright yellow to pale olive green. The ears lack tufts. The bottom portion of the wings (primaries and secondaries) and the tail are barred with dark and light gray. The under parts are a grayish-white with dark grayish-brown streaks. Males and females are identical in plumage except that the females may appear slightly darker and larger.

The great gray owl inhabits many types of forests in North America, favoring dense coniferous forests that are near muskegs, meadows, or open fields. This combination allows conifers for nesting and roosting, along with abundant small rodents that occur in the forest openings. In the southern parts of its range, the owl seeks deciduous or coniferous forests at elevations up to 9,200 feet (2,800 m) (Bull and Duncan 1993). In Idaho and Wyoming, over 90% of sightings of great gray owls are in the lodgepole pine (*Pinus contorta*)-Douglas-fir (*Pseudotsuga menziesii*)-aspen (*Populus tremuloides*) zone (Franklin 1987). The owl may migrate to lower elevations during winter months (Bull and Henjum 1990).

The great gray owl does not build its own nest or modify a nest in any way other than to potentially deepen the cup (Voous 1988). Most nesting is done in abandoned raptor or crow nests or broken-off treetops. Nest sites are often reused for several years (Bull *et al*. 1989, Franklin 1988). The age at first breeding is commonly 3 years, although some birds occasionally breed at 2 years, and rarely in their first year (Bull and Duncan 1993). A mated pair will produce one brood per year.

Typically, clutch size is between 3 and 5 eggs (Franklin 1988). If eggs are lost, renesting may occur two additional times, but only one clutch is raised yearly (Voous 1988). The female usually lays one egg per day, and the incubation period is generally 30 days (Franklin 1988). The male does all the hunting during this period (Bull and Duncan 1993). Although the owlets leave the nest at 20 to 29 days old, they are incapable of flight (but can climb trees well) for another 7 to 14 days (Franklin 1988). Fledging occurs before the owlets are 55 days old, but they are cared for by the female until 4 to 5 months of age when they begin to disperse (Bull and Henjum 1990). Great gray owls can live for at least 13 years (Bull and Duncan 1993).

The great gray owl's diet consists almost entirely of small rodents. About 90% of the diet is pocket gophers (*Thomomys* spp.) and voles (*Microtus* spp.) (Franklin 1988). Other small mammals taken by the owl include shrews (*Sorex* spp.), deer mice (*Peromyscus maniculatus*), squirrels, young rabbits, hares (*Lepus* spp.), rats, moles (*Scapanus* spp.), and weasels (*Mustela* spp.). Also taken are birds, usually small, though there are records of sharp-shinned hawks (*Accipiter striatus*), ducks, and grouse being taken (Collins 1980, Nero 1980, Bull *et al*. 1989). Small mammals are usually swallowed whole, while larger prey is torn into pieces.

The great gray owl can detect prey under snow by sound alone and will dive into the snow for hidden prey (Law 1960, Godfrey 1967, Nero 1969). Generally, the owl hunts from a perch by listening and watching. Although primarily nocturnal and crepuscular, the owl may occasionally hunt by day both during winter when days are dark and overcast and while feeding young (Brunton and Pittaway 1971, Bull and Duncan 1993).

The great gray owl is generally tolerant of other owls and diurnal birds of prey. However, there is frequent predation on juvenile great gray owls by northern goshawks and great horned owls, particularly when grouse and hares are scarce (Nero 1980). Red-tailed hawks are also known to attack juvenile great gray owls (Bull and Henjum 1990). Lynx (*Lynx canadensis*) and great horned owls may occasionally kill an adult great gray owl (Duncan 1987). Other potential predators are black bears (*Ursus americanus*) and fishers (*Martes pennanti*) (Duncan 1987).

Colliding with automobiles is a major cause of mortality in some years (Nero and Copland 1981). Timber harvest has the greatest potential impact on populations (Bull and Duncan 1993). Perches need to be left in clear-cut areas so that the owls can readily hunt. Strychnine poisoning of pocket gophers may also have a potential harmful effect (Bull and Duncan 1993).

4.2 Black-backed Woodpecker (*Picoides arcticus*)

The black-backed woodpecker is dependent on fire landscapes and other large-scale forest disturbances (Hutto 1995, Caton 1996, Murphy and Lehnhausen 1998, Hoyt 2000). Fire suppression and post-fire salvage logging are detrimental to this species and have reduced its habitat. This woodpecker is listed as a species of special concern in Idaho.

Compared with other woodpeckers, the black-backed woodpecker is missing a hind toe and thus has only two toes in front and one behind. The male has a yellow cap, which the female does not have; a solid black back and white throat, breast; and belly; and heavily barred sides. The solid black color is glossy, reflecting green on the back and blue on the head. The face pattern consists of a fine white line behind the eye. The bird is approximately 9 to 10 inches (23–25 cm) long and has a wingspread of about 14 to 15.75 inches (36–40 cm) (Robbins *et al*. 1966). The female resembles the male except for lacking the yellow cap and having a more conspicuous line of white behind the eye.

The black-backed woodpecker is an active bird, climbing along branches looking for insects. It hops down blackened/burnt trees, on which it blends in quite well, and strips away bark to expose grubs. The black-backed woodpecker's diet includes approximately 75% insects such as wood-boring beetles, grubs, weevils, ants, other beetles, and spiders (Beal 1911, Goggans *et al*. 1988, Murphy and Lehnhausen 1998). Besides insects, it also feeds on berries and other small fruits, acorns, and nuts (Beal 1911; Lippincott 1997).

The nest of this species is generally excavated by both sexes, but mostly by the male, in the body of dead trees such as spruces, ponderosa pine, and birches. The entrance hole is about 1.6 to 2 inches (4–5 cm) in diameter and from 10 to 15 inches (25–38 cm) deep (Dixon and Saab 2000). The nest cavity is smooth and broad at the bottom and can be anywhere from 5 to 69 feet (1.5–21 m) above the ground. From mid-May to mid-June, approximately 3 to 6 eggs (usually 4) are laid; they are rounded and pure white. Only one brood is raised in a season (Bent 1939). Incubation is carried out by both sexes and lasts approximately 14 days (Lippincott 1997). The young follow their parents until autumn. There is no data on survivorship or longevity, but it is believed that the black-backed woodpecker can live as long as 8 years (Dixon and Saab 2000).

Little information is available on the causes of mortality, but it is presumed that predation by raptors is a factor. Another limiting factor for the black-backed woodpecker is its dependence upon dramatic changes in forest structure and composition, like fire and insect outbreaks. Fire-management policies and prescribed-burning programs (USDI and USDA 1998) that diminish the chances of large, severe wildfires may have negative consequences for the black-backed woodpecker.

4.3 Boreal Owl (*Aegolius funereus*)

The boreal owl occupies boreal and subalpine forests across Canada and southward to northeastern Washington, Idaho, Montana, and northeastern Minnesota and farther south in mountains to Colorado and New Mexico. In Montana and Idaho, the boreal owl is found to favor spruce-fir or subalpine-fir above 5,180 feet (1,580 m) (Palmer 1986).

The boreal owl is a small owl that lacks ear tufts. The male and female are alike in plumage. The general color of the upper parts is dark brown. The backside has dispersed, large, white spots. The owl's crown is thickly spotted with smaller white spots. The facial disk is white with a dark brown border at the sides. A slim black border surrounds the eyes. Cinnamon-brown occurs below and at the sides of the bill. The chest, flanks, and belly are white and heavily streaked with brown. The feet are feathered; the claws are black. The irises are lemon yellow, and the bill is dark grayish-horn with a yellowish tip.

Except in years of reduced food availability, both sexes can breed the year after hatching (Korpimaki 1988). The boreal owl nests in woodpecker holes (pileated and northern flicker) or nest boxes (Hayward and Hayward 1993). Clutch size ranges from 2 to 4 eggs, with 3 being the most common. The incubation period is from 26 to 32 days (Hayward and Hayward 1993). The young owls fledge at 28 to 36 days but remain close (< 100 yards) from the nest for the first week while being fed by the adults. They slowly move farther away but do not become independent until 3 to 6 weeks after leaving the nest cavity. Banded boreal owls have been known to live for almost 16 years. In Idaho, annual survival for adults was 46% (Hayward 1989).

The primary foods of the boreal owl are small mammals, birds, and insects. The owl's preferred food is the vole, which may make up as much as 75% of the diet (Palmer 1986, Hayward *et al.* 1993). The boreal owl is primarily a nocturnal forager, except in the far north where there is continuous light during summer, though the owl will also forage intermittently during daylight hours in the southern latitudes (Norberg 1970, Mikkola 1983). It is a "sit and wait" predator (Hayward *et al*. 1993). It can locate prey by sound alone and capture prey beneath the snow or vegetation (Norberg 1970).

Martens (*Martes* spp.) are important predators of owlets and adult females at nest sites. Another nest predator is the pine squirrel (*Tamiasciurus hudsonicus*). Important predators of young and adults include the Cooper's hawk (*Accipiter cooperi*), northern goshawk (A. *gentiles*), and great horned owl (*Bubo virginianus*) (Herrera and Hiraldo 1976, Mikkola 1983, Reynolds *et al*. 1990).

The correlation of prey availability and both the owl's nomadic movement patterns and yearly variation in nesting success and productivity suggests that food supply may regulate owl abundance in some portions of its range (Hayward and Hayward 1993). Pileated woodpecker and common flicker distributions may also limit nest cavity availability and, therefore, owl abundance.

4.4 Northern Goshawk (*Accipiter gentilis*)

The range of the northern goshawk (*Accipiter gentilis atricapillus*) is circumpolar (Knopf 1977). Its year-round range[1] in North America extends from northern Alaska and Canada south to northern Mexico, Colorado, Minnesota, and western Maryland (AOU 1957, Scott 1987). Winter sightings of the northern goshawk have been recorded in Missouri, Tennessee, West Virginia, Virginia, and Florida (AOU 1957). Winter migration begins in late August to early September. Spring migration begins in early February and is usually complete by mid-March. Many birds, however, remain in their territories year-round, moving only when prey is limited (Palmer 1988).

The northern goshawk is a forest dweller, using a wide variety of forest ages, structural conditions, and successional stages (Reynolds *et al*. 1992a,b). For hunting habitat, the northern goshawk prefers the transitional zones from bog to forest and forest to shrubland. Riparian zones and mosaics of forested and open areas are also important hunting habitats (DuBois *et al*. 1987, Palmer 1988). The northern goshawk uses stands of old growth forest as nesting sites (DuBois *et al*. 1987). The northern goshawk often dwells in ponderosa pine (*Pinus ponderosa*), mixed-species, and spruce-fir forests. Douglas-fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), and grand fir (*A. grandis*) frequently dominate the mixed-species forests. Dominants in spruce-fir forests include Engelmann spruce (*Picea engelmannii*) and subalpine fir (*A. lasiocarpa*) (Reynolds *et al*. 1992b).

The home range size for a pair of northern goshawks is about 6,000 acres (2,400 ha). Within the home range, there are three areas of use: the nest area, the post-fledging family area, and the foraging area. More than 20% of the home range is old growth forest (Reynolds *et al*. 1992a,b; St. Clair 1992]. Within a home range, there are usually two to four alternative nest areas (Reynolds *et al*. 1992a,b). The tree selected for nesting has a crotch, fork, or several limbs on one side to support the platform nest (Palmer 1988). The post-fledging family area is about 420 acres (168 ha) made up of a mosaic of forest types that provide hiding cover for the fledglings and habitat for abundant prey (Reynolds *et al*. 1992a,b). The foraging area is about 5,400 acres (2,160 ha) and consists of a mosaic of shrublands, forests, and openings with perching trees from which the owls can

[1] *A. gentilis* ssp. *atricapillus* occupies most of the mentioned range; *A. gentilis* ssp. *laingi* occupies a limited range on Masset, Queen Charlotte, and Vancouver islands, British Columbia (AOU 1957).

observe prey (Palmer 1988, Reynolds *et al*. 1992a,b).

Northern goshawks are monogamous. If a mate is lost, the northern goshawk will form another pair bond (Palmer 1988). The goshawk selects a preexisting nest or builds a platform nest (Knopf 1977). Nesting occurs from early April to mid-June, depending on latitude (Palmer 1988). Some yearling females breed with older males; yearling males are typically incapable of breeding (Palmer 1988). Generally, 25% of northern goshawks breed as yearlings; another 25%, in their second year; and the remainder, in their third year (Ehrlich *et al.* 1988).

The clutch size of the northern goshawk varies from 1 to 5 eggs, with a mean of 3 eggs per clutch. One egg is laid every 2 days. If a nest is destroyed early in the breeding season, the northern goshawk will nest again. The incubation period is 32 to 34 days. The young fledge in 37 to 41 days, with the smaller, faster-developing males fledging a few days before the females (Palmer 1988).

The female northern goshawk begins molting at the start of incubation and pauses when the young are about ready to fledge. The male molts during this pause. The female resumes molting when the young are flying and hunting on their own (Palmer 1988).

The diet of the northern goshawk changes with the season. In spring and summer, the diet is mainly birds, with a few small mammals. In winter, it consists of prey species that do not migrate or hibernate. In northern portions of the goshawk's range, the bird preys upon ptarmigans (*Lagopus* spp.) in the winter. In southern portions of the range, the goshawk consumes ruffed grouse (*Bonasa umbellus*), blue grouse (*Dendragapus obscurus*), hares (*Lepus* spp.), and red squirrels (*Tamiasciurus hudsonicus*) (Palmer 1988).

The wide distribution of the northern goshawk results in a varied prey base. Stomach and pellet contents show the following prey animals: robins (*Turdus migratorius*), Steller's jays (*Cyanocitta stelleri*), mallards (*Anas platyrhynchos*), black ducks (*Anas rubripes*), sparrows (Ploceidae), warblers (Parulidae), kestrels (*Falco tinnunculus*), crows (*Corvus* spp.), hares, cottontails (*Sylvilagus* spp.), chipmunks (*Eutamias* spp.), ground squirrels (*Spermophilus* spp.), woodchucks (*Marmota monax*), muskrats (*Ondantra zibethicus*), mice (Heteromyidae), and shrews (*Soricidae* spp.) (Palmer 1988).

The northern goshawk is fairly high in the food web; its predators are large avian species such as the bald eagle (*Haliaeetus leucocephalus*) and golden eagle (*Aquila chrysaetos*) (Bosakowski *et al*. 1992).

5 Juniper/Mountain Mahogany

5.1 Curl-leaf Mountain Mahogany (*Cercocarpus ledifolius*)

A native, xerophytic, evergreen shrub or small tree, curl-leaf mountain mahogany grows up to 35 feet (10.6 m) tall and 3 feet (0.9 m) in diameter (Davis 1990). The thick, tortuous, leaf-scarred branches arise from a short trunk and form a round or umbrella-shaped crown. Leaves are broadly elliptic to lanceolate, 0.5 to 1 inch (12–25 mm) long, leathery, somewhat resinous, and curled under at the margins. Flowers are borne singly or in rows of three in the leaf axils. Achenes retain their long, plumose styles. The roots of curl-leaf mountain mahogany play a key role in its ability to inhabit water- and nutrient-deficient substrates. Dealy (1978) suggested that a combination of initial rapid root growth and slow top growth might help curl-leaf mountain mahogany out-compete its associates.

Curl-leaf mountain mahogany can be extremely long-lived, with some trees in Nevada aged at over 1,350 years. In Idaho, curl-leaf mountain mahogany plants at least 150 years old were found; older stems had rotten cores that made accurate aging impossible (Scheldt and Tisdale 1970).

Curl-leaf mountain mahogany occurs throughout the Rocky Mountains and Intermountain West in shrub ecotones or mountain brush communities, in open forests, on ridgetops, and on rock outcrops (Davis 1990). Curl-leaf mountain mahogany usually occurs in isolated, pure patches that are often very dense. In mid-elevation forests, it does not develop dense canopies. It is commonly associated with limber pine (*Pinus flexilis*), lodgepole pine (*P. contorta*), ponderosa pine (*P. ponderosa*), Douglas-fir (*Pseudotsuga menziesii*), Englemann spruce (*Picea engelmannii*), subalpine fir (*Abies lasiocarpa*), and white fir (*A. concolor*) (Bradley *et al.* 1992); it may also occur with quaking aspen (*Populus tremuloides*) and whitebark pine (*Pinus albicaulus*) above 9,000 feet (2,750 m).

As a codominant member of the sagebrush-forest ecotone in Idaho, curl-leaf mountain mahogany is associated with snowberry (*Symphoricarpos* spp.), mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*), green rabbitbrush (*Chrysothamnus viscidiflorus*), bluebunch wheatgrass (*Pseudoroegneria spicata*), Sandberg bluegrass (*Poa secunda*), Idaho fescue (*Festuca idahoensis*), and Columbia needlegrass (*Stipa columbiana*) (Scheldt and Tisdale 1970).

Curl-leaf mountain mahogany is good forage for all classes of browsing animals in both summer and winter (Stanton 1974, Davis 1990). It is one of the few browse species that meets or exceeds the protein requirements for wintering big game animals (Davis 1990). In Idaho, curl-leaf mountain mahogany is very palatable to bighorn sheep and mountain goats (Dittberner and Olson 1983). In mature stands, much of curl-leaf mountain mahogany foliage is out of reach of browsing animals but provides excellent winter cover (Stanton 1974).

Curl-leaf mountain mahogany may be planted to help stabilize soil in disturbed areas such as roadcuts and mine spoils (Hungerford 1984). Because of its tolerance to heat and drought, curl-leaf mountain mahogany can be used for water-efficient landscaping in arid environments (Gutknecht 1989).

Fire usually kills curl-leaf mountain mahogany. Only lightly seared curl-leaf mountain mahogany survived. Intense heat alone may cause mortality in curl-leaf mountain mahogany by searing green growth.

Curl-leaf mountain mahogany seedlings establish after fire, although establishment may be slow. A curl-leaf mountain mahogany stand near MacKay, Idaho, had burned around 1900. In 1968, the stand contained plants ranging from 8 to 54 years of age (Scheldt and Tisdale 1970). A stand that burned in 1965 showed no signs of regeneration by 1968. However, Collins (1980) described excellent seedling emergence in post-fire year one after a 1979 wildfire in the Salmon National Forest, possibly due to an unusually wet growing season.

6 Whitebark Pine

6.1 Whitebark Pine (*Pinus albicaulis*)

Whitebark pine is a slow-growing, long-lived, ectomycorrhizal, native conifer characteristic of the tree line (Ahlenslager 1987). Trees often reach 400 to 700 years of age. The oldest known cored tree is 750 years old and is in Mount Robson Provincial Park, British Columbia (Arno and Hoff 1990). In Crowsnest Forest, Alberta, the largest whitebark pine is 121 feet (37 m) high and 26 feet (792 cm) in dbh (Day 1967). The largest reported whitebark pine in the United States is in the Sawtooth Range of central Idaho; it is 69 feet (21 m) high and 9.5 feet (2.9 m) in dbh (Pitel and Wang 1980, Arno and Hoff 1990).

Trees in well-developed stands are 49 to 66 feet (15–20 m) tall and 23 to 35 inches (60–90 cm) in diameter (Ahlenslager 1987). Growing at the uppermost limits of growth, trees usually are dwarfed or contorted. At the upper tree line, this species takes on a spreading growth form and grows in isolated cushions of “alpine scrub” between 1 and 3.3 feet (0.3–1 m) tall (Ahlenslager 1987).

Whitebark pine trees commonly have two or more trunks that are often partially fused at the base. Electrophoretic evidence revealed that two or more trunks of what appears to be a single tree are indeed separate trees with distinct genotypes. This finding supports the idea that several mature trees can arise from single seed caches (Luckman *et al*. 1984) and that seeds cached by Clark’s nutcrackers are instrumental in establishing trees (Steele *et al.* 1983). On most sites, trees develop a deep and spreading root system (Arno and Hoff 1990).

The minimum seed-bearing age of whitebark pine is between 20 and 30 years, and the interval between large seed crops is 3 to 5 years (Ahlenslager 1987). On most sites, significant amounts of seed occur only on trees older than 80 years (Tomback 1986). Large seed crops are produced at irregular intervals, interrupted by smaller crops and crop failures (Lanner 1980). Cone production fluctuates widely between years, and variations in seed crops may play an important role in the initial establishment of a stand (Ahlenslager 1987).

Whitebark pine grows on dry, rocky sites on high mountains between 5,900 and 9,940 feet (1,800–3,030 m). It is characteristic of the tree line, where it forms dense krummholz thickets. The dispersal of whitebark pine seeds by Clark’s nutcrackers strongly affects the distribution and abundance of this species (Tomback 1978). Trees occur on dry, rocky, subalpine slopes and exposed ridges. Stands are generally open, with undergrowth of low shrubs, forbs, and grasses (Arno 1986). Sites where whitebark pine occurs as a climax species are drier than sites where it is seral.

Whitebark pine is important in areas where the mean annual precipitation is 23.5 to 31.5 inches (60–80 cm) (Arno and Hoff 1990). The climate is characterized by cool summers and cold winters with deep snowpack. Trees have high frost resistance and low shade tolerance. Trees are also found predominately on acidic substrates, although they have also been reported on calcareous ones. Most soils under whitebark pine stands are Inceptisols (Ahlenslager 1987).

In upper-elevation subalpine forests, whitebark pine is generally seral and competes with and is replaced by more shade-tolerant trees. Subalpine fir, a very shade-tolerant species, is the most abundant associate and most serious competitor of whitebark pine. Although whitebark pine is more shade tolerant than lodgepole pine and subalpine larch (*Larix lyallii*), it is less shade tolerant than Engelmann spruce and mountain hemlock (*Tsuga mertensiana*) (Ahlenslager 1987). Whitebark pine is the potential climax species on high, exposed tree-line sites and exceptionally dry sites (Arno and Hoff 1990). It sometimes acts as a pioneer species in the invasion of meadows and burned areas (Forcella and Weaver 1977). On dry, wind-exposed sites, the regeneration of whitebark pine may require several decades, even though it is often the first tree to become established (Weaver and Dale 1974, Arno and Hoff 1990).

The distribution of seral whitebark pine is strongly affected by the dispersal of seeds by Clark's nutcrackers (Tomback 1978). The fact that bird dispersion of seed occurs allows whitebark pine to be more widespread as a seral species. The dispersal of seeds by them throughout subalpine habitats is partly responsible for the status of whitebark pine as a pioneer and post-fire invader (Steele *et al.* 1983). Additional birds that feed on whitebark pine seeds include Williamson's sapsucker, white-headed woodpecker, mountain chickadee, white-breasted nuthatch, Cassin's finch, red crossbill, pine grosbeak, and blue grouse (Tomback 1978, 1981, 1982).

Bears are also known to regularly eat pine seeds in spring (March to June) and fall (September and October). Most whitebark pine seed eaten by grizzly and black bears are from red squirrel cone caches. Rodents, such as red squirrels, Douglas squirrels, ground squirrels, and chipmunks, store large quantities of intact cones in middens at the base of trees or underground in caches. Although deer mice cannot gnaw the cones, they eat and cache loose seeds (Kendall 1981, Tomback 1982).

Whitebark pine survives where tree growth is limited and provides hiding and thermal cover for wildlife (Ahlenslager 1987). Cavity-nesting birds use tree trunks and snags. Mule deer, elk, and predatory animals also use whitebark habitat (Pfister *et al.* 1977, Tomback 1981).

An assessment of the interior Columbia River basin found that the area of whitebark pine cover types has declined 45% since the turn of the century (Keane 1995). Most of this loss occurred in the more productive, seral whitebark pine communities: 98% of them have been lost. Practically all of the remaining whitebark pine stands are old. Daubenmire and Daubenmire (1968) found that squirrel pressures on seed crops and blister rust damage are factors in the decline of whitebark pine populations in Idaho and Washington. In addition, regeneration of whitebark pine is sporadic. Rust infection rates in the Sawtooth National Recreation Area in central Idaho are generally light, but low elevations may harbor some heavily infected sites (Smith 1995). Mortality and rust infection levels decline in the drier areas to the south. In addition, successional replacement due to fire exclusion has also contributed to whitebark pine decline (Keane *et al.* 1994, Arno 1995). Whitebark pine cannot maintain its functional role in mountain ecosystems unless areas suitable for its regeneration are available across the landscape (Arno 1995).

6.2 Clark's Nutcracker (*Nucifraga columbiana*)

The Clark's nutcracker is distinctive in appearance and behavior and not easily confused with any other species within its range. The sexes are similar in appearance. The bird is light to medium gray, with varying amounts of white around the eyes, on the forehead, and on the chin. The tail and wings are glossy black, with white at the base of the tail and secondary wing feathers and around the vent. The pointed bill is black and accompanied with short nasal bristles.

Pine seeds are the primary food for both the adults and nestlings, although the bird is known to eat insects, acorns, berries, snails, carrion and sometimes eggs of small birds (Mulder *et al*. 1978, Tomback 1978, Tomback and DeWolfe 1981). The Clark's nutcracker is also aggressive enough to prey upon small vertebrates, such as ground squirrels (*Spermophilus* spp.), chipmunks (*Tamias* spp.), and voles (*Microtus*) (Mulder *et al.* 1978).

Several pines depend on nutcrackers for seed dispersal. One is the whitebark pine. The interaction between whitebark pine and the Clark's nutcracker is mutualistic and a result of coevolution (Tomback 1982). Clark's nutcrackers have evolved a sublingual throat pouch in which to carry pine seeds to sites where they cache them (Bock *et al*. 1973). The birds bury the pine seeds about 1 cm below the soil surface in groups of one to five. A nutcracker can carry as many as 150 seeds in its throat pouch and store 850 seeds per day. Over a 42-day period, one bird may cache as many as 32,000 seeds. Birds harvest and cache seeds in the late summer and fall for use during the following winter and spring. Nutcrackers store three to five times their energetic requirements, so more seeds are buried than recovered. Seed dispersal by the Clark's nutcracker has, therefore, resulted in ring tree cluster growths and altered the whitebark pine's genetic population structure compared with that of wind-dispersed pines (Furnier *et al*. 1987, Schuster and Mitton 1991, Carsey and Tomback 1994, Tomback and Schuster 1994).

As early as July, the nutcracker begins to eat unripe seeds from new pinecones, usually at upper montane or subalpine elevations. Storage of ripe pine seeds begins by early September; a few weeks later, many birds switch to new seed sources, usually migrating to lower elevations. The nutcracker may continue making seed stores through December. During winter, the bird harvests the seeds remaining in cones and uses the more accessible seed stores. Nesting begins as early as January or February, despite harsh winter weather. Both sexes participate in building the nest, incubating the eggs, and feeding the young (Mewaldt 1956). Females lay between two and six eggs that hatch in about 18 days (Mewaldt 1956). Fledglings leave the nest about 20 to 22 days after hatching (Mewaldt 1948). Although there is no data on survivorship, the bird is known to live for at least 17 years (Kennard 1975).

The Clark's nutcracker is moderately social and tends to form loose flocks (Tomback 1998). It is vigilant for predators during all activities and will mob avian predators like the red-tailed hawk (*Buteo jamaicensis*) and great horned owl (*Bubo virginianus*) (Johnson 1900). The species is also known to provoke and chase small raptors like the American kestrel (*Falco sparverius*) and sharp-shinned hawk (*Accipiter striatus*). The Clark's nutcracker is also relatively tolerant of people; in national parks, the bird frequents scenic turnouts, picnic areas, and campgrounds for food handouts from tourists.

There is little information on the causes of mortality for the Clark's nutcracker, although predation by raptors is one factor. Habitat loss and availability of seeds from large seeded conifers are probably the principal factors in regulating population size.

7 Aspen

7.1 Quaking Aspen (*Populus tremuloides*)

Quaking aspen is in subsection Trepidae of the genus *Populus*. It is a native deciduous tree that is small to medium-sized, typically less than 49 feet (15 m) tall and 16 inches (40 cm) in diameter (Hickman 1993). The quaking aspen has spreading branches and a pyramidal or rounded crown (Jones and DeByle 1985, Gleason and Cronquist 1991). The bark is thin. Leaves are orb- to ovately shaped, with flattened petioles. The fruit is a tufted capsule bearing six to eight seeds. A single female catkin usually bears 70 to 100 capsules. The root system is relatively shallow, with wide-spreading lateral roots and vertical sinker roots descending from the laterals. Laterals may extend over 98 feet (30 m) into open areas (Jones and DeByle 1985).

Quaking aspen forms clones connected by a common parent root system. It is typically dioecious, with a given clone being either male or female; however, some clones produce both stamens and pistils (Jones and DeByle 1985). Quaking aspen stands may consist of a single clone or aggregates of clones. Clones can be distinguished by differences in phenology, leaf size and shape, branching habit, and bark character and by electrophoresis (Perala 1990). In the West, quaking aspen stands are often even-aged, originating after a single top-killing event. Some stands, resulting from sprouting of a gradually deteriorating stand, may be only broadly even-aged (Jones and DeByle 1985). Clones east of the Rocky Mountains tend to encompass a few acres at most (Perala and Carpenter 1985), and aboveground stems are short-lived. Maximum age of stems in the Great Lakes states is 50 to 60 years. Clones in the West tend to occupy more area, and aboveground stems may live up to 150 years (Johnston and Hendzel 1985).

Optimum conditions for germination and seedling survival include a moist mineral seedbed with adequate drainage, moderate temperature, and freedom from competition (McDonough 1979). In various collections, seeds have germinated at temperatures from 32 to 102 °F (0–39 °C), with germination sharply reduced from 35.5 to 41 °F (2–5 °C) and progressively curtailed above 77 °F (25 °C) (Faust 1936).

Seedlings may reach 6 to 24 inches (15–61 cm) in height by the end of their first year, and roots may extend 2 to 10 inches (5–25 cm) deep and up to 16 inches (41 cm) laterally. Roots grow more rapidly than shoots; some seedlings show little top-growth until about their third year. During the first several years, natural seedlings grow faster than planted seedlings but not as fast as sprouts do. High mortality characterizes young quaking aspen stands regardless of origin. In both seedling and sprout stands, natural thinning is rapid. Stems that occur below a canopy die within a few years (Perala 1990).

Quaking aspen is the most widely distributed tree and a major cover type in North America. Distribution is patchy in the West, with trees confined to suitable sites. Quaking aspen occurs in a large number of other forest cover types over its extensive range. It grows on moist upland woods, dry mountainsides, high plateaus, mesas, avalanche chutes, talus, parklands, gentle slopes near valley bottoms, and alluvial terraces and along watercourses. In the Rocky Mountains, quaking aspen groves are scattered throughout Engelmann spruce-subalpine fir (*Picea engelmannii-Abies lasiocarpa*) forests. Prostrate quaking aspens occur above the timberline (Perala and Carpenter 1985). Throughout its range, quaking aspen occurs in mid- to upper-elevation riparian zones (Franklin and Dyrness 1973, Perala 1990). Quaking aspen grows on soils ranging from shallow and rocky to deep loamy sands and heavy clays. Good quaking aspen sites are usually well drained, loamy, and high in organic matter and nutrients (Perala 1990). Cryer and Murray (1992) stated that stable quaking aspen stands are found on only one soil order, mollisols, and a few soil subgroups, of which Agric Pachic Cryoborolls and Pachic Cryoborolls are dominant. The best stands in the Rocky Mountains and Great Basin are on soils derived from basic igneous rock such as basalt and from neutral or calcareous shales and limestones. The poorest stands are on soils derived from granite.

Quaking aspen is not shade tolerant (Perala 1990), nor does it tolerate long-term flooding or waterlogged soils (Perala 1990). Even if quaking aspen survives flooding in the short term, stems subjected to prolonged flooding usually develop a fungus infection that greatly reduces stem life (and renders the wood commercially useless) (Davidson *et al*. 1959). Quaking aspen readily colonizes after fire, clear-cutting, or other disturbances.

Quaking aspen is seral to conifers in most of its range in the West and some portions of its eastern range. Still, quaking aspen is apparently stable on some sites. These stands can remain stable for decades but eventually deteriorate. Deteriorating stands are often succeeded by conifers, but shrubs, grasses, and/or forbs gain dominance on some sites. Succession to grasses and forbs is more likely on dry sites and more common in the West than in the East.

Quaking aspen forests provide important breeding, foraging, and resting habitat for a variety of birds and mammals. Wildlife and livestock utilization of quaking aspen communities varies with species composition of the understory and relative age of the quaking aspen stand. Young stands generally provide the most browse. Quaking aspen crowns can grow out of reach of large ungulates in 6 to 8 years (Patton and Jones 1977). Although many animals browse quaking aspen year-round, it is especially valuable during fall and winter, when protein levels are high relative to other browse species (Tew 1970).

Quaking aspen is palatable to all browsing livestock and wildlife species (DeByle 1985). The buds, flowers, and seeds are palatable to many bird species including numerous songbirds and grouse. Elk browse quaking aspen year-round, feeding on bark, branch apices, and sprouts. Quaking aspen is important forage for mule and white-tailed deer. Deer consume the leaves, buds, twigs, bark, and sprouts. New growth on burns or clear-cuts is especially palatable to deer. Quaking aspen is valuable moose browse for much of the year (Brinkman and Roe 1975). Moose utilize it on summer and winter ranges. Young stands generally provide the best quality moose browse. However, researchers in Idaho found that, in winter, moose browsed mature stands of quaking aspen more heavily than they browsed nearby clear-cuts dominated by quaking aspen sprouts (Ritchie 1978).

8 Mountain Brush

8.1 Antelope Bitterbrush (*Purshia tridentata*)

Antelope bitterbrush is a native, deciduous shrub (Blauer *et al.* 1975). The fruit is an achene, 0.13 to 0.5 inch (3–13 mm) long. Antelope bitterbrush has two common ecotypes, both present throughout its range: multiple-stemmed, decumbent plants and single-stemmed, columnar plants (Blauer *et al*. 1975, Murray 1983, Bunting *et al*. 1985, Richardson *et al*. 1986). Plants may reach 12 to 15 feet (3.6–4.5 m) high but usually grow to 3 or 4 feet (0.9–1.2 m) (Berry 1963). The decumbent form is more prevalent at higher elevations. Antelope bitterbrush is long-lived. Nord (1965) reported a 115-year-old plant that was 10 inches (25 cm) high and spread over 7 square feet (1.8 m^2). At a lower elevation, Nord (1965) found a 128-year-old plant that was 12 feet (3.6 m) high and 20 feet (6 m) across.

Antelope bitterbrush has a long taproot or taproots that extend as long as 15 to 18 feet (4.5–5.4 m) (Noste and Bushey 1987) and few shallow roots (Baker and Torrey 1979). Antelope bitterbrush sometimes has nitrogen-fixing root nodules, a result of a symbiotic association with *Frankia* spp. actinomycetes (Murray 1983, Righetti *et al*. 1986). Degree of nodulation depends on site conditions including soil moisture content and salinity, presence of inoculants, and available nitrogen (Righetti *et al*. 1983, Righetti *et al*. 1986). Presence of nodules, even in high numbers, does not necessarily indicate that significant amounts of nitrogen are being added to the soil (Ritchie 1978).

Antelope bitterbrush occurs from British Columbia east of the Cascade Range through Washington and Oregon; in the Klamath, North Coast, Cascade, and Sierra Nevada ranges of California; southeast into western Montana and throughout the Rocky Mountains; in the Great Basin; and in Arizona and New Mexico (Blauer *et al.* 1975, Murray 1983). It is distributed over approximately 340 million acres (Furniss 1983).

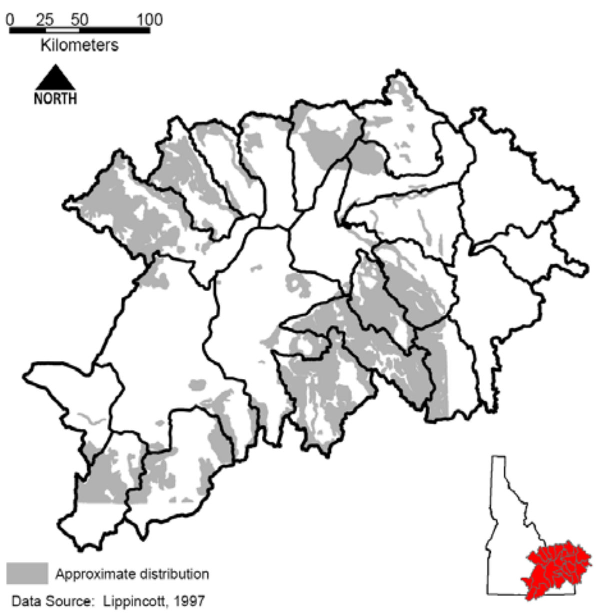
Antelope bitterbrush appears in several mesic habitat types. Plant communities with antelope bitterbrush include range types such as antelope bitterbrush-bluebunch wheatgrass (*Pseudoroegneria spicata*) and antelope bitterbrush-Idaho fescue (*Festuca idahoensis*), other steppe vegetation, and tree-dominated types such as ponderosa pine (*Pinus ponderosa*) forest and juniper (*Juniperus* spp.) woodland (Richardson *et al*. 1986). At Craters of the Moon National Monument, Idaho, antelope bitterbrush appears with wheatgrass (Triticeae), cheatgrass (*Bromus tectorum*), Indian ricegrass (*Achnatherum hymenoides*), and basin wildrye (*Leymus cinereus*) (Barrington *et al*. 1988). In the Wyoming mountain shrub community, antelope bitterbrush appears with big sagebrush, bluebunch wheatgrass, spike fescue (*Leucopoa kingii*), Ross sedge, and needle and thread (*Hesperostipa comata*) (Cook *et al*. 1994).

Antelope bitterbrush is important browse for wildlife and livestock (Murray 1983, Noste and Bushey 1987, Vander Wall 1994). Pronghorn (Young 1989), mule deer (Gullion 1964, Williams and Aldon 1976), elk (Hobbs *et al.* 1981), bighorn sheep, and moose utilize antelope bitterbrush extensively (Murray 1983). Mule deer use of antelope bitterbrush peaks in September, when antelope bitterbrush may compose 91% of the diet (Austin and Urness 1983). Winter use is greatest during periods of deep snow (Shaw and Monsen 1983). Domestic livestock and mule deer may compete for antelope bitterbrush in late summer, fall, and/or winter (Clements and Young 1997). Cattle prefer antelope bitterbrush from mid-May through June and again in September and October (Shaw and Monsen 1983). Antelope bitterbrush seed is a large part of the diet of rodents (Wagstaff 1980), especially deer mice and kangaroo rats (Noste and Bushey 1987).

Antelope bitterbrush supports several insect populations (Giunta *et al.* 1978), some of which eat the seeds or cotyledons (Giunta *et al.* 1978). Especially important are Pogonomyrmex ants, which stash seeds and are therefore important to natural regeneration (Evans *et al*. 1983), and tent caterpillars, which often cause antelope bitterbrush die back (Noste and Bushey 1987).

Ungulates, birds, and rodents use antelope bitterbrush for cover (Parker 1975, Griffith and Peek 1989). Mule deer preferred antelope bitterbrush habitat during winter in central Washington, maybe because of height and large crown of antelope bitterbrush (Carson and Peek 1987). Pronghorn prefer shrubs up to 2 feet tall (0.6 cm), so tall, decadent, fire-excluded stands of antelope bitterbrush are not good pronghorn habitat (Young 1989). Sage grouse use short (12-inch [30.5 cm]) antelope bitterbrush for cover in Idaho (Klebenow 1969, Marks and Marks 1987), Oregon (Range et al. 1981), and Wyoming (Klott and Lindzey 1990). Antelope bitterbrush and other shrubs provide important cover for Lewis's woodpeckers (Koehler 1981).

8.2 Green-tailed Towhee (*Pipilo chlorurus*)



The green-tailed towhee is fairly common throughout much of its range. The bird spends much of its time on or near the ground in thick, shrubby habitats. Green-tailed towhees are about 7 inches (18 cm) long and weigh about 1 ounce (29 g) (Dunning 1993). Adults have a long greenish tail, olive green upperparts, gray breast, white throat outlined in black, and reddish brown cap.

The species breeds in the United States from the Northwest to the Midwest and migrates south to winter in California, Arizona, New Mexico, Texas, and Mexico. In the northern Rocky Mountains, the green-tailed towhee breeds mainly south of the Snake River Plain, east through south-central Idaho counties, and north to Clark County in eastern Idaho (Burleigh 1972, Stephens and Sturts 1998). Green-tailed towhees also breed in most of Wyoming and in southwest and south-central Montana (Oakleaf *et al*. 1992).

The age of the bird at first breeding is unknown, but the species is an annual breeder (Dobbs *et al*. 1998). Female green-tailed towhees lay between 2 and 5 eggs each year, with 4 being the usual number (Norris 1968). The species will renest as many as four times after a nest failure, usually beginning to build replacement nests within a couple of days of a failure (Dotson 1971). Chicks hatch after an incubation period of about 12 days (Martin and Li 1992). Only the female incubates the egg, and the males occasionally feed incubating females (Dotson 1971). Both parents feed the nestlings; only the female alternates brooding and foraging activity (Dobbs *et al*. 1998). Fledglings depart the nest 11 to 14 days after hatching, and the parents continue to feed them for up to 2 weeks (Dotson 1971). The maximum age recorded for a banded green-tailed towhee was over 7 years (Klimkiewicz and Futcher 1987).

The green-tailed towhee scratches the ground for insects, seeds, and berries; drinks morning dew from leaves; and occasionally visits feeding stations. Major food items for the bird are weed seeds and insects. Insect species eaten by the towhee include beetles (Coleoptera), bees and wasps (Hymenoptera), butterflies and moths (Lepidoptera), grasshoppers and crickets (Orthoptera), true bugs (Hemiptera), and flies (Diptera) (Norris 1968, Dotson 1971, Oberholser 1974). Stomach contents of two green-tailed towhees were 29% animal matter and 71% vegetable matter (Bryant 1911).

Predators of the green-tailed towhee adults and juveniles include the sharp-shinned hawk (*Accipiter striatus*), Cooper's hawk (*A. cooperii*), northern goshawk (*A. gentilis*), peregrine falcon (*Falco peregrinus*), American kestrel (*F. sparverius*), red-tailed hawk (*Buteo jamaicensis*), and long-eared owl (*Asio otus*) (Dotson 1971, Lima 1993). Other predators of towhee nests include the Steller's jay (*Cyanocitta stelleri*), red squirrel (*Tamiasciurus hudsonicus*), least chipmunk (*Eutamias minimus*), long-tailed weasel (*Mustela frenata*), black-billed magpie (*Pica pica*), striped skunk (*Mephitis mephitis*), spotted skunk (*Spilogale putorius*), and gopher snake (*Pituophis catenifer*) (Dotson 1971, Dobbs *et al*. 1998).

8.3 Mule Deer (*Odocoileus hemionus*)

The mule deer is a popular game species in Idaho. Prior to the settlement of the West in the late 1800s and early 1900s, mule deer were not as abundant as they are currently (IDFG 1990). Intense grazing by domestic animals, as well as fire suppression, changed plant communities once dominated by grasses to ranges dominated by shrubs. This habitat change to shrub-dominated ranges in combination with reduced livestock grazing, reduced competition from other wild ungulates due to hunting, and regulated deer harvest promoted the growth of mule deer populations (IDFG 1990).

The mule deer mating season usually begins in mid-November and continues through mid-December (Snyder 1991a). The gestation period lasts 203 days, with most young born between May and June (Lippincott 1997). Some July and August births also occur in some areas. Mature females commonly have twins, while yearlings have only single fawns. Weaning begins at about five weeks and is usually completed by the sixteenth week. Female mule deer usually breed at 2 years of age, while males may not mate until they are at least 3 or 4 years old due to competition with older males. The life span of a female mule deer can be as long as 22 years, while males may live as long as 16 years. Males begin to shed their antlers in December, though shedding can continue into March; mature and less healthy males might shed their antlers earlier.

Mule deer are most likely to be found in open forested regions or on the plains and prairies (Snyder 1991a). In the mountainous regions of the West, they prefer rocky or broken terrain at elevations near or at the subalpine zone (Carpenter and Wallmo 1981). They are also found in alpine, montane, and foothill zones. Mule deer seek shelter at lower elevations when snows become deep. In the mountains of the Southwest, mule deer are found in lower-elevation shrublands, while white-tailed deer occupy the higher-elevation montane areas. In open prairie regions, mule deer tend to concentrate in river breaks and brushy stream bottoms (Mackie *et al*. 1987). In the high ranges of the Rocky Mountains, mule deer migrate during winter, sometimes moving 50 to 100 miles (80 to 160 km) (Mackie *et al*. 1987).

Mule deer are better adapted to open areas than white-tailed deer are, although cover becomes important in winter (Snyder 1991a). Areas where cover can prevent snow from accumulating beyond 12 inches (30 cm) are most beneficial (Hanley 1984, Nyberg 1987). Wallmo and Schoen (1980) reported that mule deer could cope with snow up to 24 inches (60 cm) if not dense or crusty. Leckenby *et al*. (1982) and Black *et al.* (1976) listed optimal cover attributes for the Great Basin shrub-steppe region, including estimates of tree heights and canopy closure for thermal, hiding, fawning, and foraging cover. They estimated the proportions of cover and forage at 55% forage, 20% hiding cover, 10% thermal cover, 10% fawn-rearing cover, and 5% fawn habitat.

Mule deer are primarily browsers, feeding on several thousand different plant species across their range (Snyder 1991a). They are capable of altering or severely damaging plant communities through overbrowsing (Reed 1981). Mule deer consume leaves, stems, and shoots of woody plants most often during summer and fall, while grasses and forbs compose the bulk of spring diets. However, feeding behavior is quite variable in any given location. Some of the most common foods are rabbitbrush (*Chrysothamnus* spp.), mountain mahogany (*Cercocarpus* spp.), snowberry (*Symphoricarpos* spp.), buffaloberry (*Shepherdia* spp.), ceanothus (*Ceanothus* spp.), rose (*Rosa* spp.), serviceberry (*Amelanchier* spp.), sagebrush (*Artemisia* spp.), sumac (*Rhus* spp.), common chokecherry (*Prunus virginiana*), willow (*Salix* spp.), Gambel oak (*Quercus gambellii*), mockorange (*Philadelphus lewisii*), ninebark (*Physocarpus* spp.), antelope bitterbrush (*Purshia tridentata*), mariposa (*Calochortus elegans*), juniper (*Juniperus* spp.), yucca (*Yucca* spp.), euphorbia (*Euphorbia* spp.), manzanita (*Arctostaphylos* spp.), lechuguilla (*Agave lechuguilla*), western yarrow (*Achillea millefolium*), red huckleberry (*Vaccinium parvifolium*), swordfern (*Polystichum munitum*), milkvetch (*Astragalus* spp.), and dandelion (*Taraxacum officinale*). Grasses include bluegrasses (*Poa* spp.), wheatgrasses (*Agropyron* spp.), and bromes (*Bromus* spp.) (Wallmo and Regelin 1981, Gruell 1986, Mackie *et al.* 1987, Happe *et al*. 1990).

Mule deer predators include people, domestic dogs (*Canis familiaris*), coyotes (*Canis latrans*), wolves (*Canis lupus*), black bears (*Ursus americanus*), grizzly bears (*U. arctos*), mountain lions (*Felis concolor*), lynx (*Lynx canadensis*), bobcats (*F. rufus*), and golden eagles (*Aquilla chrysaetos*) (Mackie *et al.* 1987).

The effects of logging on mule deer populations vary between and within regions; therefore, it is difficult to generalize conclusions (Lyon and Jensen 1980). Site-specific studies are required to determine logging effects, although many studies confirm that slash depth is a major factor limiting mule deer use of harvested areas (Lyon and Jensen 1980, Hanley 1984). Studies in Alaska have shown that black-tailed deer avoid second growth forests after 20 to 30 years and instead turn to “over-mature” forests (older than 300 years) because these forests provide more browse than younger stands (Wallmo and Schoen 1980, Hanley 1984). Happe *et al*. (1990) have shown that, in coastal forests, forage in old growth has higher crude protein values than forage in clear-cuts. Tannin astringency of browse, which reduces digestive protein, is higher in clear-cuts than in old growth forests. Hanley (1984) recommended scattering clear-cuts in old growth in irregular shapes and spreading them over a wide elevational range.

A study in Colorado showed that, following a treatment in lodgepole pine-spruce-fir forests of alternating clear-cuts with uncut strips, mule deer increased after 10 years. Strips 100 feet (30 m) wide produced the best results (Wallmo 1969). Wallmo and Schoen (1980) listed management guidelines for timber harvesting that benefit deer in the western United States. However, they stated that some of these guidelines are based on speculation and all contradict claims that large clear-cuts are better for mule deer.

Mule deer are vulnerable to a variety of viral, fungal, and bacterial diseases (Hibler 1981). Epizootic hemorrhagic disease (EHD) resides in a small portion of the deer population and is spread from deer to deer by Culicoides gnats. The areas most affected include lower elevations along the Salmon River near White Bird and Riggins. Mule deer tend to inflict heavy crop damage, as well as damage to hayfields, stackyards, orchards, and reforestation projects (Snyder 1991a). Mule deer are often attacked and killed by domestic dogs, and several hundred thousand deer are killed by vehicles each year (Reed 1981). Mule deer are not as tolerant of human activity and not as adaptable to disturbances as white-tailed deer are (Reed 1981).

8.4 Rocky Mountain Elk (*Cervus elaphus nelsoni*)

The Rocky Mountain elk is Idaho's premier big game species (IDFG 1991). In the 1800s, elk were among the most widespread and abundant large animals in northwestern North America, but by the end of the century, the elk population was reduced to low numbers due mostly to unregulated harvest and habitat destruction. In Idaho, however, elk populations have increased as a result of habitat changes and protection. In addition, wildfires in north and central Idaho created extensive brush fields, which provided abundant forage for elk, resulting in population increases (IDFG 1991).

Because elk have historically had a wide distribution, their preferred habitat also varies widely (Skovlin 1982). Populations in the mountain tend to inhabit coniferous forests associated with rugged, broken terrain or foothill ranges (Snyder 1991b). During summer, elk spend most of their time in high mountain meadows of alpine or subalpine zones or in stream bottoms (Adams 1982). Studies of elk slope preferences indicate that elk use a variety of slope percentages, although they most frequently chose slopes in the 15 to 30% class (Skovlin 1982). Elk may use more open areas during spring and summer because of earlier spring green-up (Edge *et al.* 1987). During hot summer months, elk seek shaded, cool habitats (Kuchler 1964). Elk need cover for protection against heat and extreme cold, as well as for hiding and calving. Ideal cover is grassland or meadows interspersed with forests that have large amounts of edge (Skovlin 1982). Elk use of open areas tends to decrease at 100 m from cover. Calving cover requirements vary from place to place and within populations (Skovlin 1982). Security or hiding cover is necessary in places of human disturbance (Peek 1982).

Rocky Mountain elk are mostly crepuscular to nocturnal. Diurnal feeding is more common in summer than in winter (Snyder 1991b). Also, feeding periods are more prolonged in winter and concentrated in morning and evening (Snyder 1991b). In Idaho, elk herds move to lower elevations in winter to feed. Elk are ruminant herbivores; their food habits are extremely variable throughout their range.

Some elk populations prefer to graze, while others rely more heavily on browse. Grasses and forbs are preferred during spring and early summer, and woody browse is preferred during winter. Elk browse conifers in areas where snow has covered other forage. Some important elk foods include eriogonum (*Eriogonum* spp.), tidytips (*Layia* spp.), blazing-star (*Mentzelia* spp.), scalebud (*Anisocoma acaulis*), five hook bassia (*Bassia hyssopifolia*), alkali mallow (*Sida hederacea*), black alfalfa (*Medicago sativa*), antelope bitterbrush (*Purshia tridentata*), greasewood (*Sarcobatus vermiculatus*), galleta (*Hilaria jamesi*), knotgrass (*Paspalum distichum*), bigleaf sandwort (*Arenaria macrophylla*), spotted cat's-ear (*Hypochoeris radicata*), buckthorn plantain (*Plantago lanceolata*), trefoil foamflower (*Tiarella trifoliata*), cowparsnip (*Heracleum lanatum*), sedges (*Carex* spp.), wildrye (*Elymus* spp.), maple (*Acer* spp.), huckleberry and blueberry (*Vaccinium* spp.), larkspur (*Delphinium* spp.), western goldthread (*Coptis occidentalis*), lupine (*Lupinus* spp.), penstemon (*Penstemon* spp.), clover (*Trifolium* spp.), wheatgrass (*Agropyron* spp.), brome (*Bromus* spp.), bluegrass (*Poa* spp.), sagebrush (*Artemisia* spp.), ceanothus (*Ceanothus* spp.), currant (*Ribes* spp.), and quaking aspen (*Populus tremuloides*) (Nelson and Leege 1982).

Elk are gregarious, although some bulls may be solitary (Snyder 1991b). Males shed their antlers in March and April. Mature males defend the female herds during the rut season that extends from September through to October. Older, dominant males do most of the mating. Females breed at 2 years of age. Most of the births occur in the late spring and are usually a single calf, but twins are common. Gestation lasts between 249 and 262 days (Snyder 1991b).

Elk predators include people, wolves (*Canis lupus*), coyotes (*Canis latrans*), black bears (*Ursus americanus*), grizzly bears (*U. arctos*), and mountain lions (*Felis concolor*) (Taber *et al.* 1982). Elk can damage a range from overgrazing, as well as damage tree plantations, crops, orchards, and haystacks (Lyon and Ward 1982). Elk compete with cattle and may completely avoid using pastures grazed by livestock (Lyon and Ward 1982). Elk can suffer from fungal, bacterial, and viral diseases, including a parasitic meningeal worm (*Parelaphostrongylus tenuis*) carried by white-tailed deer and an arterial worm carried by mule deer.

Logging operations can negatively affect elk use of an area. Models have been developed to determine elk use of clear-cuts (Lyon 1976). Elk use increases in cutover areas as the vegetation exceeds 4 feet (1.2 m) in height and when slash in and around the cut is less than 1.5 feet (0.5 m) deep. Elk move as far away from areas near active harvest operations as topography allows, such as over ridges (Lyon 1979, Edge and Marcum 1985). Neither an undisturbed forest adjacent to a harvest operation, nor long distances from a harvest operation are as effective as topographic features in providing security cover for elk during logging (Lyon 1979). Recommendations are to log summer range in winter or reduce the length of operation and the number of concurrent harvests in any one management unit. Habitat availability will be reduced for elk within 1,640 to 3,280 feet (500–1,000 m) of an active harvest operation (Edge and Marcum 1985).

Elk avoid well-traveled forest roads from spring through fall (Edge 1982). Less well-traveled roads may receive more use, but without tree cover, elk use will diminish within 2,460 feet (750 m). Recommendations for logging and road building in critical elk habitat are listed by several authors (Kuchler 1964, Edge 1982, Thomas *et al*. 1988). For comprehensive information on the effects of logging on elk in western Montana, refer to the final report of the Montana Cooperative Elk–Logging Study (Lyon *et al.* 1985).

Prescribed fire is used routinely to create or enhance elk habitat in many western states (Snyder 1991b). Historical evidence shows that early Native Americans used fire to attract ungulates (McCabe 1982). Fire can be used to rejuvenate aspen stands, encourage early spring green-up of grasslands by reducing litter, slow or prevent conifer dominance in important foraging areas, increase palatability of foods, reduce the height of browse species, and stimulate regeneration through sprouting or heat scarification of seed (Weaver 1987, Jourdonnais and Bedunah 1990). In Glacier National Park, fires increased carrying capacity on winter range by creating a mosaic of thermal and hiding cover and forage areas (Martinka 1976). Prescribed burns in the Lochsa River drainage of Idaho produced the best results when conducted from the end of March until mid-May (Leege 1968, Leege and Godbolt 1985). Hot summer fires are needed to germinate redstem ceanothus (*Ceanothus sanguineus*), an important forage species (Weaver 1987).

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