A REPORT TO THE USFS

ASSESSMENT OF INVERTEBRATES OF THE COLUMBIA RIVER BASIN: UNDERSTORY HERBIVORES (LEPIDOPTERA)

BY

JEFFREY C. MILLER
DEPARTMENT OF ENTOMOLOGY
ORGON STATE UNIVERSITY
CORVALLIS, OR 97331-2907

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The focus of this report is on the ecology of understory herbivores (Lepidoptera) of forested lands within the greater Columbia River Basin in the Pacific Northwest of North America. The report is divided into six sections: 1) Introduction - Scope of project; 2) Biogeographical considerations; 3) Species of special interest; 4) Vegetation associations; 5) Future needs; and 6) References. Each section is further divided into various topics, such as a listing of species groups and the ecological role of given species-in'the ecosystem.

SECTION I: INTRODUCTION - SCOPE OF PROJECT

This section consists of five topics: A) Ecological realm; B) Invertebrate taxa; C) Geograhical range; D) A.Database template - Ecological functional groups: and E) Species information forms.

A. Ecological realm.

The generalized habitat consisting of the understory vegetation of forested lands is the environment considered in this report. The understory Vegetation involves hundreds of plant species and as defined for consideration of invertebrate herbivores I have limited the floral scope to the herbaceous/graminaceous plants and shrubs. The herbivores of trees, defined as those plants with a single main woody trunk and exceeding 3 m in height when fully grown, are discussed by M. Wagner in a companion report on the assessment of canopy herbivores of the Columbia River Basin.

Herbaceous plants are defined as low growing and nonwoody. Species of herbaceous plants are well represented among many families such as, Apiaceae (*Heracleum*), Aspidiaceae (*Polystichum*), Asteraceae *(Senecio),* Brassicaceae (*Cardamine*, *Sisymbrium),* Crassulaceae (*Sedum*), Fabaceae *(Lotus, Lupinus*), Hydrophyllaceae *(Phacelia),* Lamiaceae (*Mentha*), Liliaceae (Calochortus, *Trillium),* Onagraceae (*Epilobium*, *Eriogonum),* Ranunculaceae (*Potentilla*), and Violaceae (Viola).

Grasses (Poaceae) are easily distinguished by their characteristic flower heads and leaf morphology. Species of grasses that typically occur in the region Of the Columbia River Basin are: *Andropogon, Avena, Bromus, Festuca,* and *Poa.*

The shrubby vegetation is defined as plants with woody growth, without a single main trunk, and generally less than 3 m tall. shrubs are represented by numerous families, such as, Asteraceae *(Artemisia, Chrysothmanus),* Caprifoliaceae (*Symphoricarpos*), Ericaceae (*Arctostaphylos*, Gaultheria, Rhododendron, *Vaccinium)* , Grossulariaceae *(Ribes),* Rhamnaceae *(Ceanothus),* 'and Rosaceae (*Holodiscus*, *Purshia, Rosa, Rubus*, Spiraea).

B. Invertebrate taxa.

The functional group of invertebrates addressed *in* this report concerns the Lepidoptera (butterflies and moths). In the classification of insects at the ordinal level the Lepidoptera are the most speciose and abundant taxon found on understory vegetation. Another major herbivore taxon associated with understory vegetation is the Heteroptera, this group is addressed by J.D. Lattin in this

series of reports assessing the invertebrates of the Columbia River Basin. Other taxa, such as some species of Orthoptera (grasshoppers and crickets), Coleoptera (beetles), and Diptera (flies), which occur on understory vegetation were determined to be beyond the scope of this report.

Approximately 38 families and 2,500 species of Lepidoptera occur in the Pacific Northwest. The Lepidoptera are subdivided into two main groups: the moths and the butterflies. The families of moths and butterflies found in the Columbia River Basin are listed below.

MOTHS		BUTTERFLIES
Alucitidae	Arctiidae	Danaidae
Blastobasidae	Choreutidae	Hesperiidae
Cochylidae	Coleophoridae	Lycaenidae
Cosmopterigidae	Cossidae	Nymphalidae
Dioptidae	Drepanidae	Papilionidae
Epiplemidae	Gelechiidae	Pieridae
Geometridae	Hepialidae	Riodinidae
Incurvariidae	Lasiocampidae	Satyridae
Limacodidae	Lymantriidae	
Micropterygidae	Noctuidae	
Notodontidae	Plutellidae	
Oecophoridae	Pyralidae	
Pterophoridae	Sesiidae	
Saturniidae	Thyatiridae	
Sphingidae	Tortricidae	

Each of these families is represented in the Columbia River Basin by a rough count figure of 1,500 species. However, many of these species, in general 30-40% are restricted to broad-leaf and coniferous trees (see Wagner report) and are therefore not part of the understory herbivore functional group as defined above. Nonetheless, it would appear that 800-1,000 species of Lepidoptera are associated with understory vegetation in the Coiumbia River Basin. In Section II consideration is given to areas of particularly high species richness, endemism, and special habitats for these species in general. Section IIII covers selected groups of species of special interest and their place in the ecosystem. Section IV lists representative species associated with broadly defined vegetation types.

C. Geograhical range.

The Columbia River Basin is outlined in Figure 1. In general terms the west boundary is defined by the crest of the Cascade mountains from the Canadian-US border to the California-Oregon border. The southern boundary is defined along the Oregon/Idaho-California/Nevada border (42^{o} latitude), including the northern portion of Elko Co., Nevada, and excluding Oneida, Franklin and Lake Co., Idaho. The eastern boundary includes a small region of Wyoming centered on Teton Co., the central portion of the eastern border of Idaho, and the westernmost counties of Montana. The northern boundary is defined by the US-Canadian border.

D. Ecological functional group8 of species: A Database template

1. Name of ecological functional group:

UNDERSTORY HERBIVORES (LEPIDOPTERA)

2. Key ecological functions of this group:

a. NUTRIENT CYCLING..
b. MAJOR INFLUENCE ON PLANT GROWTH RATES AND FITNESS.
c. STAND COMPOSITION, PLANT SPECIES ABUNDANCE.
d. POLLINATION.
e. KEY PREY FOR CARNIVOROUS SPECIES: INVERTEBRATES SUCH AS SPIDERS AND VERTEBRATES SUCH AS FISH, BIRDS, BATS, AND MAMMALS.

3. Examples of species in this group:

Colias pelidne (Pieridae, sulphur butterfly)
Drepanulatrix unical cararia (Geometridae, inchworm)
Hemileuca hera (Saturniidae, silk moth)
Neominois ridingsii (Satyridae, eatyr butterfly)
Papilio *zelicaon* (Papilionidae, swallowtail)
Sphinx vashti (Sphingidae, sphinx moth)
Syngrapha orophila (semi-looper moth)

E. species information forma.
Panel Species Information Forms are detailed for the species listed above.

Columbia River Basin - Panel Species Information Page of

Date: 12/28/94 Panelist Name: Jeff Miller

Species or Species Group:. *Colias pelidne*

"I did not complete this form because.."

Province and/or Section:

alpine tundra-CRB005

Key Environmental Correlates

Larval hostplant: *Vaccinium* spp.

1.

Categorical XX	Continuous
Suitable categories	Unit of Measure
1 *V. parvifolium*	
2 *V. scoparium*	
3	
4	
5	Minimum
6	
Applies seasonally? Y XX N__	Maximum
Which season? spring, summer	

Nectar source for adults

2.

Categorical XX	Continuous
Suitable categories	Unit of Measure
1 various species of Asteraceae	
2 various species of Apiaceae	
3	
4	
5	Minimum
6	
Applies seasonally? Y XX N__	Maximum
Which season? spring-fall	

3. Elevation

Categorical
Suitable categories
1
2
3
4
5
6

Applies seasonally? Y__ N XX
Which season? N/A
. . ,

Continuous XX
Unit of Measure

feet

Minimum
9,000

Maximum
12,000

Key Ecological Functions

1. decreases primary production of host plant.
2. enhances nutrient cycling.
3. influence species abundance in respective plant communities
4. provides food for various insectivorous invertebrates.
5. provides food for various insectivorous vertebrates.

Key Assumptions:

Temperature conditions in a given year allow for the completion of at least one generation.

Nectar feeding may or may not be host specific.

Key Unknowns and Monitoring or Research Needs:

Role of parasitoids, predators1 and disease in population dynamics.

Importance of this species as food for vertebrates.

Effect of herbivory by this species on the fitness of the host plant and subsequent effects on the plant community)

Long term population trends.

Dispersal

/'Dispersal mode:
independent flight

Requirements for dispersal:
adult life stage
warm daytime temperatures
low wind conditions

Degree of confidence in knowledge of species	
High	
Medium	
Low XX	

Trend	
Increasing-	
Stable__	
Decreasing-	
Unknown XX	

Comments: This species occurs only in high mountain alpine meadows.

Columbia River Basin - Panel Species Information Page of

Date: 12/28/94 Panelist Name: Jeff Miller

Species or Species Group: *Drepanulatrix unicalcararia*

"I did not complete this form because.."

Province and/or section:

subalpine herbaceous

Key Environmental Correlates

Larval host plant: Ceanothus spp..

1.

Categorical XX	Continuous
Suitable categories	Unit of Measure
1 C. velutinus	
2 *C. integerrimus*	
3	
4	
5	
6	Minimum
Applies seasonally? Y XX N__	
Which season? spring, summer	Maximum

Nectar source for adults

2.

Categorical XX	Continuous
Suitable categories	Unit of Measure
1 various species of Asteraceae	
2 various species of Apiaceae	
3	
4	
5	
6	Minimum
Applies seasonally? Y XX N__	
Which season? spring-fall	Maximum

Key Ecological Functions

1. decreases primary production of host plant.
2. enhances nutrient cycling.
3. influence species abundance in respective plant communities
4. provides food for various insectivorous invertebrates.
5. provides food for various insectivorous vertebrates.

Key Assumptions:

Temperature conditions in a given year allow for the completion of at least one generation.

Nectar feeding may or may not be host specific.

Key Unknowns and Monitoring or Research Needs:

Role of parasitoids, predators/ and disease in population dynamics.

Importance of this species as food for vertebrates.

Effect of herbivory by this species on the fitness of the host plant and subsequent effects on the plant community1

Long term population trends.

Dispersal

Dispersal mode: independent flight

Requirements for dispersal:
adult life stage
warm nightime temperatures
low wind conditions

I

Degree of confidence in knowledge of species

High___

Medium___

Low XX

Trend

Increasing__

Stable__

Decreasing__

Unknown XX

Comments: The larva of this species feed only on foliage of *Ceanothus* spp., in particular *C. velutinus.*

Columbia River Basin - Panel Species Information Page of

Date: 12/28/94 Panelist Name: Jeff Miller

Species or Species Group: *Hemileuca hera*

"I did not, complete this form because.."

Province and/or Section:

mixed grass, shrubland-CRB002

Key Environmental Correlates

1.

Larval host plant: *Artemisia* spp.

Categorical XX	Continuous
Suitable categories	Unit of Measure
1 *A. tridentata*	
2 *A. rigida*	
3 *A. arbuscula*	
4	
5	
6	Minimum
Applies seasonally? Y X X N	
Which season? spring; summer	Maximum

2.

Categorical	Continuous
Suitable categories	Unit of Measure
1	
2	
3	
4	
5	
6	Minimum
Applies seasonally? Y N	
Which season?	Maximum

Key Ecological Functions

1. decreases primary production of host plant.

2. enhances nutrient cycling.

3. influence species abundance in respective plant communities

4. provides food for various insectivorous invertebrates.

5. provides food for various insectivorous vertebrates.

Key Assumptions:

Temperature conditions in a given year allow for the completion of at least one generation.

Key Unknowns and Monitoring or Research Needs:

Role of parasitoids, predators1 and disease in population dynamics.

Importance of this species as food for vertebrates.

Effect of herbivory by this species on the fitness of the host plant and subsequent effects on the plant. community

Long term population trends.

Dispersal

Dispersal mode:
independent flight

Requirements for dispersal:
adult life stage
warm daytime temperatures
low wind conditions

Degree of confidence in knowledge of species	Trend
High	Increasing-
Medium	Stable__
LOW XX	Decreasing-
	Unknown XX

Comments: This species does not have functional mouthparts, thus, nectar sources for the adult are not critical as for other species of understory Lepidoptera. Also, this species is a day-flying moth so daytime temperatures will affect flight behavior.

Columbia River Basin - Panel Species Information Page of

Date: 12/28/94 Panelist Name: Jeff Miller

Species or Species Group: *Neominois ridingsii*

"I did not complete this form because.."

Province and/or Section:

seral shrubland-CRB003

Key Environmental Correlates

1. Larval host plant: Bouteloua gracilis

Categorical XX	Continuous
Suitable categories	Unit of Measure
1	
2	
3	
4	
5	
6	Minimum
Applies seasonally? Y XX N__	
Which season? spring, summer	Maximum

2. Nectar source for adults

Categorical XX	Continuous
Suitable categories	Unit of Measure
1 various species of Asteraceae	
2 various species of Apiaceae	
3	
4	
5	
6	Minimum
Applies seasonally? Y XX N__	
Which season? spring-fall	Maximum

Key Ecological Functions

1. decreases primary production of host plant.

2. enhances nutrient cycling.

3. influence species abundance in respective plant communities

4. provides food for various insectivorous invertebrates.

5. provides food for various insectivorous vertebrates.

Key Assumptions:

Temperature conditions in a given year allow for the completion of at least one generation.

Nectar feeding may or may not be host specific.

Key Unknowns and Monitoring or Research Needs:

Role of parasitoids, predators1 and disease in population dynamics.

Importance of this species as food for vertebrates.

Effect of herbivory by this species on the fitness of the host plant and subsequent effects on the plant community1

Long term population trends.

Dispersal

Dispersal mode: independent flight

Requirements for dispersal:
adult life stage
warm daytime temperatures
low wind conditions

Degree of confidence in knowledge of species	Trend
High	Increasing__
Medium	Stable__
Low XX	Decreasing-
	Unknown XX

Comments: The northwestern-most extent in the distribution of this butterfly occurs in limited areas of the Columbia River Basin. Only two records exist for this species in Oregon and none for Washington.

Columbia River Basin - Panel Species Information Page of

Date: 12/28/94 Panelist Name: Jeff Miller

Species or Species Group: "I did not complete this form because.."
Papilio zelicaon

Province and/or Section:

seral shrubland-CRB003

Key Environmental Correlates

Larval host plant: Generalist feeder on species of Apiaceae
1.

Categorical	Continuous
Suitable categories	Unit of Measure
1 *Heracleum lanatum*	
2 *Foeniculum vulgare*	
3	
4	
5	
6	Minimum
Applies seasonally? Y XX N__	
Which season? spring, summer	Maximum

Nectar source for adults
2.

Categorical XX	Continuous ___
Suitable categories	Unit of Measure
1 various species of Asteraceae	
2 various species of Apiaceae	
3	
4	
5	
6	Minimum
Applies seasonally? Y XX N__	
Which season? spring-fall	Maximum

Key Ecological Functions

1. decreases primary production of host plant.
2. enhances nutrient cycling.
3. influence species abundance in respective plant communities
4. provides food for various insectivorous invertebrates.
5. provides food for various insectivorous vertebrates.

Key Assumptions:

Temperature conditions in a given year allow for the completion of at least one generation.

Nectar feeding may or may not be host specific.

Key Unknowns and Monitoring or Research Needs:

Role of parasitoids, predators1 and disease in population dynamics.

Importance of this species as food for vertebrates.

Effect of herbivory by this species on the fitness of the host plant and subsequent effects on the plant community1

Long term population trends.

Dispersal

Dispersal mode:
independent flight

Requirements for dispersal:
adult life stage
warm daytime temperatures
low wind conditions

Degree of confidence in knowledge of species	Trend
High	Increasing-
Medium	Stable__
Low XX	Decreasing-
	Unknown X

Comments: This is a very common and well collected species. The Anise swallowtail is the only swallowtail to to feed on vegetation of the understory plant community.

Columbia River Basin - Panel Species Information Page of

Date: 12/28/94 Panelist Name: Jeff Miller

Species'or Species Group: *Sphinx* vashti

"I did not complete this form because.."

Province and/& Section:

subalpine herbaceous-CRB004

Key Environmental Correlates

Larval host plant: *Symphoricaxpos albus*

1.

Categorical XX	Continuous
Suitable categories	Unit of Measure
1 S. *albus*	
2	
3	
4	
5	
6	Minimum
Applies seasonally? Y XX N__	
Which season? spring, summer	Maximum

Nectar source for adults

2.

Categorical XX	Continuous
Suitable categories	Unit *of* Measure
1 various species of Asteraceae	
2 various species of Apiaceae	
3	
4	
5	
6	Minimum
Applies seasonally? Y XX N__	
Which season? spring-fall	Maximum

Key Ecological Functions

1. decreases primary production of host plant.

2. enhances nutrient cycling.

3. influence species abundance in respective plant communities

4. provides food for various insectivorous invertebrates.

5. provides food for various insectivorous vertebrates.

Key Assumptions:

Temperature conditions in a given year allow for the completion of at least one generation.

Nectar feeding may or may not be host specific.

Key Unknowns and Monitoring or Research Needs:

Role of parasitoids, predators1 and disease in population dynamics.

Importance of this species as food for vertebrates.

Effect of herbivory by this species on the fitness of the host plant and subsequent effects on the plant community1

Long term population trends.

Dispersal

Dispersal mode: independent flight

Requirements for dispersal: adult life stage
warm nightime temperatures
low wind conditions

Degree of confidence in knowledge of species

High___

Medium___

Low XX

Trend

Increasing-

Stable__

Decreasing__

Unknown XX

Comments: This species occurs in association with its host plant as an indicator of moist (riparian) habitats.

Columbia River Basin - Panel Species Information Page *of*

Date: 12/28/94 **Panelist Name:** Jeff Miller

Species or Species Group:
Syngrapha orophila

"I did not complete this form because.."

Province and/or Section:

subalpine herbaceous-CRB004

Key **Environmental Correlates**

Larval host plant: *Vaccinuim* spp.

1.

Categorical-G Suitable categories	Continuous Unit of Measure
1 *V. parvifolium*	
2 *v. membranaceum*	*I*
I 3	
I 4	
I 5	
6	Minimum
Applies seasonally? Y XX N	
Which season? spring, summer-	Maximum

Nectar source for adults

2.

Categorical XX Suitable categories	Continuous Unit of Measure
1 various species of Asteraceae	
2 various species of Apiaceae	
3	
4	
5	
6	Minimum
Applies seasonally? Y XX N	
Which season? spring-fall	Maximum

Key Ecological Functions

1. decreases primary production of host plant.
2. enhances nutrient cycling.
3. influence species abundance in respective plant communities
4. provides food for various-insectivorous invertebrates.
5. provides' food for various insectivorous vertebrates.

Key Assumptions:

Temperature conditions in a given *year* allow for the completion of at least one generation.

Nectar feeding may or may not be host specific.

Key Unknowns and Monitoring or Research Needs:

Role of parasitoids, predators and disease in population dynamics.

Importance of this species as food for vertebrates.

Effect of herbivory by this species on the fitness of the host plant and subsequent effects on the plant community

Long term population trends.

Dispersal

Dispersal mode: independent flight

Requirements for dispersal: adult life stage
warm nightime temperatures
low wind conditions

Degree of confidence in knowledge of species

High___
Medium___
Low XX

Trend

Increasing-
Stable__
Decreasing-
Unknown XX

Comments: This species occurs in mid to late seral stage habiats in the subalpine zone where larvae feed only on the foliage of *Vaccinium.*

SECTION II. Biogeographical considerations

This section consist of three topics: A) Species richness; B) Endemism; C) Special habitats and conservation. Maps were not produced because no specific sites were noteworthy due to lack of knowledge not lack of eventual need to conserve special habitats and species.

A. Species richness.

Unpublished data from J. Miller and P. Hammond demonstrate that sampling (sampled by operating a blacklight trap for an entire season, May-October) of a "typical" site will result in the recovery of 350-450 species of Macro-Lepidoptera. Also, unpublished reports from J. Powell suggest that the Micro-Lepidoptera fauna is equal to that of the Macro Lepidoptera fauna in a given region. Thus, a given site may contain 700-800 species of Lepidoptera. Perhaps half of the species are associated with understory vegetation.

The regions listed below have been identified as areas where the fauna of understory Lepidoptera has been at least qualitatively assessed and found to be relatively rich in species abundance. These areas are addressed below under consideration of habitats of special interest. In general, the areas represent mountain ranges that are to one degree or another isolated from other similar types Of environments. The exceptions are the Warm Springs Indian Reservation and the Metolius Basin/Camp Sherman area which occur in the Cascade Mountain Range.

Wallawa Mountains-Hell's Canyon-Seven Devils Mountain, Oregon-Idaho
Devine Canyon, Harney Co., 10 miles north of Burns, Oregon
Warm Springs Indian Reservation, Oregon
Metolius Basin/Camp Sherman, Oregon
Starkey Forest, Blue Mountains, Oregon
Alvord Desert, Oregon
Warner Mountains, Oregon
Albian Mountains - South Hills, Idaho
Bitteroot Mountains, Idaho
Sawtooth Mountains, Idaho

B. Endemism.

See report by Paul Hammond for butterflies.

Endemism in species of moths within the Columbia River Basin is not well studied. Our present knowledge of endemic species is limited because the overall range of many moth species is unknown. Therefore, the collection of an uncommon species will at first appear to indicate endemism. However, additional studies on the presence absence of species will provide the data needed to declare a species to be endemic to a certain site. For instance, *Oncocnemis piffardi* is known from within the Columbia River Basin from only one specimen collected by J.C. Miller at Prairie Farm, 30 miles north of Sisters, Oregon. The question remains as to whether this species is limited to the Prairie Farm site or does the species range over a broad landscape but is very rare. Similary, *Pronoctua peabodyae is* known from within the Columbia River Basin from only one specimen collected by L. Crabo.

Areas within the Columbia River Basin that‘appear to possess endemic species are: Okanagon.Mountains (unpublished studies on noctuid moths by L. Crabo); Wallawa Mountains – Hell's Canyon - Seven Devils Mountain (unpublished studies on butterflies and moths by P. Hammond. These sites, in particular, are characterized as alpine habitat and represent the only known collection sites for species such as Anepia *capsularis* and *Synedoida petricola.*

Some attention should be given to the status of species with a limited distribution within the Columbia River Basin but otherwise widely distributed outside this area. The reasoning behind this statement is that such species may exhibit a northern- southern- or western- most range in their distribution along the border of the Columbia River Basin. Conservation of such populations may be critical for maintainance of genetic diversity and the dynamics of metapopulations which contribute to the existence/possible extinction of a species. Below is a list of butterfly species which exhibit an edge of their overall distribution along the boundary of the Columbia River Basin from: 1) California distribution, 2) Rocky Mountain range, 3) Canadian-boreal zone.

Anthocaris lanceolata
Atalopedes campestris
Atlides halesus
Battus philenor
Boloria alberta
Boloria freija
Callophrys lemberti
Coenonympha California
Colias gigantea
Colias meadii
Erebia vidleri
Hemiargus isola
Hersperia columbia
Hersperia uncas
Hesperia lindseyi
Lycaena arota
Lycaena gorgon
Thessalia leanira
Lycaena hylus
Lycaena phlaeas
Lycaena xanthoides
Mitoura bumei
Nathalis iole
Neominois ridingsii
Ochlodes agricola
Ochlodes yuma
Oenis melissa
Papilio canadensis
Polites mardon
Polites peckius
Polites thnnistocles
Pyrgus centaureae
Satyrium auretonun
Satyrium liparops
Satyrium tetra

C. Special habitats and conservation.

Consideration was given only to regions that are within the Columbia River Basin regarding the following states: Idaho, Montana, Nevada, Oregon, Washington, and Wyoming. Consideration of local sites is not possible due to lack of information on specific collection localities for various species. However, consideration may be given to areas defined by county boundaries or major geological formations such as mountains and gorges. These areas were identified through personal communication with individuals that are serious collectors of Lepidoptera. Published data on these sites do not exist and voucher specimens, which provide 'collecting data, are scattered among numerous collections, private and institutional.

Idaho - At least three areas of particular interest occur in Idaho:
1) Hell's Canyon/Seven Devils Mountain
2) Albian Mountains/South Hills
3) Bitteroot Mountains/Sawtooth Mountains

Montana - No information was available regarding habitats of special interest Or of conservation concern.

Nevada - No information was available regarding habitats of special interest or of conservation concern.

Oregon - At least seven areas of interest occur in Oregon. (This list of special habitats is biased towards Oregon because the author has better knowledge of Oregon than the other states and because butterflies and moths in Oregon have been more intensely collected relative to some of the other states). The areas Of special interest are:

1) Wallawa Mountains
2) Starkey Forest, Blue Mountains
3) Devine Canyon, Harney Co., 10 miles north of Burns
4) Warm Springs
5) Camp Sherman
6) Alvord Desert
7) Warner Mountains

Washington - The only area of major interest was the Okanagon Mountains. Most of this area is presently under conservation management as part of Glacier National Park.

Wyoming - The only area of special interest was Teton Co. in general and the mountains within the limits of this county in particular. Most of this area is presently under conservation management as part of the Teton National Park.

SECTION III - Species of special interest

A. Profile of species.

The species given special consideration for this report are: *Colias pelidne skinneri, Drepanulatrix unicalcararia, Hemileuca hera, Neominois ridingsii, Papilio zelicaon, Sphinx vashti,* and *Syngrapha orophila.* Each of the species in this section is discussed with regard to six topics: 1) Justification of special status; 2) Habitat associations; 3) Distribution; 4) Functional role in ecosystem; 5) Disturbance sensitivity; and 6) Population trends.

Colias pelidne skinneri - Skinner's sulphur

1. Justification of special status.
   This subspecies is one of three subspecies of *C. pelidne* which is a butterfly in the Pieridae. The Skinner's sulphur represents a subspecies with a limited distribution in its general biogeographic range and its preference for high mountain meadows.

2. Habitat associations.
   Larvae feed on species of *Vaccinium.* The species occurs primarily in high mountain meadows above 3,000 meters, typical of the Canadian to Arctic/Alpine zone forests.

3. Distribution.
   Throughout the Columbia River Basin Skinner's sulphur is most common in Idahb, western Montana, and western Wyoming. The species is uncommon in Washington and Oregon. Adults occur from late June to early September.

4. Functional role in ecosystem.
   The only known role for this species is that larvae feed on blueberry and therefore would influence the growth, reproduction, distribution, and abundance of *Vaccinium* spp., but to an unknown degree. No reports exist on the use of C. *pelidne* as a host or prey'of carnivores.

5. Disturbance sensitivity.
   The effect of fire, grazing, clearing, and pesticides have not been quantitatively documented. However, pesticides that are not species specific may have a negative impact on populations of C. pelidne. Also, grazing would be expected to exhibit a negative impact. However, within limits the role of fire and clearing may be to enhance the meadow type of habitat which C. *pelidne* requires for suitable larval host p l a n t s .

6. Population trends.
   unknown.

SECTION III cont'd - Species of special interest

Drepanulatrix unicalcararia

1. **Justification of special status.**
   This species belongs to a genus of moths in the Geometridae. All the known species of this genus that occur in the region of the Columbia River Basin feed in *Ceanothus* spp. Thus, the species serve as bioindicators of understory vegetation that occurs in open sunny locations.

2. **Habitat associations.**
   Larvae only feed on the foliage of *Ceanothus* spp.

3. **Distribution.**
   Unknown, but is found in the same general environemt as are species of *Ceanothus.*

4. **Functional role in ecosystem.**
   The only known role for this species is that larvae feed on various species of *Ceanothus* and therefore would influence the growth, reproduction, distribution, and abundance of snowbrush, *C. velutinus,* the most widespread and common species of *Ceanothus.* Defoliationof *C. velutinus* by *Drepanulatrix* spp. can be severe in certain years at local sites. No reports exist *on* the use of *D. unicalcararia* as a host or prey of carnivores.

5. **Disturbance sensitivity.**
   The effect of fire, grazing, clearing, and synthetic pesticides have not been quantitatively documented. *However,* the pathogen *Bacillus thuringiensis kurstaki,* had a negative impact on populations of *D. unicalcararia* (author, unpubl. data). Within limits the role of grazing, fire and clearing may be to enhance the early succesional type of vegetation within which species of *Ceanothus* are particularly abundant.

6. **Population trends.**
   unknown.

SECTION III cont'd - Species of special interest

Hemileuca hera

1. **Justification of special status.**
   This species is a moth in the Saturniidae. *Hemileuca hera* is an indicator species of sagebrush habitat.

2. **Habitat associations.**
   Larvae feed on sagebrush, *Artemisia* spp.

3. **Distribution.**
   The species may be found throughout most of the Columbia River Basin: eastern Oregon and Washington, western Montana, Idaho, western Wyoming, and Nevada.
   The egg is the overwintering life stage, larvae occur from mid May to July, adults occur from early July through late August.

4. **Functional role in ecosystem.**
   The only known role for this species is that larvae feed on sagebrush and therefore would influence the growth, reproduction, distribution, and abundance of *Artemisisa* spp., but to an unknown degree. No reports exist on the use of *H. hera* as a host or prey of carnivores.

5. **Disturbance sensitivity.**
   The effect of fire, grazing, clearing, and pesticides have not been quantitatively documented. However, pesticides that are not species specific, including pathogens such as *Bacillus thuringi ensi s kurstaki,* may have a negative impact on populations of *H. hera*. However, within limits the role of grazing, fire and clearing may be to enhance the grassland/shrubland type of vegetation within which species of *Artemisia* are particularly abundant.

6. **Population trends.**
   unknown.

SECTION III cont'd - Species of special interest

***Neominois ridingsii stretchii* - Riding's satyr**

1. **Justification of special status.**
   This subspecies is a butterfly representing the Family Satyridae. Ridings' satyr exhibits a limited distribution within the region of the Columbia River Basin, thereby representing a species with the northwest extent of its range determined by a few special areas of suitable habitat.

2. Habitat **associations.**
   Larvae feed on the grass *Bouteloua gracilis.* This grass grows in open woodland, sagebrush, and prairie environments.

3. **Distribution.**
   The species is very uncommon throughout most of the Columbia River Basin: only two records exist for *N ridingsii* in eastern Oregon and none for Washington. The species has been documneted in northern Nevada, east-centarl Idaho, western Wyoming, and western Montana. Thus, the northwestern extent of Ridings' satyr range is bounded by the southern and eastern boundaries of the Columbia River Basin.
   Eggs are laid in the late spring, third and fourth instars overwinter, pupae occur in the soil, adults fly from late June to early August.

4. **Functional role in ecosystem.**
   The only known role for this species is that larvae feed on grassess and therefore would influence the growth, reproduction, distribution, and abundance of its host plant(s). No reports exist on the use of *N. ridingsii* as hosts or prey of carnivores.

5. **Disturbance sensitivity.**
   Due to limited distribution within the Columbia River Basin, which implies a minimal source of populations for recolonization following disturbance, disturbance by fire, grazing, clearing or pesticides would likely be very negative on populations of this butterfly.

6. **Population trends.**
   unknown.

SECTION III cont'd - Species of special interest

Papilio *zelicaon* - Anise swallowtail

1. Justification of special status.
This species is a butterfly in the swallowtail family, Papilionidae. The anise swallowtail is the only species that is an understory herb-forb feeder within the family and distributed within the Columbia River Basin. Swallowtails are well studied and often collected by professional scientist and amateurs. Thus, *P. zelicaon* represents one of the best documented species of the region.

2. Habitat associations.
The larvae feed on various species of Apiaceae, in particular *Heracl* eum and *Foeni cul* um. Thus, this swallowtail is generally associated with woodland and early to mid aged coniferous forest vegetation.

3. Distribution.
The western tiger swallowtail is distributed throughout the Columbia River Basin. Records of adults occur in all but seven counties in this region. The species ranges from low elevations to near timberline.
Adults fly from mid March May to early September. Eggs are laid in late spring, pupae overwinter.

4. Functional role in ecosystem.
The only known role for this species is that larvae feed on various species of Apiaceae and therefore would influence the growth, reproduction, distribution, and abundance of its host plant(s). Reports on the use of butterflies as food, including swallowtails in general (but not specifically for P. *zelicaon)* list adults, larvae, and pupae as prey for bats, birds,. rodents, miscellaneous mammals, and a multitude of invertebrate predators.

5. Disturbance sensitivity.
The effect of fire, grazing, clearing, and pesticides have not been quantitatively documented. However, pesticides that are not species specific may have a negative impact on populations of P. *zelicaon.* Also, grazing would be expected to exhibit a negative impact. However, within limits the role of fire and clearing may be to enhance the unshaded, open type of habitat which *P. zelicaon* requires for suitable larval host plants.

6. Population trends.
unknown.

SECTION III cont'd - Species of special interest

Sphinx vashti

1. **Justification of special status.**
   This species is a moth in the Sphingidae. *Sphinx vashti* may be considered an indicator species typical of moist areas and riparian habitats.

2. **Habitat associations.**
   The larvae feed on common snowberry; *Symphoricarpos albus*.

3. **Distribution.**
   The species is widespread throughout the Columbia River Basin: eastern Oregon and Washington, western Montana, Idaho, western Wyoming, and Nevada.
   The pupa is the overwintering life stage, larvae occur in May, June and July, adults fly from April through August;

4. **Functional role in ecosystem.**
   The only known role for this species is that larvae feed on snowberry and therefore would influence the growth, reproduction, distribution, and abundance of S. *albus*, but to an unknown degree. No reports exist on the use of S. *vashti* as a host or prey of carnivores.

5. **Disturbance sensitivity.**
   The effect of fire, grazing, clearing, and pesticides have not been quantitatively documented. However, pesticides that are not species specific, including pathogens such as *Bacillus thuringiensis kurstaki,* may have a negative impact on populations of *H. hera*. Also, the grazing, fire and clearing may be detrimental to populations of *S. vashti* because of negative impacts on the larval host plant due to alteration of the microclimate most suitable to *Symphoricarpos.*

6. **Population trends.**
   Unknown.

SECTION III cont'd - Species of special interest

Syngrapha orophila

1. Justification of special status.
This species is a moth in the Noctuidae, subfamily Plusiinae. Among the species of Plussiinae in the Columbia River Basin, *S. orophila* is not commonly collected although it is widespread. This species may serve as a bioindicator of middle to late seral stages of plant succession.

2. Habitat associations.
Larvae of *S. orophila* feed on blueberry, *Vaccinium* spp. Thus, the species is associated with the shade tolerant understory vegetation of middle aged to older growth coniferous forests.

3. Distribution.
Syngrapha orophila occurs from northern British Columbia to northwestern Wyoming, central Idaho, and southern Oregon. Adult are in flight from mid July to late August. The species is found at higher elevations where its host plant grows.

4. Functional role in ecosystem.
The only known role for this species is that larvae feed on blueberry and therefore would influence the growth, reproduction, distribution, and abundance of *Vaccinium* spp., but to an unknown degree. No reports exist on the use of S. *orophila* as a host or prey of carnivores.

5. Disturbance sensitivity.
The effect of fire, grazing, clearing, and pesticides have not been quantitatively documented. However, pesticides that are not species specific, including pathogens such as *Bacillus thuringiensis kurstaki,* may have a negative impact on populations of *S. orophila.* Also,the grazing, fire and clearing may be detrimental to populations of *S. vashti* because of negative impacts on the larval host plant due to alteration of the microclimate most suitable to *Vaccinium.*

6. Population trends.
unknowrl.

SECTION III - Species of special interest

B. MODEL INFORMATION FOR SPECIES OF SPECIAL CONCERN

1. Key environmental factors.

Numerous factors must be considered in attempting to model-the distribution and abundance of a species. Very little quantitative data are available for modelling efforts concerning the understory Lepidoptera of the Columbia River Basin. However, measurements on the following factors could be conducted and used in modelling populations once data are acquired. See the-section-on,future needs for further discussion of these factors.

temperature: developmental threshold, degree-day requirements
nectar sources for adults
larval-host. plant(s)
natural enemies: parasitoids, predators, pathogens
disturbance regimes: fire, grazing, clearing, pesticides

2. Key functional roles.

All of the species of understory Lepidoptera function in the same general roles of: 1): regulation of host plant growth and fitness; 2) influence on composition of species in the community; 3) nutrient cycling; and 4) food web relationships, namely as a food source for carnivorous species. Also, numerous species may serve as facultative or fortuitous pollinators for certain plants. None of these roles have been quantified for any species of lepidopteran occurring on understory vegetation of the Columbia River Basin.

SECTION IV - Vegetation associations

This section consists of a listing of understory vegetation types followed by discussion of six topics.

The vegetation types are: 1) Agricultural land use; 2) Mixed grass, agriculture, shrubland; -3) Seral shrubland; 4) Subalpine herbaceous; and 5) Alpine tundra.

The discussion topics are: A) Representative species; B) Habitat requirements; C) Distribution; D) Functional role in ecosystem; E) Sensitivity to disturbance; and F) Population trends.

SECTION IV cont'd - Vegetation associations

Vegetation Type: Agricultural land use - CRB001

This vegetation type is characterized by arable cropping systems where commodities such as alfalfa, mint, wheat, and various vegetables have been planted.

A. Representative species.
Spodoptera praefica
Euxoa ochrogaster
Trichoplusia ni

B. Habitat requirements.
These species are herbivores in agricultural commodities such as alfalfa, peppermint, wheat, and vegetables. Most of the species occurring in this vegetation type appear to be rare to nonexistant outside the environment of an arable cropping system. Also, many of these crop pests are not native to North America.

C. Distribution.
Throughout the Columbia River Basin where crop production occurs. Such areas are typically in the valley bottomlands and lower slopes of foothills.

D. Functional role in ecosystem.
These species often attain high population levels achieving pest status and are typically sprayed with pesticides. The use of pesticides on epizootic populations of agriculturally oriented species may result in negative effects on populations of nontarget invertebrates and vertebrates.

E. Sensitivity to disturbance.
Species of herbivorous insects associated with agricultural plants often thrive under conditions of habitat disturbance. The disturbance regime inherent in crop production serves in part to promote population epizootics of these species by interfering with natural control agents such as predators, parasitoids, and pathogens.

F. Population trends.
Populations of these species are typically at high levels during summer months within a given year. Trends in high seasonal populations across years tend to be consistent.

SECTION IV cont'd - Vegetation associations

Vegetation Type: Mixed grass, shrubland - CRBO02

This vegetation type is characterized by the presence of grasses such as, *Agropyron* and *Festuca* in association with shrubs such as *Artemisia* and *Purshia*.

A. Representative species.

Apamea occidens
Hemileuca hera
Neominois ridingsii
***Speyeria* spp.**

B. Habitat requirements.

These species occupy a habitat that is generally considered an open rangeland/prairie type of environment. The presence of larval host plants and plants that provide a nectar source for adults are critical requirements.

C. Distribution.

Species occurring in this vegetation type are distributed in valley bottoms and the prairie/plains environments.

D. Functional role in ecosystem.

A primary role for these species is that larvae feed on many of the dominant species of this vegetation type. Therefore, plant community composition may be influenced, albeit to unknown degrees, by the presence/absence-of high and low population levels of these herbivores. Furthermore, the growth, reproduction, distribution, and abundance of respective host plant(s) will be affected. Reports on the use of these species as food are general in nature (lists of prey used by vertebrates may only mention insects at the class or ordinal-level) but do mention that adults, larvae, and pupae of butterflies and moths are preyed upon by bats, birds, rodents, miscellaneous mammals, and a multitude of invertebrate predators.

E. Sensitivity to disturbance.

Invasion of exotic grasses that displace native grass' species is detrimental to native Lepidoptera, the exotic species-are not suitable host plants. Invasion is facilitated by intentional plantings and soil disturbance,. including overgrazing.

F. Population trends.

Unknown.

SECTION IV cont'd - Vegetation associations

Vegetation Type: Seral shrubland **- CRBO03**

This vegetation type is characterized by the presence of trees belonging to the genera *Quercus, Salix, Prunus* and *Juniperus,* among others; Also, species of shrubs belonging to the genera Purshia, Arctostaphylos, *Salix, Rosa,* and *Rubus* may be present.

A. Representative species.
Hemileuca eglanterina
Papilio zelicaon
Polia purpurissata
Sphinx perelegans

B. Habitat requirements.
The presence of larval host plants and plants that provide,a nectar source for adults are critical requirements.

C. Distribution.
Species occurring in'this vegetation type are generally distributed at elevations below mountain foothills.

D. Functional role in ecosystem.
A primary role for these species is that larvae feed on many of the dominant species of this vegetation type. Therefore, plant community composition may be influenced, albeit to unknown degrees, by the presence/absence of high and low population levels of these herbivores. Furthermore, the growth, reproduction, distribution, and abundance of respective host plant(s) will be affected. Reports on the use of these species as food are general in nature (lists of prey used by vertebrates may only mention insects at the class or ordinal level) but do mention that adults, larvae, and pupae of butterflies and moths are preyed upon by bats, birds, rodents, miscellaneous mammals, and a multitude of invertebrate predators.

E. Sensitivity to disturbance.
Fire might enhance populations of seral shrubland species by preventing this habitat from becoming densely wooded. However, grazing, if not strictly regulated, would be expected to have a negative impact on species occurring in the seral shrubland understory because of the negative impact on the soil and the herbaceous cover vegetation. Also, the use of pesticides would have a negative impact on populations of understory Lepidoptera.

F. Population trends.
Unknown.

SECTION IV cont'd - Vegetation associations

Vegetation Type: Subalpine herbaceous: CRB004

This vegetation type is characterized by a very-diverse flora: coniferous forests, understory hardwoods and numerous species of shrubs and herbs.

Discussion of understory subalpine herbaceous vegetation under the topics of sensitivity to disturbance and population trends is presenteded in the context of three seral stages: 1) early regrowth-regeneration; 2) middle-aged, canopy closure stage; and 3) old-growth overstory.

A. Representative species.

Drepanulatrix unicalcararia
Hesperumia sulphuraria
Nymphalis antiopa
Oncocnemis dunbari
Parnasius clodius
Sphinx vashti
Syngrapha orophila

B. Habitat requirements.
The presence of larval host plants and plants that provide a nectar source for adults are critical requirements.

C. Distribution.
Species occurring in this vegetation type are distributed throughout the Columbia River Basin where coniferous forest are present. This environment typically occurs between 2,500-9,000 feet elevation.

D. Functional role in ecosystem.
A primary role for these species is that larvae feed on many of the abundant shrubs that occur in-this vegetation type. Therefore, plant community composition may be influenced, albeit to unknown degrees, by the presence/absence of high and low population levels of these herbivores. Furthermore, the growth, reproduction, distribution, and abundance of respective host plant(s) will be affected. Reports on the use of these species as food are general in nature (lists of prey used by vertebrates may only mention insects at the class or ordinal level) but do mention that adults, larvae, and pupae of butterflies and moths are preyed upon by bats, birds, rodents, miscellaneous mammals, and a multitude of invertebrate predators.

E. Sensitivity to disturbance. Three categories of disturbance are assessed.

1) Early regrowth-regeneration.
The species of understory Lepidoptera occurring in the subalpine herbaceous vegetation type will likely increase in population density when newly available habitat is created from fire or timber harvesting. Sites characterized by early regrowth contain many of the herbaceous and shrub species that promote high biodiversity among the Lepidoptera.

2) Middle-aged, canopy closure stage.
Eventual growth by trees will result in partial to complete shading of the understory vegetation which in turn will result in a change of Lepidoptera due to at least two factors: 1) a change will occur in the compositioon of (host) plants and the types of flowers producing nectar, and 2) a change in temperature/sunlight which then affects behavior of adult butterflies in particular. Disturbance of this habitat will likely cause a shift in the flora/fauna to an early regrowth-regeneration phase.

3) Old growth overstory.
Continued growth by trees will result in complete shading which in turn will result in a-change of Lepidoptera due to at least two factors: 1) further changes in the composition of (host) plants and the types of flowers producing nectar, and 2) further changes in temperature/sunlight which then affects behavior of adult butterflies in particular. Disturbance of this habitat will likely cause a shift in the flora/fauna to an early regrowth -regeneration phase.

F. Population trends.

1) Early regrowth-regeneration.
Unknown.

2) Middle-aged, canopy closure stage.
Unknown.

3) Old growth overstory.
Unknown.

SECTION IV cont'd - Vegetation associations

Vegetation Type: Alpine tundra - CRB005

This vegetation *type* is characterized by species such as Arctostaphylos *uva-ursi, Lupinus lepidus, Pedicularis contorta,* and *Sphagnum* spp.

A. Representative species.
Anepia capsularis
Colias pelidne skinneri
Lycaena phlaeas
Oenis chryxus
Neominois ridingsii
Synedoida petricola
Syngrapha sackenii

B. Habitat requirements.
The presence of larval host plants and plants that provide a nectar source for adults are critical requirements.

C. Distribution.
The alpine environment occurs in fairly distinct situations. For instance the Okanagon Mountains, Wallawa Mountains, Seven Devils Mountains, Warner Mountains, Albian Mountains, and Teton Mountains are documented to possess certain species with distributions limited alpine meadows.

D. Functional role in ecosystem.
A primary role for these species is that larvae feed on many of the dominant species of this vegetation type. Therefore, plant community composition may be influenced, albeit to unknown degrees, by the presence/absence of high and low population levels of these herbivores. Furthermore, the growth, reproduction, distribution, and abundance of respective host plant(s) will be affected. Reports on the use of these species as food are general in nature (lists of prey used by vertebrates may only mention insects at the class or ordinal level) but do mention that adults, larvae, and pupae of butterflies and moths are preyed upon by bats, birds, rodents, miscellaneous mammals, and a multitude of invertebrate predators.

E. Sensitivity to disturbance.
Fire and timber harvesting 'along timberline might enhance populations of alpine species by increasing the availability of this habitat and by retarding tree and large shrub growth into meadow habitat. Disturbance of the alpine meadow proper (hiking trails, pack animal grazing, and off-road all terrain vehicles) could lead to local extinction of a population that could contribute to the demise of the species because colonization from the nearest similar type of habitat may be highly improbable due to the distances between alpine environments.

F. Population trends.
unknown.

SECTION V - Future needs

This section consist of three topics: A) Survey and inventory; B) Population ecology; and C) Role and importance in the ecosystem.

A. Survey and inventory.
I present three points for consideration:

1) The distribution of the species of understory Lepidoptera is poorly known. An exception to this statement would involve some, but not many, of the butterfly species.

2) Likewise, species richness for various regions and plant community types is poorly documented. Few studies exist that would qualify as a intense study defined as listing the understory Lepidoptera for an entire season at a given site.

3) My recommendation is to initiate a regionally based study with the objective of determining the presence/absence of species focusing on the areas of special interest discussed earlier in this report. The products would be a listing of species richness/ diversity for a given area, new information regarding distribution of all relevant species, data on abundance which if available among multiple years provides information on population trends for which we have no knowledge at present.

B. Population ecology.
I present two points for consideration:

1) Population trends. As mentioned in the previous section trends in populations of understory Lepidoptera are virtually unknown, even in the butterflies which are the best studied group. My recommendation is to establish long-term studies at selected sites which have as their protocol multiple sampling efforts per year to accurately detect population fluctuation within seasons, within a year, and among years.

2) Information is needed for an effort to model populations (density and distribution). Presently such information is generally lacking. For instance, data are needed for the following environmental correlates:

temperature - high and low limits, developmental thresholds and degree-day requirements. My recommendation is to conduct studies that elucidate thermal requirements for special species. These data would be helpful in determining key ecological correlates for a species involved in projects performing high resolution mapping and for projects involving the transplantation of individuals for conservation/re-establishment goals.

nectar sources - necessary as a carbohydrate source to fuel flight, specialist and generalist patterns of behavior are-- basically unknown in the moths and relatively well documented for the butterflies. My recommendation is to initiate field studies that involve observations on adult Lepidoptera and flower relationships.

larval host plants - approximately 15% of the Macro-Lepidoptera occurring in the Pacific Northwest have no known larval host plant.' The percentage is much greater (but unknown to the author) for the Micro-Lepidoptera. Another 35-45% have only one known host plant that may or may not be the only plant larvae of the species feed on. My recommendation is to establish studies that involves sampling certain plant species for larvae of Lepidoptera to associate host plant relationships and acquire quantitaive data on abundance through the season, among years, and among sites.

parasitoids/predators/pathogens - natural enemies such as parasitoids are major regulators of density in host populations, few of the Columbia River Basin Lepidoptera have records of parasitoids, let alone the impact of parasitoids on host populations. My recommendation is to establish studies involving the collecting' and rearing of immature Lepidoptera for associating natural enemies with their hosts and for acquiring quantitative data on the abundance of hosts and natural enemies.

disturbance impacts - Few quantitative studies are available on the impacts of fire, grazing, clearing, and pesticides. In certain cases a limited degree of disturbance will enhance populations of understory Lepidoptera and in other cases populations could become extinct. Presently, we have no ability to accurately predict (let alone guess) the outcome of various management/disturbance regimes. My recommendation is to conduct experiments that address disturbance dynamics, with particular attention given to management oriented disturbances such as prescribed fires, grazing, timber harvest, and pesticides.

C. Role and importance in the ecosystem.
I present two points for consideration:

1) The influence of invertebrate herbivores of the understory vegetation in influencing the general species composition of respective communities is poorly understood. My recommendation is to conduct experimental manipulations altering the density of herbivore populations (exclusion experiments) and monitor impacts resulting from the manipulations.

2) The roles of species in predator/prey food web relationships are poorly documented. In particular, use of understory Lepidoptera by various species of vertebrates is poorly documented below the level of insect order. For instance, beetles, moths, and grasshoppers might be listed as prey items for a bird but very rarely are the insects listed to the level of genus or species. Such a level is critical to understanding the fidelity of predators to certain prey and the importance of selected prey species in the diet at critical times of the season in the life cycle of the predator (ie., nursing mammals, migrating birds, prehibernation animals).

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