



United States
Department of
Agriculture

Forest
Service

Cooperative
State Research
Service

Agriculture
Handbook No. 653

Spruce Budworms Handbook

Management Guidelines for Increasing Populations of Birds That Feed on Western Spruce Budworm

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*Mountain
Chickadee*

In 1977, the United States Department of Agriculture and the Canadian Department of the Environment agreed to cooperate in an expanded and accelerated research and development effort, the Canada/United States Spruce Budworms Program (CAN-USA), aimed at the spruce budworm in the East and the western spruce budworm in the West. The objective of CANUSA was to design and

evaluate strategies for controlling the spruce budworms and managing budworm-susceptible forests to help forest managers attain their objectives in an economically and environmentally acceptable manner. The work reported in this publication was funded by the Program. This manual is one in a series on the western spruce budworm.



Canada
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Spruce Budworms
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August 1986

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Management Guidelines for Increasing Populations of Birds That Feed on Western Spruce Budworm

By Lisa A. Langelier and Edward O. Garton¹

Introduction

Recent research has shown that birds help regulate populations of the western spruce budworm. Birds can reduce budworm populations up to 72 percent in a single summer (Torgersen and Campbell 1982). Takekawa and Garton (1984) found that individual birds may eat as many as 25,000 larvae and pupae in one season. Their observations suggest that

- Insecticides would be needed more often if birds were not feeding on budworms.
- Management actions aimed at improving bird habitat could increase both populations and species diversity.
- Spending money to enhance bird habitat would be profitable.

This manual is for foresters who wish to consider enhancing populations of predaceous birds in budworm-susceptible stands. Foraging behavior and habitat preferences are summarized for 14 of the dominant

budworm-eating birds in mixed-conifer forests. These summaries are followed by guidelines for improving bird habitat. The information presented comes from several sources: early literature, recent studies by the authors, and papers from three symposia (DeGraff 1978, 1980; Smith 1975) that summarized knowledge on managing nongame birds in various regions of the West.

We think the proposed guidelines will be most effective at critical pest densities, such as during preoutbreak or early increase phases (Takekawa and others 1982). Despite abundant information on habitat requirements of nongame birds, little quantitative information is available to predict the degree of bird response to management activities. Accordingly, while the suggestions are based on the best information available, the guidelines are still tentative. In the interests of improving these guidelines, we solicit reports from foresters who use them.

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General Dietary, Habitat, and Behavioral Needs of Birds

The 14 species of birds that our research in Washington, Oregon, Idaho, and Montana showed to be the most voracious predators of western spruce budworm are listed in tables 1 and 2, along with information on their habitat requirements. Additional information on each species is in the appendix.

Understanding the general dietary, habitat, and behavioral characteristics of birds will put the guidelines in perspective. Some of the 14 birds listed forage on flying insects; others search the ground or canopy layers for food. The food may be primarily animal, such as insects, spiders, and crustaceans; vegetable, including berries, fruit, seeds, or green leaves; or a combination of both animal and vegetable. Diets of many species change from year to year in response to changes in availability of food.

The vertical and horizontal distribution of vegetation is important in habitat selection for some species. Bird numbers can be influenced by the amount of foliage, the density and height of trees, and the interspersed openings or vegetation types within a stand. Some birds prefer certain successional stages, but others occur throughout stand development. Absence of some vegetative canopy cover—such as the shrub layer or low, middle, or high canopy layers—may prevent a species from using that habitat (Willson 1974).

Ground cover—duff, forbs, grasses, rocks, bare ground, and slash—may

affect the presence and density of some forest birds. Ground cover can provide building material and critical protection for nesting. Water and salt may be important for many bird species; others may need mud for nest construction.

Snags are critical for cavity-nesting woodpeckers, chickadees, and nuthatches. Many other species use snags for foraging, nesting, singing posts, hunting perches, and roosting sites (Miller and Miller 1980).

Finally, the number of birds in an area can be restricted by competition with other birds for limited food, cover, or space. Territorial limits prevent many species from increasing beyond certain densities, even during budworm outbreaks when food is abundant. Nevertheless, the diversity of the forest bird community can usually be enhanced, and a diverse group of territorial birds is important because their constant predation helps keep budworm populations low. Non-territorial, opportunistic bird species—such as the evening grosbeak or pine siskin—become important when budworm population densities begin to increase.

Management Options

Birds respond to management-induced habitat changes and help regulate budworm numbers; therefore, forest managers who incorporate the needs of predaceous birds in management plans will benefit. Two critical needs that management activities influence are feeding and nesting areas; the guidelines offer general ways to reduce limitations on these areas. Keep in mind that all treatments cannot be implemented in the same area and that some may not be practical,

depending on the site and the goals of management. Also, remember that forest practices are not categorically beneficial or detrimental to the bird community; practices that reduce numbers of one species can increase numbers of others. With these limitations in mind, we suggest that managers do the following:

- **Plan for horizontal diversity.** Horizontal diversity can be increased by thinning dense stands,



Figure 1—Birds that eat western spruce budworms flourish in areas like these with horizontal and vertical diversity. Such variation is produced by interspersing small areas with varied treatments, which provides nesting and feeding sites for many different kinds of birds.

Table 1—Habitat stages preferred for feeding (F) and reproduction (R), special needs, feeding location, and budworm consumption rank (Garton 1985) for 14 important budworm-eating birds

Bird species	Budworm consumption rank	Feeding location	Habitat stage (after Verner 1980)								Special needs		
			Grass-forb	Shrub-seedling, sapling	Pole-medium tree (% canopy cover)			Pole-large tree (% canopy cover)					
					0-39	40-69	70+	0-39	40-69	70+			
American robin (<i>Turdus migratorius</i>)	2	Ground, low canopy	F	RF	RF	RF	RF	RF	RF	RF	RF	RF	Water for mud-lined nest, openings
Cassin's finch (<i>Carpodacus cassinii</i>)	4	Ground, canopy	F	F	F	RF	RF	RF	RF	RF	RF	RF	Abundant food
Chipping sparrow (<i>Spizella passerina</i>)	7	Ground, low canopy		F	+++	RF	RF	RF	RF	RF	RF	RF	Openings
Dark-eyed junco (<i>Junco hyemalis</i>)	8	Ground, low canopy	RF	RF	+++	RF	RF	RF	RF	RF	RF	RF	Openings
Evening grosbeak (<i>Coccothraustes vespertinus</i>)	1	Canopy	F			+++	RF		RF	RF	RF	RF	Abundant food
Golden-crowned kinglet (<i>Regulus satrapa</i>)	11	Outer branches of mid to upper canopy		F	F	RF	RF		+++	RF	RF	RF	Dense canopy

Hammond's flycatcher (<i>Empidonax hammondii</i>)	13	Air	F	F	F	RF	RF	RF	RF	+++	+++	Openings, clumps of tall conifers
Mountain chickadee (<i>Parus gambeli</i>)	5	Canopy, under bark			RF	RF	RF	RF	RF	+++	+++	Nest cavity
Pine siskin (<i>Carduelis pinus</i>)	3	Mid to upper canopy	F	F	RF	RF	RF	RF	RF	RF	RF	Abundant food
Red-breasted nuthatch (<i>Sitta canadensis</i>)	6	Canopy, bark				RF	RF	RF	RF		+++	Nest cavity
Swainson's thrush (<i>Catharus ustulatus</i>)	12	Ground, low canopy			RF	RF	RF	RF	RF	+++	+++	Trees, dense shrubs near water
Townsend's warbler (<i>Dendroica townsendi</i>)	—	Upper canopy				F	RF	RF	RF	+++	+++	Tall trees for nesting
Western tanager (<i>Piranga ludoviciana</i>)	10	Mid to upper canopy	F	F	F	RF	RF	RF	RF	+++	+++	Shrub understory
Yellow-rumped warbler (<i>Dendroica coronata</i>)	9	Mid canopy			+++	RF	F	RF	RF	+++	+++	Openings

¹+++ = most preferred.

Table 2—Habitat features that are preferred or avoided by 14 important budworm-feeding birds (P = prefers habitat feature; A = avoids areas with this habitat feature; N = neutral or favors moderate value for given feature)

Species	Habitat feature					Height of conifer foliage			Deciduous conifer mix
	Canopy openings	Unbroken canopy	Dense saplings	High basal area of conifers	Deciduous understory	0–10 ft (0–3 m)	23–33 ft (7–10 m)	33+ ft (10+ m)	
American robin	P	A			P				
Cassin's finch	N	A	P	P	N		P	P	P
Chipping sparrow	P	A			A	P			
Dark-eyed junco	P	A			A	P	A		
Evening grosbeak	A	A			N		P		
Golden-crowned kinglet	A	P	P	P	P			P	
Hammond's flycatcher	P	N	P	P	P			P	
Mountain chickadee	A	A			P	P			
Pine siskin	A	P		P	A		P		
Red-breasted nuthatch	A	P			N	P	P		
Swainson's thrush	A	P	P		P			P	
Townsend's warbler	A	P	P	P	P				
Western tanager	N	P	P		P				P
Yellow-rumped warbler	N	A		A	P		P		P

group selection cutting, or interspersing small- to moderate-sized clearcuts (12 to 40 acres, 5 to 16 ha) throughout a planning unit. Aim for a wide range of successional stages within an area and maintain snags, riparian zones, and edges. Interspersing or mixing successional stages and cutting units provides feeding and nesting habitat for several bird species.

- **Plan for vertical diversity.**

Vertical diversity can be achieved by thinning to provide for several degrees of canopy closure. Thinning also tends to maintain or enhance shrub understories. Modifying the vertical diversity of foliage may enhance the efficiency of bird predation by reducing the foliage available for foraging birds (Garton and Langelier 1983).

- **Avoid large clearcuts.** Clearcut size should not exceed 40 acres (16 ha). When past practices or stand health demand large cuts, leave buffer strips or islands of uncut trees within the cutting area to provide refuges or nesting sites until the cut areas grow back.

- **Provide edges.** Timber harvest affords the opportunity to provide edges, which attract several species of birds and thus improve natural protection from budworm.

- **Avoid high-grading.** Trees left behind after high-grade and diameter-limit cuts are generally unsuitable for bird nesting or feeding. Patches of spindly, overstocked trees

stagnate and reduce stand health and bird habitat.

- **Avoid homogeneous, plantation-like stands.** Encourage more than one species in a regenerating stand. A single species provides fewer feeding or nesting sites for birds than does a mixed forest, and single-species stands of budworm host are highly susceptible to outbreaks.

- **Leave some slash.** Slash offers cover and nesting sites for some ground-feeding birds, including juncos, robins, and chipping sparrows. By removing all slash, managers discourage these budworm predators. Windrowing slash can create a temporary edge that attracts such birds as Cassin's finch, yellow-rumped warbler, western tanager, and Hammond's flycatcher.

- **Reduce herbicide use.** Deciduous shrubs dramatically increase the diversity and abundance of birds in forest stands (Garton and Langelier 1983). Herbicides can reduce populations of species that depend on grass, forbs, or deciduous shrubs. If possible, wait until after the nesting season (late July) to apply herbicides if they must be used, and choose herbicide with the least impact on desired bird species.

- **Control grazing.** Limit grazing in riparian areas and newly cut stands. Riparian corridors attract a diverse and abundant bird community that can help keep the budworm population in check. Heavy or year-

long grazing can significantly alter the nesting and feeding opportunities that riparian zones provide.

- **Provide for cavity-nesting birds.** Because many cavity-nesting species do not migrate, they may contribute significantly to mortality of overwintering budworm larvae. Snags and nest sites should be provided for these birds. Restricting firewood cutting in budworm-susceptible stands, managing snags, and erecting nest boxes can improve the habitat for cavity nesters. A minimum of six snags 11 inches (28 cm) in diameter at breast height and 6 ft (2 m) tall should be left per acre (15 snags/ha). Providing three nest boxes per acre (7/ha) spaced at least 40 yd (36 m) apart will reduce cavity limitations.

- **Provide salt.** Salt blocks or small piles of rock salt can be distributed throughout budworm-susceptible areas to attract species such as the pine siskin, evening grosbeak, red crossbill, and Cassin's finch.

- **Provide water.** Water can be a limiting factor sometimes, for example, during nesting. Concrete basins that fill naturally with rain can provide water. One to four basins per 60 acres (24 ha) will be most advantageous on dry sites.

In summary, forest managers are encouraged to plan small timber harvest units within large areas, maximize habitat patchiness, and provide a variety of habitat stages in close

proximity. By varying canopy closure, stocking with more than one species, and providing edge, openings, snags, deciduous understories, nesting boxes, water, and salt, managers help create habitat that favors birds and increases opportunity for natural protection from budworm outbreaks.

References Cited

- Bent, Arthur Cleveland.** Life histories of North American woodwarblers. New York: Dover Publishers, Inc.; **1963.** 367 p. Part 1. 367 p. Part 2.
- Bent, Arthur Cleveland.** Life histories of North American thrushes, kinglets, and their allies. New York: Dover Publishers, Inc.; **1964.** 452 p.
- Bent, Arthur Cleveland.** Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows, and allies, order Passeriformes: family Fringillidae. New York: Dover Publishers, Inc.; **1968.** 602 p. Part 1. 646 p. Part 2. 640 p. Part 3.
- Blais, J. R.; Parks, G. H.** Interaction of evening grosbeak (*Hesperiphona vespertina*) and spruce budworm (*Choristoneura fumiferana* (Clem.)) in a localized budworm outbreak treated with DDT in Quebec. Canadian Journal of Zoology. 42: 1017-1024; **1964.**
- DeGraff, R. M.,** ed. Proceedings of the workshop on nongame bird habitat management in the coniferous forests of the Western United States. Gen. Tech. Rep. PNW-64. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; **1978.** 100 p.
- DeGraff, R. M.,** ed. Workshop proceedings: management of western forests and grasslands for nongame birds. Gen. Tech. Rep. INT-86. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; **1980.** 535 p.
- Dickson, J. G.; Noble, R. E.** Vertical distribution of birds in a Louisiana bottomland hardwood forest. Auk. 90: 19-30; **1978.**
- Dilger, W. C.** Adaptive modifications and ecological isolating mechanisms in the thrush genera *Catharus* and *Hylocichla*. Wilson Bulletin. 68: 171-199; **1956.**
- Erskine, Anthony J.** Birds in boreal Canada: Communities, densities and adaptations. Report Series No. 41. Ottawa, ON: Canadian Wildlife Service; **1977.** 73 p.
- Franzreb, K. E.** Bird population changes after timber harvesting of a mixed conifer forest in Arizona. Res. Pap. RM-184. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; **1977.** 26 p.
- Garton, E. O.** Habitat requirements of avian predators. In: Brookes, Martha H.; Campbell, Robert W.; Colbert, J. J.; Mitchell, Russel G.; Stark, R. W., tech. coords. Western spruce budworm. Tech. Bull. 1694. Washington, DC: U.S. Department of Agriculture; **1985.**

- Garton, E. O.; Langelier, L. A.** Effects of stand characteristics on avian predators of western spruce budworm. In: Safranyik, L., ed. The role of the host in the population dynamics of forest insects. Proceedings of the IUFRO conference. 1983 September 4-7; Banff, AB. Victoria, BC: Canadian Forestry Service; **1985**: 65-72.
- Hagar, D. C.** The interrelationships of logging, birds, and timber regeneration in the Douglas-fir region of northwestern California. *Ecology*. 41: 116-125; **1960**.
- James, F. C.** Ordinations of habitat relationships among breeding birds. *Wilson Bulletin*. 83: 215-236; **1971**.
- James, F. C.; Shugart, H. H., Jr.** Phenology of the nesting season of the robin. *Condor*. 76: 159-168; **1975**.
- Langelier, L. A.** Habitat selection of common breeding bird species in western spruce budworm outbreak areas. Moscow, ID: University of Idaho; **1983**. 118 p. M.S. thesis.
- Manuwal, D. A.** Notes on territoriality of Hammond's flycatcher in western Montana. *Condor*. 72: 364-365; **1970**.
- Miller, E.; Miller, D. R.** Snag use by birds. In: Workshop proceedings: management of western forests and grassland for nongame birds. Gen. Tech. Rep. INT-86. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; **1980**: 337-356.
- Morse, D. H.** Competitive relationships between parula warblers and other species during the breeding season. *Auk*. 84: 490-502; **1967**.
- Morse, D. H.** The insectivorous bird as an adaptive strategy. *Annual Review of Ecology and Systematics*. 2: 177-200; **1971**.
- Noon, B. R.; Dawson, D. K.; Inkley, D. B.; Robbins, C. S.; Anderson, S. H.** Consistency in habitat preference of forest bird species. In: Transactions of the 45th North American Wildlife and Natural Resources Conference. 1980 March 22-26; Miami Beach, FL. Washington, DC: Wildlife Management Institute; **1980**: 226-244.
- Peterson, S. R.** A preliminary survey of forest bird communities in northern Idaho. *Northwest Science*. 56: 287-298; **1982**.
- Samson, F. B.** Territory, breeding density, and fall departure in Cassin's finch. *Auk*. 93: 477-497; **1976**.

Shugart, H. H., Jr.; Patten, B. C. Niche quantification and the concept of niche pattern. In: Patten, B. C., ed. *Systems analysis and simulation in ecology*. New York: Academic Press; **1972**: 283–327.

Smith, D. R., ed. Proceedings of the symposium on management of forest and range habitats for nongame birds. Gen. Tech. Rep. WO-1. Washington, DC: U.S. Department of Agriculture, Forest Service; **1975**. 343 p.

Szaro, R. C.; **Balda, R. P.** Effects of harvesting ponderosa pine on nongame bird populations. Res. Pap. RM-212. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station; **1979**. 8 p.

Takekawa, J. Y.; **Garton, E. O.** How much is an evening grosbeak worth? *Journal of Forestry*. 82: 426–428; **1984**.

Takekawa, J. Y.; **Garton, E. O.;** **Langelier, L. A.** Biological control of forest insect outbreaks: the use of avian predators. In: *Transactions of the 47th North American Wildlife and Natural Resources Conference*; 1982 March; Portland, OR. Washington, DC: Wildlife Management Institute; **1982**: 393–409.

Thomas, J. W.; **DeGraff, R. M.;** **Mawson, J. C.** Determination of habitat requirements for birds in suburban areas. Res. Pap. NE-357. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; **1977**. 15 p.

Titterington, R. W.; **Crawford, H. S.;** **Burgason, B. N.** Songbird response to commercial clearcutting in Maine spruce–fir forests. *Journal of Wildlife Management*. 43: 602–609; **1979**.

Torgersen, Torolf R.; **Campbell, Robert W.** Some effects of avian predators on the western spruce budworm in north central Washington. *Environmental Entomology*. 11(2): 429–431; **1982**.

Verner, J. Bird communities of mixed-conifer forests of the Sierra Nevada. In: *Workshop proceedings: management of western forests and grasslands for nongame birds*. Gen. Tech. Rep. INT-86. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; **1980**: 198–223.

Appendix

Verner, J.; Beedy, E. C.; Granholm, S. L.; Ritter, L. V.; Toth, E. T. Birds. In: California wildlife and their habitats: western Sierra Nevada: Proceedings of the symposium. Gen. Tech. Rep. PSW-37. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station; **1980**: 75–302.

Webb, W. L.; Behrend, D. F.; Saisorn, B. Effect of logging on songbird populations in a northern hardwood forest. Wildlife Monograph. 55: 34 p.; **1977**.

Welty, Joe Carl. The life of birds. Philadelphia, PA: Saunders College Publishing; **1982**. 754 p.

Willson, M. F. Avian community organization and habitat structure. Ecology. 55: 1017–1029. **1974**.

Winn, D. S. Terrestrial vertebrate fauna and selected coniferous forest habitat types on the North Slope of the Uinta Mountains. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Region, Wasatch National Forest; **1976**. 145 p.

Ground and Low-Canopy Feeders

Ground and low-canopy feeding species that eat many budworm larvae and pupae include the Swainson's thrush, American robin, chipping sparrow, dark-eyed junco, and Cassin's finch. They occur on stands ranging from midseral through mature conifer forest communities. Although typically seedeaters, these birds eat insects and feed them to their nestlings during the breeding season (Morse 1971). All species defend territories for feeding, nesting, and mating during the breeding season (Welty 1982), with the exception of Cassin's finch, which defends a mate rather than a territory (Samson 1976). Habitat features that each species avoids or prefers are given in table 2.

Swainson's thrush—Swainson's thrush selects areas with moderate to dense canopies (39- to 100-percent canopy closure), numerous shrubs and saplings, and little bare ground. This interior forest species prefers damp areas of midseral to mature seral conifer communities (Bent 1964, Dilger 1956, Peterson 1982, Verner and others 1980).

American robin—The American robin selects habitat to meet its requirements for feeding (Noon and others 1980). Robins can exist in a wide range of habitats and are relatively insensitive to habitat change (Peterson 1982). They can be found in midseral to mature conifer successional communities and prefer areas with bare ground and some shrub

understory (Langelier 1983). Robins are a forest-edge species that requires isolated trees, open habitats, and some mud source for nest building (James 1971, James and Shugart 1975, Szaro and Balda 1979, Thomas and others 1977, Verner and others 1980).

Chipping sparrow—Chipping sparrows select dry conifer habitats with open canopies and grass understories (Langelier 1983). These birds occur in a wide range of mixed-conifer communities with low to moderate canopy coverage and some edge (Shugart and Patten 1972, Thomas and others 1977, Verner and others 1980). Territory location of the chipping sparrow was similar in years with high (> 30 larvae/yard², > 36 larvae/m² foliage) and low budworm density on one of our study sites. This suggests that habitat structure may be more critical than food abundance for selection of chipping sparrow habitat.

Dark-eyed junco—A common forest-edge species, the dark-eyed junco prefers areas with high slash and bare-ground coverage and large volumes of conifer foliage in the 0- to 10-ft (0- to 3-m) height range (Langelier 1983). Although the junco is tolerant of various habitat conditions, it often nests near water (Bent 1968), is not adversely affected by logging (Hagar 1960, Webb and others 1977), and is abundant in early seral communities (Peterson 1982, Titterton and others 1979).

Cassin's finch—Samson (1976) says the Cassin's finch breeds where food is abundant and that finch populations are limited by the number of females available for breeding. Our research indicates this finch selects habitats from midseral through mature communities with a large conifer basal area and few forbs. Because they are nonterritorial and breed early, Cassin's finch may respond more to food availability and less to specific habitat structures.

Low-, Middle-, and High-Canopy Feeders

The yellow-rumped and Townsend's warblers, mountain chickadee, red-breasted nuthatch, golden-crowned kinglet, and western tanager are insect-eating birds that forage in the low, middle, and upper conifer and deciduous canopies. Each species defends a territory during the breeding season and is found in moderate (39- to 69-percent closure) or dense (more than 70-percent closure) conifer communities with some deciduous understory (Langelier 1983).

Yellow-rumped warbler—The yellow-rumped warbler is found in stands with moderately dense conifer cover and a dominant deciduous understory. They are most common when midcanopy (10- to 30-ft, 3- to 10-m) foliage is abundant (Bent 1963, Dickson and Noble 1978, Langelier 1983). Although they occur in most seral communities, they prefer mature forests (Noon and others 1980, Peter-

son 1982) with some openings (Szaro and Balda 1979).

Townsend's warbler—Dense conifer stands with dense deciduous undergrowth and numerous conifer saplings are common features in Townsend's warbler habitats. Although little is known about this bird, it frequents and feeds in upper crowns of stands (Bent 1963).

Western tanager—Stands preferred by the western tanager have dense foliage in conifers taller than 16 ft (5 m), many saplings, and a dense deciduous understory with sparse grass cover (Langelier 1983).

Golden-crowned kinglet—The golden-crowned kinglet selects dense conifer habitats with moderate deciduous underbrush and numerous saplings (Langelier 1983). Kinglets prefer either unbroken stands (Morse 1967) or dense, shaded forests of true firs or Douglas-fir (Verner and others 1980). Their small size and ability to hover enable them to feed in hard-to-reach, tightly foliated trees, such as spruce and firs.

Mountain chickadee—Mountain chickadees occur in a wide range of montane conifer communities and are particularly attracted to stands with trees taller than 60 ft (18 m) (Franzreb 1977). One habitat feature that may limit chickadee habitat selection is snag (cavity) availability.

Red-breasted nuthatch—Another widely distributed conifer-dependent

species, the red-breasted nuthatch occurs from midseral to mature stands but prefers the more mature stages of conifer succession (Erskine 1977, Peterson 1982). They excavate their own cavities, which can be identified by the pitch smeared around the opening. Both the chickadee and nuthatch are cavity-dependent, permanent residents that may feed on overwintering budworm larvae.² Providing nest boxes and snags are two means managers can use to attract cavity-nesting birds.

High-Canopy Flockers

The evening grosbeak and pine siskin feed in flocks high in the canopies of trees. Neither is territorial during the breeding season, and both are opportunistic nomads.

Evening grosbeak—The evening grosbeak has been termed the best biological indicator of spruce budworm presence (Blais and Parks 1964, Erskine 1977). This bird was abundant on sites where budworms were plentiful (> 30 larvae/yard², > 36 larvae/m² foliage) and rare on similarly structured sites with fewer budworms (Langelier 1983).

²Garton, E. O. Avian predation on western spruce budworm: comprehensive progress report to CANUSA-Spruce Budworms Program West, April 1979 to March 1980. 1980. 73 p. On file at: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, OR.

Pine siskin—Pine siskins occur in midseral to mature conifer stands containing many budworm. The pine siskin likes a large basal area of conifers, tall trees, and dense, mid-canopy foliage (Langelier 1983). Bent (1968) portrays the siskin as a social bird that often nests colonially and is attracted to salt sources. It is abundant in western conifer forests with some openings or edges, and moderate canopy coverage.

Because the evening grosbeak and pine siskin are nomadic and do not defend territories, they are able to exploit abundant food sources. This nomadic movement and the association of these species with insect outbreaks suggest that food is the driving factor in the habitat selection by these birds.

Aerial Feeders

Hammond's flycatcher—Hammond's flycatcher feeds on flying insects in stand openings. It selects sites with sparse herbaceous cover, a dense deciduous understory, snags, saplings, and many tall conifers (Langelier 1983). Territories of this flycatcher include a network of dense deciduous vegetation, clumps of tall trees, and many openings (Manuwal 1970). Flying insects, such as adult budworm moths, are the primary food for the Hammond's flycatcher, but it also eats many budworm larvae.