Old Forest Communities and Old-forest Wildlife Habitats In New Brunswick

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INTRODUCTION

The New Brunswick *Crown Lands and Forests Act* (1980) provides for the integrated management of the resources of Crown land, which includes habitat for the maintenance of fish and wildlife populations. The New Brunswick Biodiversity Strategy identifies healthy and resilient native ecosystems and viable populations of native species among its conservation outcomes (PNB 2009). Goals for the management of New Brunswick Crown land include maintaining the natural diversity and ecological characteristics of the Acadian forest and providing the habitat necessary to support populations of native wildlife at desired levels. To these ends, management objectives for the Crown forest include maintaining specific amounts of a variety of old-forest conditions within each ecoregion.

Regenerating forest stands lack certain characteristics typically found in old forest, even when they have reached their full height. These include large-diameter trees, large woody debris, and canopy openings with consequent understorey regeneration. These features provide necessary conditions for a variety of plant and animal species, such as cavities for nesting owls, food for ground beetles, and substrates for lichens and mosses.

Old Forest Communities (OFC) are the building blocks of the Province's strategy to supply old-forest conditions on Crown land. Eighteen unique communities, within 7 ecoregions, encompass the full range of naturally occurring old-forest conditions. They are described at the stand level by composition and structure, and at the landscape level by patch size. Old-forest Wildlife Habitats (OFWH) are groups of old forest communities that are further described at the stand level by abundance of woody debris and tree cavities, and at the landscape level by patch size and inter-patch distance. OFWHs and their constituent OFCs were defined based on the requirements of the vertebrate species assigned to them. The intent here is to identify those requirements, and to describe habitats and communities in terms of their stand and landscape attributes.

Stand-level attributes are used to develop the forest community and habitat yield relationships used in forest management planning, to identify old forest communities from forest inventory data, for operational assessments, and for the development of harvest prescriptions. Landscape-level attributes are used for the layout of areas intended to provide communities and habitats, and for the post-management plan assessment of the spatial integrity of habitats.

This document presents our working classification of natural old-forest conditions in New Brunswick and our current understanding of the habitat relationships of its forest vertebrates. It is intended to serve the 2017-2022 forest management period. The document will be updated to incorporate new information on a cycle compatible with forest planning for Crown land. Special thanks are due to Marc-André Villard, Université de Moncton, Matthew Betts, Oregon State University, Matthew Smith, Parks Canada, Graham Forbes, University of New Brunswick, and Scott Makepeace, New Brunswick Department of Energy and Resource Development, for their help defining the relationships between species and their habitats.

OLD FOREST COMMUNITIES

Eighteen Old Forest Communities represent groupings of the 103 vegetation associations of the Canadian National Vegetation Classification (CNVC) that occur in New Brunswick's forests. CNVC associations depend on both overstorey and understorey vegetation for identification, and so cannot be reliably determined from photo-interpreted inventory. The simplified set of OFCs was used to allow reasonably accurate stand classification. An attempt was made to capture as many CNVC associations as possible by generating management targets separately for each of the Province's 7 ecoregions and by dispersing the contributing areas within ecoregions. Fifteen of the OFCs are nested within OFWHs and 3 do not contribute to a habitat type.

Old Forest Communities are defined at the stand level by tree species composition and by stand structure, as described by basal area and density of various diameter classes of live and dead stems. They are named for the most abundant tree species (or group of species) and are composed of at least 35% of that species (or group). The terms "tolerant" and "intolerant" in group names refer to tolerance of low light conditions. Tolerant species tend to be long-lived and regenerate well under themselves, allowing stands to persist with little change well beyond the life span of individual trees. Intolerant species require full light and establish themselves quickly after major disturbances, such as fire or clearcut harvesting. They exhibit rapid growth but have relatively short lifespans and, in the absence of major disturbances, tend to be replaced over time by more tolerant species.

OFCs named for softwood species contain at least 50% softwood. Black spruce, a shade-tolerant species, is the most common tree in New Brunswick and occupies a wide range of site conditions, from very wet and poor through to intermediate in both moisture and productivity. In order to capture the range of conditions, 2 OFCs were identified - *Black Spruce Moderate* (BS-M) and *Black Spruce Poor* (BS-P). The other common, tolerant softwood communities are *Red Spruce* (RS) and *Balsam Fir* (BF). Tolerant softwood communities of intermediate abundance are *White Spruce* (WS) and *Cedar* (CE), and the uncommon ones are *Hemlock* (HE) and *Larch* (TL). *Red Pine* and *White Pine* (RP, WP) are uncommon OFCs of intermediate tolerance, and *Jack Pine* (JP) is shade-intolerant and of intermediate abundance. The softwood-dominated groups are *Softwood-Tolerant Hardwood* (SWTH), a uncommon mixed condition of spruce or balsam fir with tolerant hardwood species, *Tolerant Softwood* (TOSW), a moderately common mix of shade-tolerant species such as red spruce, cedar and hemlock, and *Softwood Mix* (SWMX), a moderately common softwood type with no single dominant species and which frequently contains some hardwood. Management targets exist for all softwood OFCs except TOSW and SWMX.

The hardwood OFCs contain at least 50% hardwood species. *Tolerant Hardwood Pure* (THP) is a moderately common mix of sugar maple, yellow birch and American beech, with local contributions of ironwood, red oak, basswood, silver maple and the ashes. Red maple is considered a tolerant hardwood when other tolerant hardwoods are present. *Tolerant Hardwood-Softwood* (THSW) is a moderately common mix of tolerant hardwood species with red and white spruce and balsam fir. *Tolerant hardwood-Intolerant Hardwood* (THIH) is moderately common and is usually the result of significant disturbance, whether natural or anthropogenic. *Intolerant Hardwood Mix* (IH) is a common OFC that is usually the result of significant disturbance; it encompasses a variety of conditions and is usually dominated by white birch or trembling aspen. Management targets exist for THP and THSW.

All mature forest stands meet the composition requirements of one of the Old Forest Communities; however many do not meet the structural ones. The most apparent reasons are that stands are too young to have a sufficient number of large trees, or that they are poorly stocked, either naturally or due to partial harvest. A less apparent reason is that criteria were set so that stands meeting old forest community definitions would also meet the definitions for the Old-forest Wildlife Habitats in which they were nested (see below), and that forest types differ naturally in the likelihood that they meet their respective habitat definitions. Composition and structure criteria for all OFCs are provided in Table 1.

Landscape structure of an Old Forest Community is defined in terms of the size and shape of its patches. For all OFCs, minimum patch size is set at 10 ha and minimum width is set at 200 m. Patches are intended to be able to support the plant and most of the animal species that would occur in the absence of the partial isolation caused by harvesting outside the patch.

Maintaining old-forest species through the use of small patches is risky. There is an increased chance of losing the habitat due to windthrow, an increased risk of extirpation of species from a patch caused by reduced colonization through unsuitable areas, and many species are sensitive to the increased light and air flow coming in from the edges. The old-forest species most likely to do poorly in small patches are lichens, mosses and liverworts, as many are particularly sensitive to increased light or reduced moisture. The requirements of these species were therefore used to derive the size and shape criteria for OFC patches.

OFC patches are not intended to necessarily meet the large area requirements of many old-forest vertebrates; however optimal spatial arrangement of patches would have them nested within OFWH patches (below) as often as possible.

Table 1. Composition and structure of Old Forest Communities, and their associations with Old-forest Wildlife Habitats.

CRITERIA	OLD FOREST COMMUNITIES[1, 2]																	
	HE	CE	RS	TL	BS-M	BS-P	WS	SWTH	BF	TOSW	RP	WP	JP	SWMX	THP	THSW	THIH	IH
COMPOSITION																		
Primary Species	HE	CE	RS	TL	BS	BS	WS	RS, WS BF, TH	BF	HE, CE, RS	RP	WP	JP	SW	TH	TH, RS WS, BF	TH, IH	IH
Primary Species %	≥ 25	≥ 35	≥ 35	≥ 35	≥ 35	≥ 35	≥ 35	--	≥ 35	≥ 30	RP≥WP	WP>RP	≥ 35	--	--	--	--	--
SW%	≥ 25	≥ 50	≥ 50	≥ 50	≥ 50	≥ 50	≥ 50	≥ 50	≥ 50	≥ 50	WP + RP ≥ 35		≥ 50	≥ 50	--	25-50	--	--
HW%	--	--	--	--	--	--	--	--	--	--	--	-	--	--	--	--	> 50	> 50
TH%	--	--	--	--	--	--	--	≥ 20	--	--	--	--	--	--	≥ 50	≥ 30	≥ 20	< 20
TH+RM%	--	--	--	--	--	--	--	≥ 35	--	--	--	--	--	--	≥ 75	≥ 35	≥ 35	
STRUCTURE																		
Crown closure %	SW≥ 40	SW≥ 40	SW≥ 40	SW≥ 40	SW≥ 40	SW≥ 40	SW≥ 40	SW≥ 40	SW≥ 40	SW≥ 40	WP + RP ≥ 40		SW≥ 40	SW≥ 40	TH≥ 40	TH≥ 40	TH≥ 40	HW≥ 40
Total BA	≥ 18	≥ 18	≥ 18	≥ 16	≥ 18	14-17	≥ 18	≥ 18	≥ 18	≥ 18	≥ 18	≥ 18	≥ 18	≥ 18	≥ 18	≥ 18	≥ 18	≥ 18
SW BA	--	--	--	--	--	--	--	≥ 6	--	--	--	--	--	--	--	≥ 6	--	--
SF BA[3]	--	≥ 14	≥ 14	--	≥ 14	≥ 11	≥ 14	--	≥ 14	≥ 14	--	--	--	≥ 14	--	--	--	--
PI BA	--	--	--	--	--	--	--	--	--	--	≥ 10	≥ 10	--	--	--	--	--	--
HW BA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	≥ 14	≥14
TH+RM BA	--	--	--	--	--	--	--	≥ 6	--	--	--	--	--	--	≥ 14	≥ 9	≥ 8	--
Woody debris[4]	≥ 30	≥ 30	≥ 30		≥ 30		≥ 30	≥ 30	≥ 30	≥ 30				≥ 30	≥ 30	≥ 30	≥ 30	≥ 30
Stems per hectare																		
Live ≥ 20 cm diam	--	--	--	≥ 30	--	≥ 30	--	--	--	--	--	--	≥ 30	--	--	--	--	--
Live ≥ 30 cm diam	≥ 30	≥ 30	≥ 30	--	≥ 30	--	≥ 30	≥ 75	≥ 30	≥ 30	≥ 30	≥ 30	--	≥ 30	≥ 75	≥ 75	≥ 75	≥ 75
Live ≥ 45 cm diam	--	--	--	--	--	--	--	≥ 1	--	--	--	--	--	--	≥ 1	≥ 1	≥ 1	≥ 1
Dead[5] ≥ 10 cm diam	≥ 20	≥ 20	≥ 20	--	≥ 20	--	≥ 20	≥ 20	≥ 20	≥ 20	--	--	--	≥ 20	≥ 20	≥ 20	≥ 20	≥ 20
Dead[5] ≥ 20 cm diam	--	--	--	≥ 10	--	≥ 10	--	--	--	--	--	--	≥ 10	--	--	--	--	--
Dead[5] ≥ 30 cm diam	≥ 10	≥ 10	≥ 10	--	≥ 10	--	≥ 10	≥ 10	≥ 10	≥ 10	--	--	--	≥ 10	≥ 15	≥ 15	≥ 15	≥ 15
Dead[5] pine ≥ 30 cm	--	--	--	--	--	--	--	--	--	--	≥ 3	≥ 3	--	--	--	--	--	--
Dead[5] ≥ 45 cm diam	--	--	--	--	--	--	--	--	--	--	--	--	--	--	≥ 0.5	≥ 0.5	≥ 0.5	≥ 0.5

[1] Stands can meet criteria for more than 1 OFC. When more than 1 set of criteria are met, priority is given to the leftmost OFC in the table.

[2] Colour coding of OFCs indicates association with Old-forest Wildlife Habitats. OTHH OFCs are also OHWH

Old Spruce-fir Habitat	Old Pine Habitat	Old Tolerant Hardwood Habitat	Old Hardwood Habitat	Not Habitat

[3] SF includes the spruces, HE, CE and BF

[4] Woody debris expressed as m^3/ha of pieces ≥ 8 cm in diameter.

[5] Dead stems or stems with at least one dead branch of indicated diameter.

OLD-FOREST WILDLIFE HABITATS

The goal of forest habitat management is to ensure that management activities on Crown land produce a forest that can support vertebrate populations at desired levels. For most species, this translates to providing sufficient habitat to maintain viable populations across the area of Crown land to which they are indigenous.

Forest habitat management is about supplying particular forest conditions in particular locations at particular times. It functions as a component of a larger strategic planning process for multiple forest values that is applied at a large spatial extent and over a long time horizon. Inclusion in that process allows forest habitats to be tracked and directed across space and time. The process is best suited to species that are sufficiently common and widespread that habitat is a reasonable predictor of occurrence.

There are 159 vertebrates that use New Brunswick's forest for some or all of their breeding, migrating or over-winter requirements. Seventy-two of them make use of old forest conditions; the full range of their habitat associations are given in Appendix 1. Old-forest habitats were identified and defined based on the requirements of the species that utilize them; however, priority was given to the 38 species that meet the criteria of being relatively common, of not also having their needs met in mid-age forest, and of not requiring that forest be in close proximity to other habitat classes, such as non-forested uplands, wetlands and watercourses. Habitat descriptions were developed for each of the 38 species, and these were used to generate a set of old-forest habitats with sufficiently broad definitions to encompass the entire set.

The resulting 6 old-forest habitats are *Old Tolerant Hardwood* (OTHH)*, Old Hardwood* (OHWH)*, Old Spruce-fir* (OSFH)*, Old Pine* (OPIH)*, Old Mixedwood* (OMWH) and *Old Forest* (OFH). With the exception of OMWH, each habitat is explicitly composed of nested Old Forest Communities (see Table 1). OHWH, OSFH and OPIH are mutually exclusive and range from pure softwood or hardwood conditions to mixes of almost 50%. OMWH occurs when softwood (or hardwood) is between approximately 25% and 75% and always also meets the stand-level criteria for at least one other type. OTHH is always nested within OHWH. OFH is a broadly defined old-forest condition with stand-level criteria that encompass those of all the other types.

Old Tolerant Hardwood Habitat

Old Tolerant Hardwood Habitat is a subset of Old Hardwood Habitat. It provides habitat for 25 vertebrate species. Ten of those are habitat generalists whose requirements are met in a range of conditions. The remainder (15) require old deciduous forest, and 5 of those are dependent on the occurrence of OTHH (Table 2).

OTHH must meet the composition, crown closure, basal area and stem density criteria of one of its constituent OFCs (THP, THSW, THIH; see Table 1), and the tree-cavity criteria described in Table 3. Landscape structure is defined in terms of the size, shape, and relative location of habitat patches (Table 4).

Table 2. Summary of the structural characteristics of habitat for species assigned to Old Tolerant Hardwood Habitat. Stand characteristics and related minimum values are tree cavities (CV dbh), dead or partially dead trees (DD dbh), live tree boles (TB dbh), and a hardwood shrub layer (HS); values in bold are those that contribute directly to the stand structure of constituent OFCs in Table 1. Landscape characteristics are habitat area in a patch and inter-patch distance; values in bold are those that contribute directly to the landscape structure in Table 4.

	Stand Characteristics		Landscape characteristics		
			Patch Characteristics		Inter-patch Distance (km)
Species	Nesting	Foraging	Intended Use[1]	Habitat Area	
Barred owl	**CV 45**		**1 nest**	**≥ 20**	**≥ 3**
Eastern wood-pewee			10 ranges	≥ 40	≤ 1
White-breasted nuthatch	**CV 30**	**TB 30**	**10 ranges**	**≥ 100**	**≤ 2**
Black-throated blue warbler		HS	10 ranges	≥ 40	≤ 1
Scarlet tanager			10 ranges	≥ 20	≤ 1
OHWH species[2]	**DD 10, DD 30, DD 45**				

[1] Number of breeding females that patch supports; and whether patch provides entire home ranges, or nest/den sites only.
[2] OTHH is a subset of OHWH. The addition of these structural characteristics to OTHH makes it suitable for all OHWH species.

Table 3. Cavity tree characteristics for Old Tolerant Hardwood Habitat.

Cavity Type[1]	Tree Species	DBH	Tree Diameter at Cavity	Height of Cavity	Dimension of Cavity Opening
Barred owl	any	≥ 45 cm	≥ 30 cm	≥ 5 m	≥ 18 cm
WB nuthatch	any	≥ 30 cm	≥ 20 cm	≥ 5 m	≥ 5 cm

[1] Type named for principal species that requires it.

Table 4. Landscape structure of Old Tolerant Hardwood Habitat.

Criteria Set[1]	Habitat Area in Patch[2]	Proportion of Patch in Habitat[3]	Inter-patch Distance	Proportion of Objective[4]
Barred owl	≥ 20 ha	≥ 0.75	≥ 3 km	0.15
WB nuthatch	≥ 100 ha	≥ 0.75	≤ 2 km	0.85

[1] Set named for principal species for which structure defined.
[2] Area in each patch that must meet stand structure criteria.
[3] Proportion of each patch, regardless of size, that must meet stand structure criteria.
[4] Estimate of the proportion of an OTHH management objective that must meet each set of spatial criteria.

Old Hardwood Habitat

Old Hardwood Habitat (OHWH) encompasses OTHH. It provides habitat for 20 vertebrate species. Ten of those are habitat generalists whose requirements are met in a range of conditions. Habitat relationships for the remaining 10 dependent species are provided in Table 5.

OHWH must meet the composition, crown closure, basal area and stem density criteria of one of its constituent OFCs (THP, THSW, THIH, IH; see Table 1). Landscape structure is defined in terms of the size, shape, and relative location of habitat patches (Table 6).

Table 5. Summary of the structural characteristics of habitat for species assigned to Old Hardwood Habitat. Stand characteristics and related minimum values are dead or partially dead trees (DD dbh), live tree boles (TB dbh), and a litter layer (LL); values in bold are those that contribute directly to the stand structure of constituent OFCs in Table 1. Landscape characteristics are habitat area in a patch and inter-patch distance; values in bold are those that contribute directly to the landscape structure in Table 6.

	Stand Characteristics		Landscape characteristics		
			Patch Characteristics		
Species	Nesting	Foraging	Intended Use[1]	Habitat Area	Inter-patch Distance
Northern goshawk	**TB 30**		1 nest	≥ 10	**≥ 3**
Broad-winged hawk	TB 30		1 nest	≥ 10	≥ 3
Yellow-bellied sapsucker	**DD 30**		10 ranges	≥ 30	≤ 1
Downy woodpecker		**DD 10**	10 ranges	≥ 30	≤ 1
Hairy woodpecker	DD 30	DD 10	**10 ranges**	**≥ 30**	**≤ 1**
Northern flicker	DD 30		10 ranges	≥ 20	≤ 1
Pileated woodpecker	**DD 45**	DD 10	**1 nest**	**≥ 10**	**≥ 2**
Blue jay			10 ranges	≥ 30	≤ 1
Black-capped chickadee	DD 10		10 ranges	≥ 30	≤ 1
Ovenbird	TB 30	LL	10 ranges	≥ 10	≤ 1

[1] Number of breeding females that patch supports; and whether patch provides entire home ranges, or nest/den sites only.

Table 6. Landscape structure of Old Hardwood Habitat.

Criteria Set[1]	Habitat Area in Patch[2]	Proportion of Patch in Habitat[3]	Inter-patch Distance	Proportion of Objective[4]
Hairy woodpecker	≥ 30 ha	≥ 0.75	≤ 1 km	0.45
Pileated woodpecker	≥ 10 ha	≥ 0.75	≥ 2 km	0.55
Northern goshawk	≥ 10 ha	≥ 0.75	≥ 3 km	0

[1] Set named for principal species for which structure defined.
[2] Area in each patch that must meet stand structure criteria.
[3] Proportion of each patch, regardless of size, that must meet stand structure criteria.
[4] Estimate of the proportion of an OHWH management objective that must meet each set of spatial criteria.

Old Pine Habitat

Pine warbler is the only species dependant on the occurrence of Old Pine Habitat (OPIH) (Table 7). OPIH must meet the composition, crown closure, basal area and stem density criteria of one of its constituent OFCs (RP or WP, JP; see Table 1). Landscape structure is defined in terms of the size, shape, and relative location of habitat patches (Table 8).

Table 7. Summary of the structural characteristics of habitat for the pine warbler, the only species assigned to Old Pine Habitat. The principal requirement is live tree boles (TB dbh). Landscape characteristics are habitat area in a patch and inter-patch distance**.**

	Stand Characteristics		Landscape characteristics		
			Patch Characteristics		
Species	Nesting	Foraging	Intended Use[1]	Habitat Area	Inter-patch Distance
Pine warbler	TB 30		10 ranges	≥ 10	≤ 1

[1] Number of breeding females that patch supports; and whether patch provides entire home ranges, or nest/den sites only.

Table 8. Landscape structure of Old Pine Habitat.

Criteria Set[1]	Habitat Area in Patch[2]	Proportion of Patch in Habitat[3]	Inter-patch Distance
Pine warbler	≥ 10 ha	≥ 0.75	≤ 1 km

[1] Set named for principal species for which structure defined.
[2] Area in each patch that must meet stand structure criteria.
[3] Proportion of each patch, regardless of size, that must meet stand structure criteria.

Old Spruce-fir Habitat

Old Spruce-fir Habitat (OSFH) provides habitat for up to 22 species. Twelve of these are habitat generalists whose requirements are met in a range of conditions. Habitat relationships for the remaining 10 dependent species are provided in Table 9. A separate strategy exists for management of white-tailed deer habitat; hence, its requirements do not contribute to the definition of OSFH.

OSFH must meet the composition, crown closure, basal area and stem density criteria of one of its 9 constituent OFCs (see Table 1). Landscape structure is defined in terms of the size, shape, and relative location of habitat patches (Table 10).

Table 9. Summary of the structural characteristics of habitat for species assigned to Old Spruce-fir Habitat. Stand characteristics and related minimum values are woody debris (WD), dead or partially dead trees (DD dbh), live tree boles (TB dbh), shrub layer (SH), and abundant softwood seed (SS); values in bold are those that contribute directly to the stand structure of constituent OFCs in Table 1. Landscape characteristics are habitat area in a patch and inter-patch distance; values in bold are those that contribute directly to the landscape structure in Table 10.

	Stand Characteristics		Landscape characteristics		
			Patch Characteristics		
Species	Denning/ Nesting	Foraging	Intended Use[1]	Habitat Area	Inter-patch Distance
Sharp-shinned hawk			1 nest	≥ 10	≥ 2
Black-backed woodpecker	**DD 30**	**DD 10**	**10 ranges**	**≥ 375**	**any**
Boreal chickadee	DD 10		10 ranges	≥ 50	≤ 1
Red-breasted nuthatch	DD 30	**TB 30**	10 ranges	≥ 30	≤ 1
Winter wren	**WD**	SH	10 ranges	≥ 20	≤ 1
Cape May warbler			10 ranges	≥ 10	≤ 1
Red crossbill		SS	10 ranges	≥ 40	≤ 1
White-winged crossbill		SS	10 ranges	≥ 40	≤ 1
Pine siskin			10 ranges	≥ 20	≤ 1
Evening grosbeak			10 ranges	≥ 20	≤ 1

Table 10. Landscape structure of Old Spruce-fir Habitat.

Criteria Set[1]	Habitat Area in Patch[2]	Proportion of Patch in Habitat[3]	Patch Width
Black-backed woodpecker	≥ 375 ha	≥ 0.75	≥ 1 km

[1] Set named for principal species for which structure defined.
[2] Area in each patch that must meet stand structure criteria.
[3] Proportion of each patch, regardless of size, that must meet stand structure criteria.

Old Mixedwood Habitat

Old Mixedwood Habitat (OMWH) stands are composed of between 25% and 75% hardwood and always also meet the stand-level definition of at least one other type (OSFH, OPIH, OTHH, OHWH). OMWH provides critical habitat for 5 species (Table 11), though many other species use it.

OMWH stand structure is defined in terms of total, hardwood and softwood basal areas, densities of live and dead stems, volume of coarse woody debris, and occurrence of cavities (Table 12, Table 13). Landscape structure is defined in terms of the size, shape, and relative location of habitat patches (Table 14).

Table 11. Summary of the structural characteristics of habitat for species assigned to Old Mixedwood Habitat. Stand characteristics and related minimum values are tree cavities (CV dbh), live tree boles (TB dbh), midstorey layer (ML), softwood shrub layer (SS), shrub layer (SL), mast (MS) and coarse woody debris (WD); values in bold are those that contribute directly to the stand structure in Table 12 and Table 13. Landscape characteristics are habitat area in a patch and inter-patch distance; values in bold are those that contribute directly to the landscape structure in Table 14.

	Stand Characteristics		Landscape characteristics		
			Patch Characteristics		
Species	Nesting	Foraging	Intended Use[1]	Habitat Area	Inter-patch Distance
Northern flying squirrel	**CV 30**	MS, SS	**10 ranges**	**≥ 50**	**≤ 1**
Fisher	**CV 45, WD**	WD	**1 den**	**≥ 20**	**≥ 3**
Blue-headed vireo	SL	**TB 30**	10 ranges	≥ 20	≤ 1
Swainson's thrush	SS, ML	TB 30	10 ranges	≥ 20	≤ 1
Blackburnian warbler		TB 30	10 ranges	≥ 20	≤ 1

[1] Number of breeding females that patch supports; and whether patch provides entire home ranges, or nest/den sites only.

Table 12. Stand structure of Old Mixedwood Habitat.

	Stand Structure Criteria						
		Basal Area (m^2/ha)			Stems Density		
Diameter Class	Crown Closure (%)	All Stems	Softwood Stems	Hardwood Stems	Live	With Cavities	Woody Debris
≥ 8 cm							≥ 20 m^3/ha
≥ 10 cm	≥ 40	≥ 18	≥ 6	≥ 6			
≥ 30 cm					60/ha	5/ha[1]	
≥ 45 cm						5/20 ha[1]	

[1] See NF squirrel and fisher cavity criteria in Table 13.

Table 13. Cavity tree characteristics for Old Mixedwood Habitat.

Cavity Type[1]	Tree Species	DBH	Tree Diam at Cavity	Height of Cavity	Dimension of Cavity Opening
NF squirrel	any	≥ 30 cm	≥ 16 cm	≥ 5 m	≥ 4 cm
Fisher	any	≥ 45 cm	≥ 30 cm	≥ 5 m	10-16 cm

[1] Type named for principal species that requires it.

Table 14. Landscape structure of Old Mixedwood Habitat.

Criteria Set[1]	Habitat Area in Patch[2]	Proportion of Patch in Habitat[3]	Inter-patch Distance	Proportion of Objective[4]
NF squirrel	≥ 50 ha	≥ 0.75	≤ 1 km	0.95
Fisher	≥ 20 ha	≥ 0.75	≥ 3 km	0.05

[1] Set named for principal species for which structure defined.

Old Forest Habitat

Old Forest Habitat (OFH) provides habitat for 7 species that require old-forest conditions but do not require a particular overstorey composition (Table 15). OFH must meet the composition, crown closure, basal area and stem density tree criteria of any one of the 15 OFCs that contribute to an OFWH (see Table 1), and the tree-cavity criteria described in Table 16. OFH landscape structure is defined in terms of the size and shape of habitat patches. Criteria are based on the requirements of American marten in the ecodistricts where they occur, and on the requirements of brown creeper elsewhere (Table 17).

Table 15. Summary of the structural characteristics of habitat for species assigned to Old Forest Habitat. Stand characteristics and related minimum values are woody debris (WD), tree cavities (CV dbh), dead or partially dead trees (DD dbh), live tree boles (TB dbh), and Usnea lichens (US); values in bold are those that contribute directly to the stand structure of OFCs in Table 1. Landscape characteristics are habitat area in a patch and inter-patch distance; values in bold are those that contribute directly to the landscape structure in Table 17.

	Stand Characteristics		Landscape characteristics		
			Patch Characteristics		
Species	Nesting/ Denning	Foraging	Intended Use	Habitat Area	Inter-patch Distance
Porcupine	**CV 45**		1 den	≥ 20	any
American marten	CV 45	**WD**	**2 ranges**	**≥ 375**	**any**
Red-tailed hawk	**TB 30**	TB 30	**1 nest**	**≥ 10**	**≥ 3**
Northern saw-whet owl	**CV 30**		**1 nest**	**≥ 20**	**1-5**
Common raven	TB 30		1 nest	≥ 10	≥ 3
Brown creeper	**DD 30**	TB 30	**10 ranges**	**≥ 30**	**≤ 1**
Northern parula	US	TB 30	10 ranges	≥ 10	≤ 1

Table 16. Cavity tree characteristics for Old Forest Habitat.

Cavity Type[1]	Tree Species	DBH	Tree Diameter at Cavity	Height of Cavity	Dimension of Cavity Opening
Saw-whet owl	any	≥ 30 cm			
American marten	any	≥ 45 cm	≥ 25 cm	≥ 5 m	≥ 8 cm

[1] Type named for principal species for which structure defined.

Table 17. Landscape structure of Old Forest Habitat.

Criteria Set[1]	Habitat Area in Patch[2]	Proportion of Patch in Habitat[3]	Patch Width	Inter-patch Distance	Location
American marten	≥ 375 ha	≥ 0.75	≥ 1 km	any	marten ecodistricts[4]
Brown creeper	≥ 30 ha	≥ 0.75	≥ 300 m	≤ 1 km	brown creeper ecodistricts[5]

[1] Set named for principal species for which structure defined.
[2] Area in each patch that must meet stand structure criteria.
[3] Proportion of each patch, regardless of size, that must meet stand structure criteria.
[4] All of Ecoregions 1, 2, 3 and 4 and Ecodistricts 5-1 through 5-6, 6-1, 6-3, 6-4, 6-5, 6-7, and 7-2.
[5] Ecodistricts 5-7 through 5-12, 6-2, 6-6, and 7-1.

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Appendix 1. Habitat relationships of species associated with old forest. Young-forest, wetland and coastal habitats are described in the documents *Young-forest Wildlife Habitats in New Brunswick* and *Wetland and Coastal Wildlife Habitats in New Brunswick* (NB ERD 2017a, 2017b). Upland and Freshwater habitat types are not fully described.

Species	Population	Not Common[1]	Habitat Class	Forest Juxtaposition[2]	Habitat	
					Type	Stage or Sub-type[3]
LITTLE BROWN BAT	Breeding	✓	Forest		Spruce-fir	Mid / Old
			Upland		Any Upland	
			Wetland		Any Wetland	
			Freshwater		Any Open Freshwater	
TRI-COLORED BAT	Breeding	✓	Forest		Any Forest	Mid / Old
			Upland		Any Upland	
			Wetland		Any Wetland	
			Freshwater		Any Open Freshwater	
RED BAT	Breeding		Forest		Hardwood	Mid / Old
					Mixedwood	Mid / Old
			Upland		Hardwood Woodland	
HOARY BAT	Breeding		Forest		Any Forest	Mid / Old
			Upland		Softwood Woodland	
					Hardwood Woodland	
			Wetland		Any Wetland	
			Freshwater		Any Open Freshwater	
SNOWSHOE HARE	Breeding		Forest		Any Forest	Old / Young
NORTHERN FLYING SQUIRREL	Breeding		Forest		Mixedwood	Old
PORCUPINE	Breeding		Forest		Any Forest	Old

[1] Not Common: Species with populations that are rare or uncommon.
[2] Forest Juxtaposition: Species that use forest that must be in close proximity to another habitat class.
[3] Stage or Sub-type: Successional stage of forest habitat, or sub-type of wetland habitat.

Species	Population	Not Common[1]	Habitat Class	Forest Juxtaposition[2]	Habitat	
					Type	Stage or Sub-type[3]
RACCOON	Breeding		Forest	✓	Any Forest	Old
			Upland		Any Upland	
			Wetland		Emergent Shallow Marsh	
					Deep Marsh / Aquatic Bed	
					Marsh Complex - Water Far	
					Wet Shrub Complex - Water Far	
			Freshwater		Any Open Freshwater	
AMERICAN MARTEN	Breeding		Forest		Any Forest	Old
			Wetland		Cedar Swamp	
FISHER	Breeding		Forest		Mixedwood	Old
WHITE-TAILED DEER	Breeding		Forest		Spruce-fir	Old
					Hardwood	Young
					Mixedwood	Young
			Wetland		Cedar Swamp	
MOOSE	Breeding		Forest		Spruce-fir	Old
					Hardwood	Young
					Mixedwood	Old
					Mixedwood	Young
			Wetland		Cedar Swamp	
					Any Wetland	
			Freshwater		Any Open Freshwater	
WOOD DUCK	Breeding		Forest	✓	Spruce-fir	Old
					Hardwood	Old
					Mixedwood	Old
			Wetland		Emergent Shallow Marsh	
					Deep Marsh / Aquatic Bed	
					Marsh Complex - Water Near	
					Floodplain Forest	

Species	Population	Not Common[1]	Habitat Class	Forest Juxtaposition[2]	Habitat	
					Type	Stage or Sub-type[3]
COMMON GOLDENEYE	Breeding		Forest	✓	Any Forest	Old
			Wetland		Wet meadow / Tidal marsh	Beaver Pond
					Emergent Shallow Marsh	
					Deep Marsh / Aquatic Bed	
					Alder or Shrub Wetland	Beaver Pond
					Marsh Complex - Water Near	
					Wet Shrub Complex - Water Near	
					Floodplain Forest	
			Freshwater		Any Open Freshwater	
	Migrating		Coastal		Estuary	
			Freshwater		Any Open Freshwater	
	Non-breeding		Coastal		Estuary	
			Freshwater		River-Stream	
HOODED MERGANSER	Breeding		Forest	✓	Any Forest	Old
			Wetland		Wet meadow / Tidal marsh	Beaver Pond
					Emergent Shallow Marsh	
					Deep Marsh / Aquatic Bed	
					Alder or Shrub Wetland	Beaver Pond
					Floodplain Forest	
			Freshwater		Any Open Freshwater	
COMMON MERGANSER	Breeding		Forest	✓	Any Forest	Old
			Freshwater		Any Open Freshwater	
	Migrating		Coastal		Estuary	
			Freshwater		Any Open Freshwater	
	Non-breeding		Coastal		Estuary	
			Freshwater		River-Stream	
SPRUCE GROUSE	Breeding		Forest		Spruce-fir	Mid / Old
					Jack Pine	Mid

Species	Population	Not Common[1]	Habitat Class	Forest Juxtaposition[2]	Habitat	
					Type	Stage or Sub-type[3]
GREAT BLUE HERON	Breeding		Forest	✓	Any Forest	Mid / Old
			Wetland		Wet meadow / Tidal marsh	
					Emergent Shallow Marsh	
					Deep Marsh / Aquatic Bed	
					Marsh Complex - Water Far	
					Wet Shrub Complex - Water Far	
			Coastal		Salt Marsh	
					Mud Flat	
					Beach	
					Rocky Shoreline	
			Freshwater		Any Open Freshwater	
BLACK-CROWNED NIGHT-HERON	Breeding		Forest	✓	Any Forest	Mid / Old
			Wetland		Emergent Shallow Marsh	
					Alder or Shrub Wetland	
			Coastal		Salt Marsh	
					Coastal Island	
					Mud Flat	
					Rocky Shoreline	
OSPREY	Breeding		Forest	✓	Any Forest	Old
			Wetland		Deep Marsh / Aquatic Bed	
			Coastal		Estuary	
			Freshwater		Any Open Freshwater	
BALD EAGLE	Breeding	✓	Forest	✓	Spruce-fir	Old
					Pine	Old
					Tolerant Hardwood	Old
					Mixedwood	Old
			Wetland		Floodplain Forest	
			Coastal		Estuary	

Species	Population	Not Common[1]	Habitat Class	Forest Juxtaposition[2]	Habitat	
					Type	Stage or Sub-type[3]
BALD EAGLE (Continued)	Breeding		Freshwater		Any Open Freshwater	
	Non-breeding	✓	Coastal		Estuary	
			Freshwater		River-Stream	
SHARP-SHINNED HAWK	Breeding		Forest		Spruce-fir	Old
COOPER'S HAWK	Breeding	✓	Forest		Tolerant Hardwood	Old
NORTHERN GOSHAWK	Breeding		Forest		Hardwood	Old
RED-SHOULDERED HAWK	Breeding	✓	Forest		Hardwood	Old
BROAD-WINGED HAWK	Breeding		Forest		Hardwood	Old
RED-TAILED HAWK	Breeding		Forest		Any Forest	Old
AMERICAN KESTREL	Breeding		Forest	✓	Any Forest	Old
			Upland		Grassland	
					Agriculture	
					Open Low Vegetation	
			Wetland		Wet meadow / Tidal marsh	
MERLIN	Breeding		Forest	✓	Any Forest	Mid / Old
			Upland		Any Upland	
			Wetland		Any Wetland	
BARRED OWL	Breeding		Forest		Tolerant Hardwood	Old
NORTHERN SAW-WHET OWL	Breeding		Forest		Any Forest	Old
CHIMNEY SWIFT	Breeding	✓	Forest		Hardwood	Old
YELLOW-BELLIED SAPSUCKER	Breeding		Forest		Hardwood	Old
DOWNY WOODPECKER	Breeding		Forest		Hardwood	Old
HAIRY WOODPECKER	Breeding		Forest		Hardwood	Old

Species	Population	Not Common[1]	Habitat Class	Forest Juxtaposition[2]	Habitat	
					Type	Stage or Sub-type[3]
AMERICAN THREE-TOED WOODPECKER	Breeding	✓	Forest	✓	Spruce-fir	Old
			Wetland		Bog	Partially Treed
					Bog	Fully Treed
BLACK-BACKED WOODPECKER	Breeding		Forest		Spruce-fir	Old
NORTHERN FLICKER	Breeding		Forest		Hardwood	Old
PILEATED WOODPECKER	Breeding		Forest		Hardwood	Old
OLIVE-SIDED FLYCATCHER	Breeding		Forest	✓	Spruce-fir	Old
			Wetland		Bog	Partially Treed
					Bog	Fully Treed
EASTERN WOOD-PEWEE	Breeding		Forest		Tolerant Hardwood	Old
LEAST FLYCATCHER	Breeding		Forest		Hardwood	Mid / Old
BLUE-HEADED VIREO	Breeding		Forest		Mixedwood	Old
RED-EYED VIREO	Breeding		Forest		Hardwood	Mid / Old
GRAY JAY	Breeding		Forest		Spruce-fir	Mid / Old
			Wetland		Bog	Partially Treed
					Bog	Fully Treed
BLUE JAY	Breeding		Forest		Hardwood	Old
			Upland		Hardwood Woodland	
COMMON RAVEN	Breeding		Forest		Any Forest	Old
			Upland		Any Upland	
			Wetland		Any Wetland	
			Coastal		Any Coastal	
			Freshwater		Any Open Freshwater	
BLACK-CAPPED CHICKADEE	Breeding		Forest		Hardwood	Old
			Upland		Hardwood Woodland	
BOREAL CHICKADEE	Breeding		Forest		Spruce-fir	Old

Species	Population	Not Common[1]	Habitat Class	Forest Juxtaposition[2]	Habitat	
					Type	Stage or Sub-type[3]
RED-BREASTED NUTHATCH	Breeding		Forest		Spruce-fir	Old
WHITE-BREASTED NUTHATCH	Breeding		Forest		Tolerant Hardwood	Old
BROWN CREEPER	Breeding		Forest		Any Forest	Old
WINTER WREN	Breeding		Forest		Spruce-fir	Old
GOLDEN-CROWNED KINGLET	Breeding		Forest		Spruce-fir	Mid / Old
RUBY-CROWNED KINGLET	Breeding		Forest		Spruce-fir	Mid / Old
			Wetland		Bog	Partially Treed
					Bog	Fully Treed
SWAINSON'S THRUSH	Breeding		Forest		Mixedwood	Old
HERMIT THRUSH	Breeding		Forest		Any Forest	Mid / Old
			Wetland		Bog	Partially Treed
					Bog	Fully Treed
OVENBIRD	Breeding		Forest		Hardwood	Old
ORANGE-CROWNED WARBLER	Migrating	✓	Forest		Hardwood	Old
CAPE MAY WARBLER	Breeding		Forest		Spruce-fir	Old
NORTHERN PARULA	Breeding		Forest		Any Forest	Old
BAY-BREASTED WARBLER	Breeding		Forest		Spruce-fir	Mid / Old
BLACKBURNIAN WARBLER	Breeding		Forest		Mixedwood	Old
BLACK-THROATED BLUE WARBLER	Breeding		Forest		Tolerant Hardwood	Old
PINE WARBLER	Breeding		Forest		Pine	Old

Species	Population	Not Common[1]	Habitat Class	Forest Juxtaposition[2]	Habitat	
					Type	Stage or Sub-type[3]
BLACK-THROATED GREEN WARBLER	Breeding		Forest		Any Forest	Mid / Old
SCARLET TANAGER	Breeding		Forest		Tolerant Hardwood	Old
RED CROSSBILL	Breeding		Forest		Spruce-fir	Old
WHITE-WINGED CROSSBILL	Breeding		Forest		Spruce-fir	Old
COMMON REDPOLL	Non-breeding		Forest		Hardwood	Mid / Old
			Upland		Upland Shrub	
					Agriculture	
			Wetland		Alder or Shrub Wetland	
PINE SISKIN	Breeding		Forest		Spruce-fir	Old
EVENING GROSBEAK	Breeding		Forest		Spruce-fir	Old

[1] Not Common: Species with populations that are rare or uncommon.
[2] Forest Juxtaposition: Species that use forest that must be in close proximity to another habitat class.
[3] Stage or Sub-type: Successional stage of forest habitat, or sub-type of wetland habitat.