A STUDY OF THE HOLE-NESTING AVIFAUNA OF SOUTHWESTERN BRITISH COLUMBIA

by

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ABSTRACT

This study relates the species composition, numbers, and habits of a hole-nesting avifauna to its environment in successional stages of a coniferous forest in southwestern British Columbia. Emphasis is placed upon explaining an observed presence or absence of nest-site competition.

In two breeding seasons, the hole-nesting avifauna was found to be low in numbers of both species and individuals. Most of these birds were able to excavate their own nesting cavities, and commonly did so, for which activity the habitat generally provided ample opportunity. As the species present often differed widely from one another in the type and placement of their preferred nest cavities, there was usually a surplus of different cavity types present.

Secondary hole-nesters either concentrated their activities around the buildings in the nearby town, neglecting the more "natural" sites available; were not obligated to use cavities when nesting; or occurred in such low densities, and were so positioned in the available suitable habitat, as to suggest that nest-site competition had no effect upon the populations. Only scattered indications of nest-site competition were observed in wooded areas.

Four species nested in crevices in buildings and in bird boxes in a small town, where their breeding population densities were much higher than in the surrounding countryside. Nest-sites were judged to be present in excess, and nest-site competition, observed infrequently, was so rare, and apparently without significant harmful effects, that it

was judged to be of negligible importance as a population-regulating factor.

The overall absence of nest-site competition is contributed to not only by the preferences of the species regarding their nest-sites, but also by the fact that the results of their habitat selection processes, and their living habits within these habitats, tend to keep them ecologically distinct.

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The Purpose of the Study

Species of birds that nest in tree-holes are dependent upon a limited environmental resource. If the number of holes is small in relation to the number of birds that require the use of them, competition may occur. The birds involved in this competitive situation suffer as a result of their participation.

This study relates the numbers and species composition of a hole-nesting avifauna to the environment in which it occurs. Emphasis is placed upon explaining an observed presence or absence of nest-site competition.

The Area of the Study

A large part of the work was done on the University of British Columbia's Thacker Ecological Reservation near the town of Hope, British Columbia. It is located at 121° 25' W. longitude and 49° 23' N. latitude, and has a base altitude of 160 feet (49m.). Additional study areas were near and in the town itself, while survey trips were made regularly into the surrounding country. Hope is situated at the head of the Fraser Valley, and is approximately 90 miles upstream from the Fraser River's mouth in the extreme southwest corner of British Columbia. (Fig. 1)

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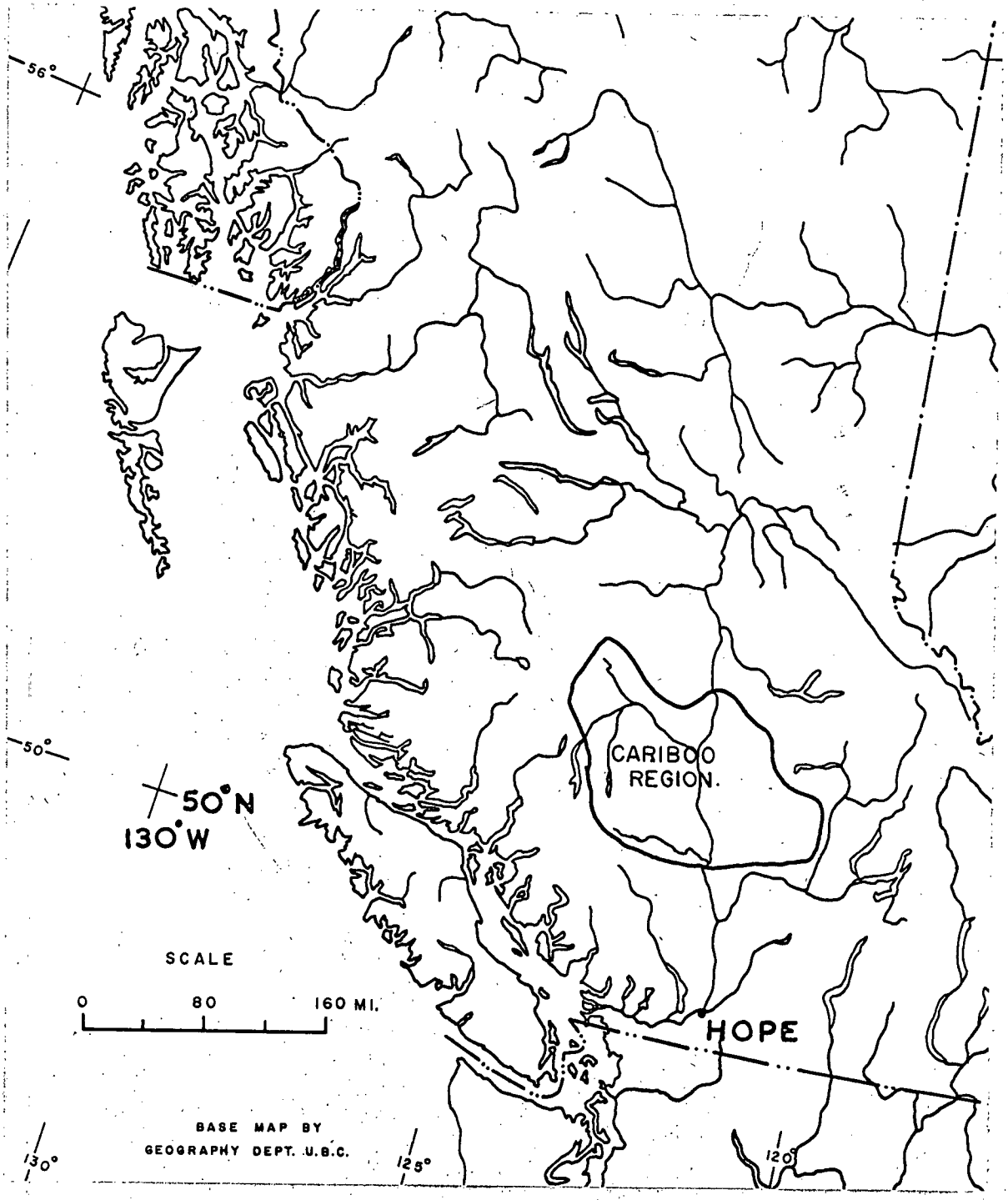

Figure 1. The province of British Columbia showing the location of Hope.

The Time of the Study

Two summers were spent in the field; from May 1 to August 31, 1961; and from April 28 to September 9, 1962. Additionally in 1962, day-long visits to the study area were made on March 18, March 31, and April 9.

METHODS

Observation of hole-nesting birds in their natural environments composed the greater part of this study. The nature of both the habitat and the hole-nesting bird population required that observations be conducted on a survey-type basis, the intention being to visit many nests as often as possible. Color-banding was employed where easily practised, 78 hole-nesters being so marked in order to give the observations greater accuracy.

A study of nest-site competition among hole-nesting birds, conducted through the analysis of measurements of the nest cavities, was done by McLaren (1963) in another region of British Columbia. Initially it was hoped that in the present study enough holes might be measured to allow comparisons to be drawn. However, almost all of the holes were in dead snags that were often of considerable height and very few of which could be climbed with safety and facility. Also, since few of the holes were occupied, even if the majority of them were measured, there would not be a large enough sample to permit accurate comparisons. Finally, the value of such comparisons is questionable, as nearly all the birds found utilizing holes were capable of digging their own, and in many cases apparently did so. Notes were made concerning each occupied snag and such data are often tabulated in order to delimit the requirements of individual species. Inspection of every snag on over one-half of the Reservation established the comparative abundance of hole-bearing snags, of which a substantial proportion were found

to possess cavities.

Two small experimental aspects were added in the second season. Ten bird boxes were erected along the marsh on May 23, 1962, in order to test a facet of the site-selection process in Tree and Violet-Green Swallows.

A new area, separate from but similar to the Reservation, was surveyed for hole-nesting birds during the first half of May, 1962. As many as possible (10) were shot during the next two weeks, and observations were continued through the remainder of the summer to detect any changes in position or composition of the remaining hole-nesting avifauna.

The surroundings of the main study areas were surveyed during June, July, and August, 1962. Weekly trips were made up the Hope-Princeton Highway as far as Pinewoods, 41 miles from Hope, and down the Fraser Valley (approximately 27 miles) toward Chilliwack, stopping at selected areas, where the kinds and numbers of all birds seen were recorded. These observations were considered to be supplementary to the main parts of the study, and their purpose was to provide a broader background for generalizations. In addition, the many nests located contribute to the value of the data to be presented on the habitat preferences of the individual species.

THE AVIFAUNA AND THE HABITAT

The Subjects of the Investigation

Table 1 presents the species involved in this study. Under Observed Resident Breeders are listed all those hole-nesting birds which were observed on the studied areas. Not Observed Resident Breeders includes those species which regional lists indicate as breeding in this area, but which were not personally observed. Some were seen by Horvath (1963, and personal communication) - the separate treatment given to each of these species details such occurrences. The digit after each species indicates its status as a primary (1) or a secondary (2) hole-nester. This classification is based upon the ability of the bird to excavate its own nesting cavity - a primary hole-nester can do so; a secondary cannot (McLaren, 1963). Some primary hole-nesters do not always excavate the cavities that they use, and any such instances known are detailed in the text.

The Non-Resident category, included for completeness, lists non-breeding hole-nesting species which may occur in the study area. Asterisks indicate those species observed during this study.

TABLE 1. HOLE-NESTING BIRDS[1]. OF THE STUDY AREA

RESIDENT BREEDERS			
OBSERVED		NOT OBSERVED	
Wood Duck	2	American (Common) Merganser	2
Hooded Merganser	2	Pigeon Hawk	2
Sparrow Hawk	2	Screech Owl	2
Red-Shafted Flicker	1	Great Horned Owl[2].	2
Pileated Woodpecker	1	Pygmy Owl	2
Red-Breasted Sapsucker	1	Spotted Owl	2
Hairy Woodpecker	1	Saw-Whet Owl	2
Downy Woodpecker	1	Lewis Woodpecker	1
Violet-Green Swallow	2	House Wren	2
Tree Swallow	2	Western Bluebird	2
Rough-Winged Swallow	2		
Black-Capped Chickadee	1		
Chestnut-Backed Chickadee	1		
Red-Breasted Nuthatch	1		
Brown Creeper	2		
Winter Wren	2		
Bewick Wren	2		
Mountain Bluebird	2		
Starling	2		
House (English) Sparrow	2		
House Finch	2		

1. Scientific names of all species (plant and animal) mentioned in the text are given in Appendix B.

2. The presence of the Great Horned Owl (Horvath, 1963), while possible, is believed to be based on insufficient evidence.

TABLE 1. Continued

NON-RESIDENT	
MIGRANT ONLY	IRREGULAR VISITANT
* Common Goldeneye	Hawk Owl
Barrow's Goldeneye	Boreal Owl
* Bufflehead	Yellow-Breasted Sapsucker
	Arctic Three-Toed Woodpecker
	Northern Three-Toed Woodpecker
	Purple Martin
	* Mountain Chickadee
	White-Breasted Nuthatch

Description of the Study Areas

Munro and Cowan (1947) identify 13 biotic areas in terrestrial British Columbia, basing a division on the presence of distinctive animal and plant species, and the absence of plant and animal species found in other biotic areas. Their Puget Sound Lowlands Biotic Area consists of the Fraser River Delta and the basal portions of the adjoining hills, - the vicinity of Hope, at the apex of the delta, marks its eastern boundary. As Hope is closely surrounded by mountains that rise steeply from the valley floor, this biotic area is here very limited in extent, and grades into the Coast Forest Biotic Area occupying the higher slopes. This transition is indicated by the dominance of coniferous vegetation, into which the deciduous growth common in the valley gradually intergrades at elevations above 500 feet.

The deciduous forests prevalent in the Puget Sound Lowlands Biotic Area consist of red alder, broad-leaf maple, flowering dogwood, cascara, black cottonwood, western birch, and vine maple in association. Much of this deciduous forest is of recent origin, replacing primitive coniferous stands, scattered remnants of which still remain. The rain forest of the Coast Forest Biotic Area typically has successional stages of Douglas fir, broad-leaf maple, and red alder, which are preliminary to climax forests of Sitka spruce, western and mountain hemlock, western red cedar, and grand fir. Undergrowth and litter may be extensive.

The Thacker Ecological Reservation, and its Surroundings

The Thacker Ecological Reservation is located on Little Mountain, which is northeast of the town of Hope (Fig. 2). The Reservation is approximately 180 acres in extent. The area studied, which included most of the Reservation, totalled 400 acres. The highest part of the Reservation is approximately 700 feet (216 m.) above sea level - the lowest portion, at the mountain's base, is at 160 feet (49 m.) elevation (Horvath, 1963). The Reservation is roughly transitional between the two biotic areas mentioned above, and many of the common bird species of the Puget Sound Lowlands Biotic Area breed on it.

Horvath (1963) presents the first detailed vegetational analysis of the Thacker Ecological Reservation, from which much of the following information is adapted, and to which reference should be made if a thorough description is desired.

The main study area, consisting of most of the Reservation and some adjacent areas, for purposes of vegetational description may be considered to be composed of seven subdivisions: west, south, southeast, and northeast slopes; open and heavily wooded upper portions; and a wooded flat lower area (S and T) (Fig. 3). All nest-site tables relate the nests described to the areas in which they were located.

West slope - Logging and burning (the last fire in July of 1961, and a previous severe burn in 1951) has reduced the vegetation to an early successional stage, and a large part of this slope is covered by shrubby thickets dominated by vine maple and hazel. Small sections of the canopy,

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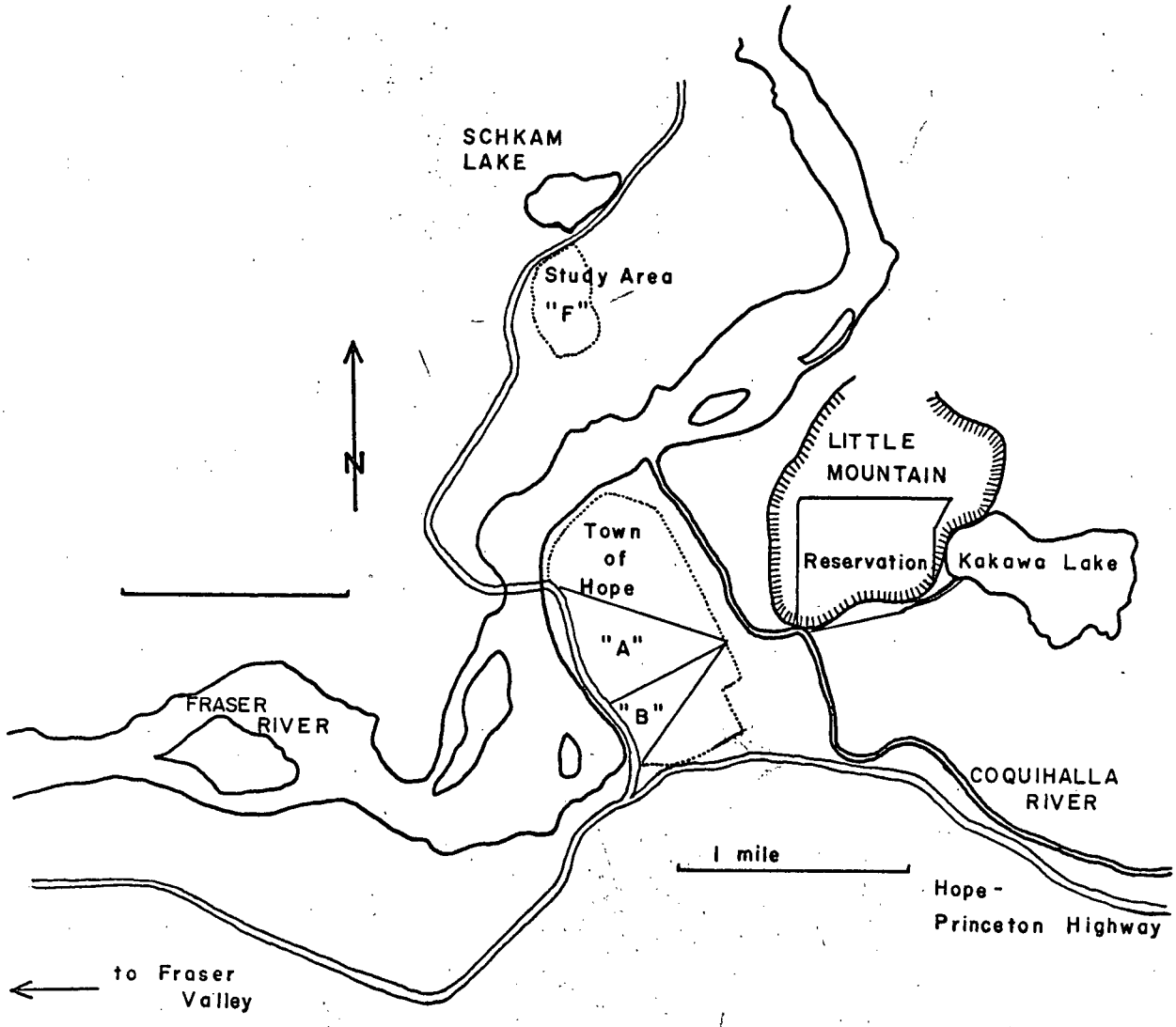

Figure 2. The region of Hope, showing the location of the main study areas.

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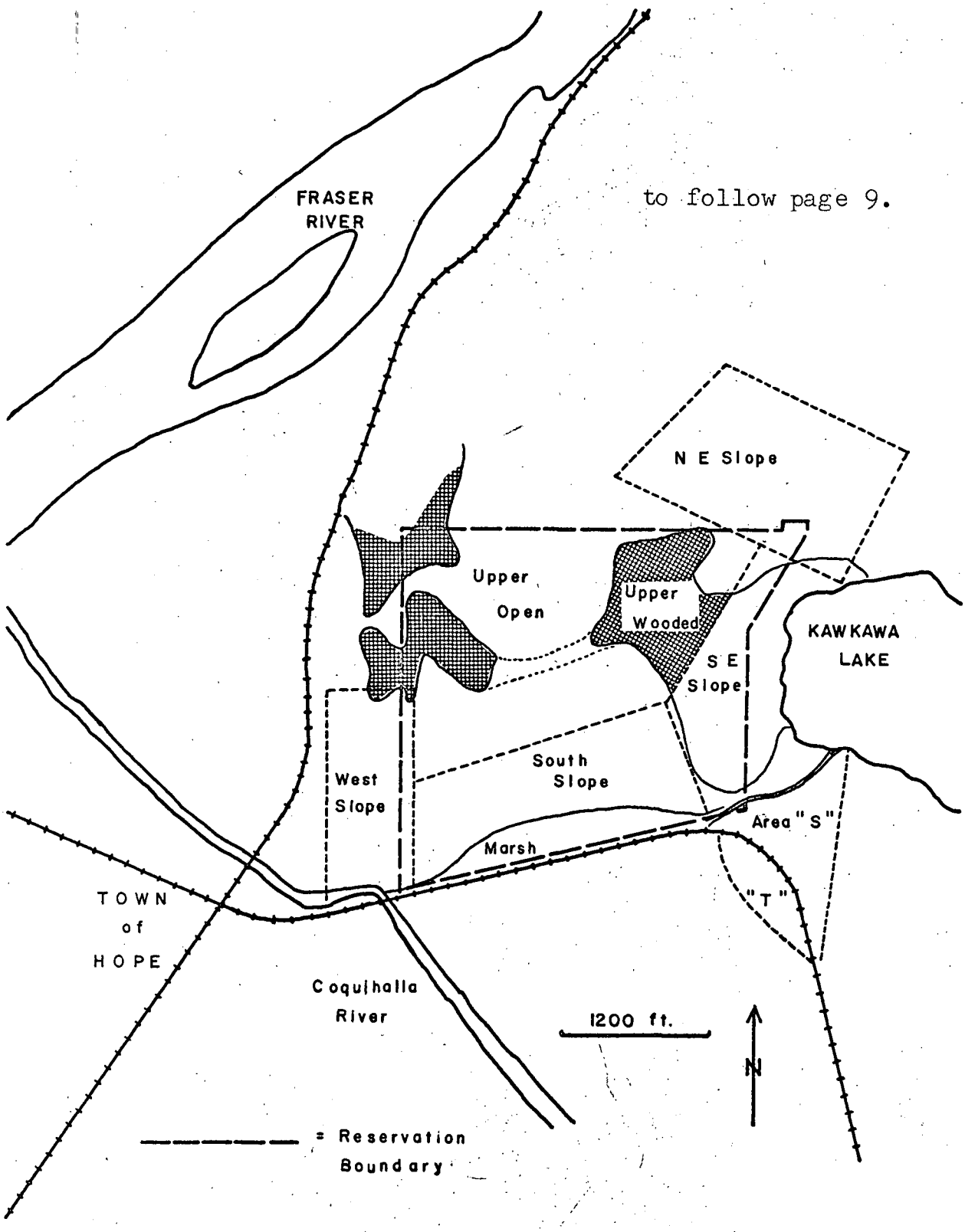

Figure 3. The main study area. Wooded areas on only the upper portions of Little Mountain have been shaded for clarity.

predominantly Douglas fir, escaped destruction, but most of the area has no overstory. Many tall snags dotted this slope before the 1961 fire, though most of them were cut down during the fire as a fire-preventive measure.

South slope (Plate 1) - This is steep, dry, and extremely rocky. It was heavily burned in 1951 and 1959. A tall, very discontinuous canopy is present over most of the slope, and is composed of commercially worthless Douglas firs, with a few broad-leaf maples and birches. A shrub layer is still developing, and is composed mainly of hazel and vine maple, with plentiful mock orange, and scattered young birch and broad-leaf maple. Most of the tall snags in the western portions were cut down at one time, but many remain elsewhere. Smaller snags of fir, maple, and birch are scattered throughout the area.

Southeast slope (Plates 2 and 3) - The vegetation on the upper slope differs from that on the lower, where soil accumulation and seepage allows a richer growth. A tall canopy of Douglas fir is almost continuous over the upper portions, being interrupted above extremely rocky areas. A very sparse understory is contributed to by broad-leaf maple and dogwood. A shrub layer, usually dense, is composed mainly of hazel, vine maple, mock orange, saskatoon berry, ocean spray, and young broad-leaf maple. The steepness of the rocky slope has restricted logging operations to peripheral portions.

The lower slope, which is less steep, supports a high, dense, mostly undisturbed canopy of ragged outline, to which

several species contribute, notably Douglas fir, western hemlock, red cedar, broad-leaf maple, and to a lesser extent, birch. Vine maple and young hemlock are plentiful understory species, with dogwood slightly less common, and young birch and cedar scattered throughout. Moss is common in areas of densest shade, and fallen branches and trunks make up an omnipresent litter.

Northeast slopes - The southern parts of this area have only small patches of canopy, made up mainly of commercially worthless firs, due to logging and a subsequent fire in 1951. Most of the northern portions were logged, but escaped burning, so that a denser coniferous canopy prevails. A stream bed runs along the bases of these slopes, and toward these moister areas a higher proportion of deciduous trees occur, until alder and cottonwood dominate on the wettest portions, which are very limited in extent.

The canopy, where it occurs, is almost entirely Douglas fir, some of the trees bearing injuries from the logging operations, which often leave many broken-topped small thin snags. Litter is extensive. On moister areas, large broad-leaf maples, birches, and clumps of vine maple are mixed with the firs. A deciduous second-growth is growing in on the open areas, and is composed of young broad-leaf maple, birch, vine maple, Douglas fir, hazel, dogwood, and willow in approximately that order of importance. This growth may be dense or sparse depending upon local conditions.

Upper Portions - The upper portions of Little Mountain, though never flat, can be considered relatively level. They

may be thought of as being bisected by an irregular belt of canopied area running from east to west, though this is practically non-existent in the middle. The majority of this canopy has not been burned in at least the last 30 years, while the open portions were burned over in 1951, after the logging operations of that year which affected most of the top of Little Mountain.

The open portions carry only a scattering of tall thin firs, which were left in small groves in places, and a few broad-leaf maple, but these are rarely dense enough to affect the undergrowth. Numerous broken-topped thin fir snags dot the entire area, but many of those in the southern portions were cut down during the 1961 fire. Second-growth successional stages compose an undergrowth varying in vigor on different sites: usually a mixture of birch, scrub willow, broad-leaf maple, hazel, dogwood, and Douglas fir, in approximately that order of importance. Young Douglas fir are common in the more open areas. This general vegetation type is modified by factors of soil and moisture, varying from extremes of a dry grass-lichen growth with a few firs, to dense 30 foot sapling groves on wetter spots.

Canopied areas on the mountain's upper portions, throughout which fir is nearly always dominant, also reflect xeric to hydric conditions. Ridges in the western part carry a high ragged fir canopy, with some young firs and lodgepole pine beneath. Moving eastward, a mixed coniferous-deciduous growth is entered, but this is interrupted in the middle of the "belt". As the swamp in the eastern portion is approached,

the fir-dominated canopy gives way to a mature growth of cedar, broad-leaf maple, alder, and birch.

Areas S and T - These areas were included mainly because their history of fire (at least two) and logging, and relative moisture, has allowed a varied habitat of predominantly deciduous growth that is ideal for Black-Capped Chickadees. Vegetation types ranged from small open grassy areas, to a dense but limited canopy of mature alder in the center of "T", and a dense mixed canopy in "S" of Douglas fir, broad-leaf maple, and birch. Young post-burning stands, predominantly of birch and willow, are extensive in each area, and provide many potential chickadee nest-stubs. Tall firs, remnants of a previous canopy, are very sparsely and irregularly distributed over the area. Area "T" especially bears numerous old tall snags.

Area F - Illustrated in Plates 4 and 5, this study area is about one mile north of the town of Hope, and is comparable to the southern portions of Little Mountain that have a similar altitude and exposure. The area (Fig. 4), which is 80 acres in extent, is quartered by two old survey lines that give the major compass points. The slope is general to the southwest. Little Mountain is approximately one mile distant.

Most of the study area was heavily burned in the spring of 1951 - the outlines of this 170 acre burn are given by the edges of the heavily canopied areas. This was the only fire since 1931, when the B.C. Forest Service's records started. The vegetation of the area is divisible into four

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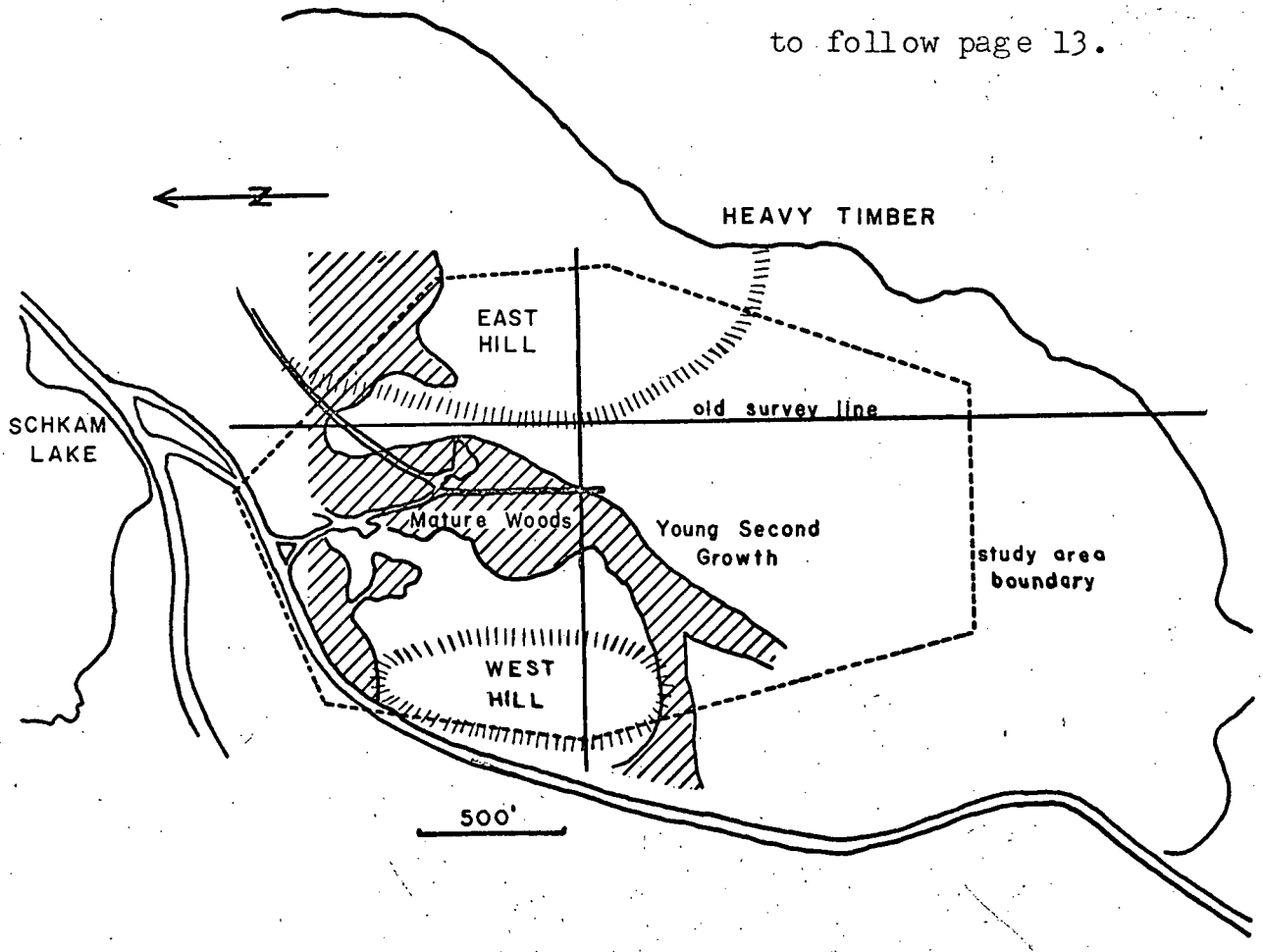

Figure 4. Study area "F".

main types, variants of which exist as permitted by soil suitability.

A large part of the southern half of the area supports a low second growth, that has established itself after the fire on the well-drained rocky soil. Only a half dozen tall living trees, and numerous tall snags, remain from the predominantly coniferous forest that once covered the area, and still exists off to the south and east. The second-growth trees are young, almost entirely deciduous, range up to 20 feet (6 m.) in height, and seldom exceed 2½ inches (6.4 cm.) in diameter. A dense growth is usual and an open scrub exists on the rockier portions. Birch and willow in approximately equal quantities make up the bulk of the vegetation; vine maple and hazel occur commonly but less abundantly, and individuals of red alder, broad-leaf maple, and young Douglas fir are scattered throughout. Both the nature of the pre-burn canopy and the intensity of the burn are likely the reasons for the absence of smaller hardwood snags and stumps, which in turn is undoubtedly why the Black-Capped Chickadee was absent as a breeding species from most of the southern half of the study area.

In wetter, lower areas of the burn, as in shallow gullies, this young second growth vegetation is more vigorous, forming a denser, taller stand. Birch predominates, and alder and vine maple are present in increased proportions, while willow and hazel are less common. Vegetation height is usually around 30 feet (9 m.). In the northern part of the area, where burning was apparently less intense, several

sections of this type bear quantities of smaller hardwood snags suitable for use by the smaller hole-nesters.

Unburned areas in the northern half of the study area, where the soil is moister and richer, support a high dense canopy of mixed coniferous and deciduous trees. They have all been modified to some extent by selective logging and occasional woodcutting, which has left some irregular openings in the canopy. The canopy is dominated by red cedar and broad-leaf maple; mixed throughout are individual tall grand firs, birches, and red alders. Douglas fir, of which only scattered individuals exist in the lower portions, is more common up the slope of the east hill, gradually becoming the most abundant canopy species. An understory, varying in height but always dense, is composed mainly of young black cottonwood, birch, broad-leaf maple, and vine maple. A thick tangled almost universal undergrowth is nearly impenetrable in places. Many of the larger deciduous trees bear dead portions, and those situated along edges provide many potential nest sites for the larger hole-nesters. The Downy Woodpecker and Red-Breasted Sapsucker nested in such situations (F-4 and F-2).

Most of the west hill supports a vegetation type different from the above, as the soil is shallow, rocky, and dry. Spotty burning on the upper portions did not affect the small area covered by thin coniferous canopy of 30 to 60 foot (9 to 18 m.) Douglas fir, and smaller lodgepole pine. Very little underbrush is present and ground cover is limited mainly to low evergreens, salal, false box, and Oregon grape.

Down the southern slope is a small area canopied by Douglas fir, and down the eastern slope of the hill stand several very tall Douglas firs, some with dead upper portions, and three tall dead fir snags. None of these were used by hole-nesters during this season. A short fir snag on the top of the hill had an unmistakable nuthatch nest from a previous year.

The Town of Hope Study Area

The portions of the town surveyed each year are indicated on Fig. 2. Both areas "A" and "B", approximately 115 acres, were surveyed during 1961. In 1962, when observations were more intensive, only the 40 acre area "B" was covered. The best description of the area is given by Plate 6, which looks toward the northeast, over the center of the 1962 study area.

The Hope-Princeton Highway Study Areas

Some of the following brief descriptions are superfluous in terms of this study's results. They are included because they illustrate the background from which conclusions were drawn and because they contribute to an understanding of the area.

This highway runs eastward into the mountains. Survey trips were taken every 7 to 10 days, during June, July, and August, 1962. The first 4 areas described were usually visited at length; the others intermittently as time allowed.

3 mile: - located 3½ miles from Hope at 775 foot (236 m.) altitude. The highway runs along a northward-facing slope, which is often very steep, the accessible portions of which

have been logged. Numerous small streams run down the slope, and the moisture, shading, and disrupted vegetation combine to create conditions generally similar to the eastern wooded upper portions of the Reservation. Here a Rough-Winged Swallow nest was located: in a tiled drain in a cement banking supporting the road.

7 mile: - located 7 miles from Hope, at 1100 foot (335 m.) elevation, where the highway runs between steep mountain slopes through a small valley. The area surveyed, along an old logging road paralleling the highway, has relatively rich moist ground, and this supports a high cedar-hemlock canopy that contains scattered trees of Douglas fir and grand fir. Small cottonwood and alder stands occur in wetter sites. Dead snags of all sizes are uncommon, except along the banks of a small river running down the valley. A dense undergrowth, almost impassible in places, covers much of the ground below the canopy. Two Winter Wren nests on low conifer branches were found here.

Old Mining Camp: - located 8½ miles from Hope at 1850 foot (564 m.) elevation. Logging and fire have greatly disrupted the habitat. Under a small highway bridge, a pair each of Rough-Winged and Violet-Green Swallows nested in tiled drain holes 30 feet (9 m.) apart (Plate 7). Three Rough-Winged pairs nested in a nearby sandy bank. Nests of Sparrow Hawks (1) and Red-Breasted Sapsuckers (1) were located at this stop.

Outram Lake: - located 10½ miles from Hope, at 2200 foot (671 m.) elevation. A tall dense undisturbed canopy exists

to the east, and is almost exclusively western hemlock, with a little cedar, and very few amabilis and Douglas fir. To the west is a heavy burn now covered with litter, felled snags, and second growth. Small Outram Lake is nearby. One nest each of Red-Breasted Sapsuckers and Chestnut-Backed Chickadees was found at the forest edge and a Hairy Woodpecker roost (?) was later located in a similar situation.

Sand Pit: - located at 2150 foot (655 m.) elevation, 15 miles from Hope. A small burn by the highway contained many potential nest-snags, in which were found nests (1 each) of Sparrow Hawk, Chestnut-Backed Chickadee, and Red-Breasted Nuthatch. One Rough-Winged Swallow pair nested in a bank. Other small areas visited infrequently were:

-24 miles from Hope, at 2650 foot (808 m.) elevation. Here Violet-Green Swallows nested semi-colonially, both in niches in rock faces and in tiled drain holes in a series of cement bankings supporting the highway.

-25½ miles from Hope, at 2475 foot (754 m.) elevation. One Red-Breasted Sapsucker nest was located here.

-28 miles from Hope, at 2950 foot (900 m.) elevation. One Pileated Woodpecker roost (?) was found here.

Pinewoods: - located 40 miles from Hope at 4000 foot (1219 m.) elevation. The lodgepole pine, and engelmann spruce-alpine fir growth here differs greatly from that on the main study areas. Nests of Tree Swallow (7+), Rough-Winged Swallow (1), Red-Breasted Nuthatch (1), Red-Breasted Sapsucker (1), Red-Shafted Flicker (2), and Flying Squirrel (1), were located in natural cavities and Violet-Green Swallow (4+), Mountain

Bluebird (1), and Starling (1), in cavities in the buildings of the Pinewoods resort.

The Upper Fraser Valley Study Areas

The roughly triangular Fraser Valley runs southwest from Hope, which is at its apex, and begins to widen appreciably where the Riverside Study Area was located.

Laidlaw Study Area: - located 10 miles from Hope on the eastern edge of the flat valley floor, which is predominantly pasture and cultivated land. The 16 acre area studied is about one-half open scrubby pasture, which is continuously grazed, and is dotted with scattered shade trees and numerous broken-topped alder snags, many of them bearing holes (Plate 8). The property's owner reported that occasional high winds caused the breakage and subsequent death of the alders. This is excellent Flicker-Starling-Swallow habitat, but the total number of holes did not appear to be fully exploited. As the Starling population increases, this type of habitat, which is very uncommon in the region, may support nest-site competition. The uncleared half of the area supports a dense 40 foot (12 m.) canopy of alder, cedar, and broad-leaf maple, with scattered large birches and cottonwoods. Nests were found of Starling (7), Red-Shafted Flicker (2), Black-Capped Chickadee (2), and Tree Swallow (5). All but one chickadee nest were in snags in the open half of the area.

Two other places were visited occasionally:

- a rock bluff by the highway 16 miles from Hope, where

one pair each of Rough-Winged and Violet-Green Swallows nested in holes drilled in the rock.

- a small highway bridge 21 miles from Hope, where 8 pair of Rough-Winged Swallows nested in 10 drain holes in the cement foundations.

The Riverside Study Area: - located 25 miles from Hope, by the bank of the Fraser River. A high 70 foot (21 m.) canopy is exclusively cottonwood; there is little suggestion of an understory. Seasonal flooding occurs on any low portions and these are usually bare of cottonwoods and underbrush, and may have low Pacific willow trees around their edges. Nests were found of Black-Capped Chickadee (1), Tree Swallow (1), Downy Woodpecker (1), and Flying Squirrel (2).

The Chapman Road Study Area: - located 28 miles from Hope, in the middle of the level valley. Impressions of the hole-nesting avifauna were gained by walking along two country roads; for approximately 4400 feet (1341 m.) along one bordering the stagnant Camp Slough, and for approximately 3000 feet (914 m.) along one running through farmlands. All suitable ground is under cultivation or pasture and trees of all sizes are found only along sloughs and ditches, around houses, occasionally along field borders and roadsides, and in whatever small orchards happen to be present. The borders of the slough carry strips of woodland, with maple, cedar, cottonwood, birch and alder growing over dense undergrowth. The farms in the area, being long-established, often have sizeable trees around the houses, and large broad-leaf maples line the roads in places. These tall bushy trees bear many

dead portions, thus providing potential nesting sites. Nests were found of Tree Swallow (1), Starling (2), and Flying Squirrel (1), and many farm buildings, which could not be inspected closely, appeared to house Violet-Green Swallows and English Sparrows.

REVIEW OF THE AVIFAUNA

Each of the observed "Resident Breeders" (Table 1) is treated separately. These descriptive sections, containing both original and published material, include such information, mainly on habitat and nest-sites utilized, and breeding habits, that defines the species in terms of nest-site competition.

Wood Duck

The appearance of a brood on Kawkawa Lake in 1960 indicated the suitability of the habitat for this species.

In 1961, the regular, though infrequent, sighting of a pair throughout May, and of a female during June and July, indicates that a nesting was probably attempted. The birds were most often flushed from the sluggish stream running between Kawkawa Lake and the marsh. Efforts to locate the nest failed, it being impossible to follow the birds very far by sight. (Wood Ducks in Illinois may nest up to one-half a mile from water, Bellrose, 1955). No young were ever seen on the marsh or the western end of the lake, so a nesting, if attempted in the area, was likely unsuccessful; or the birds may have nested at a distance (as across the lake), coming to the stream to feed.

In 1962, Wood Ducks (up to five pair at once) were flushed from the marsh and stream almost daily until the middle of May. The remainder of the summer yielded only three more sightings of lone birds; two in July and one in August.

Here at the head of the Fraser Valley, the preferred

habitat type (Bellrose, 1955, among others) is uncommon, tree-lined sluggish streams and sloughs being much more plentiful as the valley widens. There may be a shortage of nesting sites in the study area, although at least one suitable cavity existed in 1960. Three Pileated Woodpecker excavations (inaccessible, so suitability undetermined) were found within 900 feet (274 m.) of the stream. The scarcity of suitable habitat in the studied areas, plus a possible shortage of nesting cavities, will keep the Wood Duck population density low. It is not known whether competition for nest sites is a contributing factor - if so, it operates after the bird's habitat selection mechanisms have been expressed.

Hooded Merganser

The Hooded Merganser is a resident in this district (Brooks, 1917; Brooks and Swarth, 1925; Munro and Cowan, 1947). There are no records from the Fraser Valley in the B.C.N.R.S.[1].

On May 11, 1961, a pair was seen on Kawkawa Lake. This constituted the only record of the study.

Sparrow Hawk

In 1961, two pair of Sparrow Hawks were present throughout the summer months, and though no nest sites were located,[2].

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[1]. British Columbia Nest Records Scheme, Department of Zoology, University of British Columbia, Vancouver, B.C. Reference is made only to nests found in British Columbia. Data from this study have not been included in any nest totals given.

[2]."Nests" of Horvath (1963) refer to fledgling groups.

the appearance of fledglings indicates successful breeding. One pair concentrated their activities along the western slope of the Reservation, moving with their fledged young (first seen on June 28) to the southern slope after the fire of July 1-4. Members of the other pair were regularly seen in area "T", and it might be supposed that nesting took place here (as it did the following year).

In 1962, again two pair of Sparrow Hawks occupied portions of the Thacker Ecological Reservation, and both nest sites were located. Brief notes on these, and three other nests, follow.

Nest T-4: The nest site was discovered on May 6, when the male was seen to enter it. Although many apparently suitable sites were present in near-by snags, on which these birds spent a great deal of their time, they were never seen to express interest in them; apparently nest-site selection had already taken place. On July 7, young hawks were heard from the nest, and on July 15, they were seen outside it.

Nest I-4: Red-Shafted Flickers nested here in 1961, and while the hole was undoubtedly dug by Flickers, when this was done is unknown. In 1960, Red-Shafted Flickers reared a brood in a nearby hole (Horvath, personal communication) which went unused in the following summers. Sparrow Hawks were rarely seen in this area during 1961.

On May 5, the pair was seen copulating in the vicinity, and later the female entered the hole for a few seconds. The male meanwhile briefly investigated another hole in a nearby snag. Young were still in the nest on July 20.

A third nesting occurred on the experimental area, the birds surviving for reasons detailed in the section describing the experiment. The pair was present in the area when observations started in May. On May 10, the pair copulated in a tree on the south hill, and shortly after, the female closely inspected a vertical split in the top of a thick, broken-topped, Douglas fir snag. On May 14, the male was seen looking in the future nest cavity; he then mounted the nearby female. Young were still in this nest on July 27.

Two additional nests were discovered on July 25, during a survey trip up the Hope-Princeton Highway. Altitudinally located at 1850 feet (564 m.) and 2150 feet (655 m.), they both contained young on this date.

The fledged young seen on June 28 in 1961 apparently resulted from an early nesting, in which nest-site selection must have been completed by early April. Generalizing from the above data, it can be concluded that in this area Sparrow Hawks will be initiating the site-selection process by at least the beginning of May. ("Actual dates in any locality are probably dependent largely on local weather conditions." Roest, 1957).

Their habitat is: "Typically, open terrain such as plains, deserts, fields, meadows and unforested portions of mountain-sides, where ground surface affords adequate prey-supply, but only where perching places are present." (Grinnell and Miller, 1944).[3] From at least the middle of April on,

3. Data from "The Distribution of the Birds of California" is frequently included, as it is a major distributional publication dealing with the western North American avifauna.

suitable habitat, which is widespread throughout the valley, must possess unoccupied Flicker-sized (or larger) holes in sufficient quantity to house the nests of rather widely separated (in relation to the number of potential sites available) pairs of Sparrow Hawks. Competition for holes with other species can be imagined in only the rarest of cases. Cade (1955) reports that the only area defended during the nesting period is the immediate vicinity of the nest, and Roest (1957) did not observe territoriality among breeding pairs (cf. Nagy, 1963). No limits can be set to the Sparrow Hawk's radius of activity from this studies' observations, though individuals were frequently seen making flights of several thousand feet. Enderson (1960) found the average maximum diameter of the home range of four breeding pairs in Illinois farmland to be 1.4 miles. Comparing the ranges of the pairs on the Reservation in 1961 and 1962 implies that the species is not utilizing all of the potentially suitable habitat. The population density of the species in both summers approximated 0.5 pairs per 100 acres.

Table 2 presents details on the nest sites found. Bent (1938), McLaren (1963), and Roest (1957), among others, give additional data.

Hole-nesting Owls

None was observed during the study. Horvath (1963) in the summer of 1960 found a newly-fledged Pygmy Owl brood on the northeast slope of the Reservation, but no nest site was located.

TABLE 2. SPARROW HAWK NESTS

NEST NUMBER	TREE SPECIES	TREE HEIGHT	HOLE HEIGHT	DBH	DHH	SOURCE	REMARKS
I-4	D. Fir	33* (10.0)	32* (9.8)	26.5 (67.3)	14* (35.6)	U (typ-RSF)	Red-Shafted Flicker, 1961. Sparrow Hawk, 1962. Lower NE slope.
T-4	D. Fir	40* (12.2)	20* (6.1)	46.3 (117.6)	40* (101.6)	U	1962. Area "T".
F-6	D. Fir	55* (16.8)	45* (13.7)	59.5 (151.1)	24* (60.9)	U	1962. Area "F".
HPH 9 Mile	Western Hemlock	75* (22.9)	74* (22.6)	32.3 (82.0)	10* (25.4)	U	1962.
HPH 15 Mile	-	55* (16.8)	35* (10.7)	-	-	U	1962.

Legend for Tables 2 to 8:

TREE and HOLE HEIGHTS - given in feet (upper number) and meters (lower number).

DBH and DHH - given in inches (upper number) and centimeters (lower number).

DBH - the diameter of a tree trunk measured 4½ feet above ground level.

DHH - the diameter of a nest tree measured at the cavity entrance.

SOURCE - the excavator of the cavity.

* - an estimated measurement. Due to snag inaccessibility, many measurements were estimated, and while they consequently lack accuracy, they still have comparative value.

Legend for Tables 2 to 8 - Continued

U - source unknown.

(typ) - appearance of entrance is typical of, and suggests excavation by, the resident species or a species indicated (as above).
Other cavities not so marked may still have been produced by the occupants.

HPH - Hope-Princeton Highway. Mileage refers to distance from Hope.

RSF - Red-Shafted Flicker.

RBS - Red-Breasted Sapsucker.

DW - Downy Woodpecker.

HW - Hairy Woodpecker.

BCC - Black-Capped Chickadee.

CBC - Chestnut-Backed Chickadee.

RBN - Red-Breasted Nuthatch.

Red-Shafted Flicker

Regional lists indicate that the Red-Shafted Flicker is, and has been, a common resident in the Fraser Valley.

Horvath (personal communication) located two nests on the Reservation in 1960. Four nests were located on or near the Reservation during 1961.

Data on 12 nests, six on or near the Reservation, were gathered in the 1962 season. Table 3 lists information only on those nests found in the valley.

Summarizing very generally, Flickers excavate their nest sites in late April and early May, and fledging occurs in the latter half of June. The B.C.N.R.S. provides little information from the area. This timetable may be varied greatly by individual pairs, as illustrated by the following example.

On April 30, 1962, a pair was excavating in 14-2, at an inaccessible spot where an old small hole had been the previous year. Work was well advanced at this date. Inconclusive sightings in the area followed, and on May 22, the pair was seen in the vicinity of 2-15-1. No excavation had started, but on the next visit on May 26, the female was flushed from a new cavity. Young were looking out of the nest on June 29, and had left it by July 7. Production of unused cavities was noted in connection with two other nestings in 1962 (cf. Happ, 1935).

Although the species is a permanent resident (Munro and Cowan, 1947) the status of wintering individuals is unknown. Happ (1935) is similarly vague concerning the post-breeding

TABLE 3. RED-SHAFTED FLICKER NESTS

NEST NUMBER	TREE SPECIES	TREE HEIGHT	HOLE HEIGHT	DBH	DHH	SOURCE	REMARKS
12-20	D. Fir	40 (12.2)	39.5 (12)	18.6 (47.2)	7 (17.8)	U (typ)	1961. Top West slope.
16-1	D. Fir	24* (7.3)	22* (6.7)	11.3 (28.7)	-	U (typ)	1961. Top West slope.
I-4	D. Fir	33* (10)	32* (9.8)	26.5 (67.3)	14* (35.6)	U (typ)	1961. Bottom NE slope. Sparrow Hawk in 1962.
N-1	D. Fir	75* (22.9)	71* (21.6)	-	7.5* (19)	U (typ)	1961. Bottom SE slope.
M-2	Alder	35* (10.7)	34.5* (10.5)	19 (48.3)	10* (25.4)	RSF	1962. Marsh. Abandoned for 2-24-1.
2-24-1	D. Fir	85* (25.9)	84* (25.6)	42.3 (107.4)	16* (40.6)	RSF	1962. Bottom South slope.
2-15-1	D. Fir	12.5* (3.8)	9.7 (3.0)	19.8 (50.3)	19.5 (49.5)	RSF	1962. Top West slope.
14-2	B. Maple	28* (8.5)	21* (6.4)	17.8 (45.2)	13* (33)	RSF	1962. Upper open portions, abandoned for 2-15-1.
15-11	D. Fir	20* (6.1)	18* (5.5)	16.7 (42.4)	12* (30.5)	RSF	1962. Top West slope.
F-7	D. Fir	23* (7)	22* (6.7)	14.2 (36)	9* (22.9)	RSF	1962. Area "F". Nest of first pair.

TABLE 3. Continued

NEST NUMBER	TREE SPECIES	TREE HEIGHT	HOLE HEIGHT	DBH	DHH	SOURCE	REMARKS
F-9	D. Fir	25* (7.6)	22* (6.7)	20.8 (52.8)	15* (38.1)	RSF	1962. Area "F". Nest of second pair.
2-S-2	B. Maple	43* (13.1)	40* (12.2)	24.8 (62.9)	11* (27.9)	U (typ)	1962. Area "S". Abandoned.
Laidlaw	Alder	9.1 (2.8)	7.6 (2.3)	8.9 (22.6)	8.8 (22.4)	U (typ)	1962.
Laidlaw	Alder	28* (8.5)	15* (4.6)	17.2 (43.7)	14* (35.6)	U (typ)	1962.

movements of the Yellow-Shafted Flicker in the eastern United States. It is possible that breeding birds remain in this region the whole year, although migration does occur through the Fraser Valley (Udvardy, personal communication).

Flickers are highly territorialistic in early May, but much less so toward the end of the month. Birds in adjoining territories may respond to one another, but it is more common for a bird to advertise alone. However, territories are presumably well-established by May, and more conflicts may occur earlier in the season. Exact territorial boundaries could not be determined from the observations made. Happ (1935), believed that Yellow-Shafted Flickers did not behave territorially with regard to treeless areas, which were used as common feeding grounds. He also found widely varying territory sizes, with the larger territories located in poorer habitats.

That territorialism is operative in this species was illustrated by the experimental results. Area "F" was inhabited by one pair of Red-Shafted Flickers, the members of which were seen at one time or another in every portion of it, and sometimes were traced beyond its boundaries. Observations on this pair showed that they ranged over a minimum of 100 acres. (The only neighbouring flicker known was occasionally heard in the distance, far to the south). On May 15, they were seen investigating an old hole in the top of a 60 foot (18 m.) fir snag, and on May 19, a hole, still being excavated, was discovered (F-7). The birds were collected on May 28. On June 7, a pair of Red-Shafted Flickers

was found excavating a new hole (F-9). The male was giving high-intensity high calls, and later copulation was seen. The female was at the nest on June 22, but the success of this nesting was never determined. Flickers continued to be heard throughout the area during the remainder of the summer.

The Red-Shafted Flicker is an "edge" bird (Grinnell and Miller, 1944; Weydemeyer and Weydemeyer, 1928). It is typically associated with open areas that bear soft tree trunks of sufficient size for nesting. The Fraser Valley floor contains much edge-type habitat due to man's activities, and the Flicker attests to its suitability by remaining abundant.

In the preferred habitat, apparently territorialism can have some effect on the spacing of the pairs. This was implied from observations on the southern and western portions of the Reservation where in 1962, three pairs concentrated their activities in an area of approximately 80 acres. Additional support was given by the experimental results reported above, obtained on an area that had little open ground, and where the original pair had only one known distant neighbour. The average population density obtained both summers on the Reservation and its surroundings was one pair per 100 acres and comparison of the ranges used in each year suggests that the available habitat was not being utilized to the maximum.

Douglas fir snags are most commonly utilized for nesting (Table 3), and are very abundant wherever logging or burning has occurred. The Flicker's adaptability regarding its nest sites is well-documented (cf. Bent, 1939; Grinnell and Miller, 1944), but here little variation was observed, the

drilling of a hole (during 1960) under the eaves of a city building being the only example of "aberrant" nesting behavior. The hole is usually placed close to the top of a broken snag of suitable thickness, and as most of the fir snags are of considerable height, the nest is rarely close to the ground. In the few nests located, the hole almost invariably faced away from the prevailing wind direction. Entrance flyway requirements are presented by Erskine (1960) and McLaren (1963); the "bounding" flight habit limits the bird's manoeuverability, and requires a certain amount of height, so usually the holes face a clear area, and are well above obstructions, especially since the birds often "stall-in" to the nest in an upward swoop.

While excavation was detected (as by fresh chips) at 10 of the 16 sites, all but one had the appearance of fresh cavities (not counting two small ones known to have been enlarged), and it is believed that a new hole is usually produced for each nesting.

Bent (1939), Happ (1935), McLaren (1963), among others, present data on nest dimensions.

Little is known of roosting habits, and though holes are not required (Happ, 1935), they may be excavated solely for this purpose (Bent, 1939).

Pileated Woodpecker

In spite of its regular occurrence, very little information was gathered on the species. No nests were found, and the sighting of two Pileated Woodpecker on the edge of the marsh on July 27, 1962, was the only time two birds were seen

together. During the breeding season, observations were limited to sightings of single birds, and were completely unpredictable in time or location. The birds were rarely viewed for any length of time, as they range widely, move quickly, and usually remain silent. Attempts to follow individuals invariably failed. How many birds contributed to the observations is unknown, and details on territory size, preferred habitat and nest sites, and other breeding habits in this region could not be obtained.

Two observations regarding cavity production were made in 1962. On July 20, a juvenile male was found excavating a hole (on the experimental area "F"). It was just started in the top of a broken-off 30-foot (9 m.) birch, and on July 27 the hole was found to have been continued through to the other side, as the snag was thin here due to a portion of it splitting away. On July 9, at 2950 feet (900 m.) altitude 28 miles east on the Hope-Princeton Highway, a Pileated was starting a hole 21 feet (6.4 m.) up in a 25-foot (7.6 m.) cedar snag. A full size entrance was seen on the next trip.

Lewis Woodpecker

One pair resided on the Reservation during the summer of 1960, perhaps breeding, although a nest site was not located (Horvath, 1963). They were always seen on the southern slopes, in keeping with their known preferences for open forests, old burns, and logged-over areas (Grinnell and Miller, 1944).

The following two summers yielded only one observation;

that of an adult on May 27, 1961, by Horvath (personal communication).

Red-Breasted Sapsucker

In 1960, Horvath (personal communication) located two Red-Breasted Sapsucker nests, and new holes were excavated in the same snags during the following spring (W-2 and I-2).

W-2 contained five other cavities, apparently old Sapsucker workings, that were never used by other birds. It was close to the cabin used during 1961, and was passed several times a day. Yet July 1 was the only time drumming was heard, when one bird drummed near the now-empty nest. The birds were very quiet and secretive, and except when they were feeding young, were located mainly by an occasional contact call (Kilham, 1962a). They were known to range up to 1150 feet (350 m.) from the nest. They apparently lived in complete isolation from other Sapsuckers.

I-2 contained three other Sapsucker-sized openings, all of which were unused. The only drumming definitely attributable to this pair also was detected on July 1, from a position near the now-empty nest. The bird was responding to an unbanded drumming Sapsucker 400 feet (122 m.) away, who remained unidentified and was not seen again. The adults ranged up to 750 feet (229 m.) from the nest, and most of the feeding was done in a grove 575 feet (175 m.) distant. As their territory was near the edge of the area regularly surveyed, there is a geater chance that these birds had neighbours of the same species. If so, they gave no indication of it.

At this nest, the adults and young were color-banded. The only sighting of any of the young occurred on August 21, when two of them, in company with two other unbanded young Sapsuckers, were found feeding in a grove 860 feet (262 m.) away from their birthplace. One of the adults was found dead in February, 1962, at the same co-ordinates, illustrating its non-migratory status (Howell, 1953). The other adult was seen once the following year, on May 8, 1100 feet (335 m.) from the now-fallen I-2. As the area in which it was seen was used by another pair of Sapsuckers in 1962, it probably moved off the study area entirely.

In 1962, the range of the pair at W-2 was better known, the birds travelling at least 1500 feet (457 m.) to the east of the nest, and 1150 feet (350 m.) to the west. Of interest was their feeding at a small group of thin Douglas firs 1500 feet (457 m.) from the nest. They were seen here regularly until the middle of May, and cessation of the habit was probably due to the demanding nesting activities. There was no apparent reason why these trees, which were used extensively, should have been selected from the thousands available. When feeding the young, repeated flights of 900 feet (274 m.) were undertaken. Again there were no neighbouring Sapsuckers.

In area "F", the single pair present had started two cavities in F-2 by May 14, 1962, when they were collected. Although the area was visited frequently during the next two weeks, the first indication of new arrivals came around

9 P.M. on June 3, when two Sapsuckers called briefly at the north end of the study area, presumably just before roosting. At 5 A.M. the following day, a Sapsucker began drumming on a resonant branch of F-2, and at 5:13 A.M. was joined by a second bird, which flew from the roosting area after the drumming bird gave several breeding calls (Kilham, 1962a). At 5:25, drumming was performed on an exposed insulator support on a telephone pole by the old highway, the bird then flying towards F-11, where excavation was to be seen at a later date. On June 7 and 11, birds were seen at F-2, but whether additional digging was done at either of the already-started holes is unknown. Drumming at high intensity (which made this pair exceptional) was continuing on June 22, when the pair was seen at a cavity being excavated in F-11, the working bird being able to enter about half the length of its body. Constant drumming was continuing on July 1. On July 20, tapping on the favorite pole elicited an answering drum (only with this particular Sapsucker did such imitations ever "work"), and one adult, accompanied by two juveniles, was located nearby. These birds were seen again on July 27 and August 9. While the presence of juveniles might be indicative of an un-located successful nesting by this pair, it did not occur on the study area, as the vocalizations of the nestlings would certainly have been heard. Also, the pair behaved rather abnormally, exhibiting continual drumming, and excavation, at a time when Sapsucker fledglings are appearing. The 1961 observation on the four juveniles reported above illustrates that juveniles may wander onto

strange territory, where other juveniles may constitute a social attraction. Howell (1952) reports how a begging juvenile Sapsucker was attacked by adults engaged in feeding their own unfledged young. "The juvenile obviously reacted to these adults as it would to its own parents, even after it was attacked." A similar explanation likely accounts for the appearance of juveniles under these conditions.

The Red-Breasted Sapsucker is a permanent resident. What relation the breeding territory has to the winter range is unknown. It was found that the birds are paired, and nest-site selection is accomplished, by the beginning of May, and that very little territorialism is shown at this time, most drumming being heard during a brief period after the young have left the nest. In the area studied, the population level, calculated at 0.5 pairs per 100 acres in each season, did not appear to be high enough to demand maximum utilization of the available habitat. Yet the elimination experiment suggested that the presence of Sapsuckers in an area prevents others from establishing themselves there.

Howell (1952) found that Sphyrapicus varius daggetti and S. v. nuchalis generally defended areas around their nests to a radius of 150 to 225 feet (45 to 68 m.) and that the birds would range far beyond these limits, up to 600 or 900 feet (182 to 273 m.) provided that another territory was not encountered. Territory sizes appeared to depend on how heavily the area was wooded with smaller territories held in denser groves. He also found that nesting Sapsuckers exhibited aggressive behavior principally toward others of

their own species and other similar-sized Woodpeckers. Non-picids were not attacked, even though they attacked the Sapsucker. Kilham (1962a) found a high level of territorialism in the eastern race of this Sapsucker - in one case this apparently contributed to the neglect of breeding duties.

Guiguet (1954) reports that in 1946 and 1947, the Red-Breasted Sapsucker was one of the commonest birds on the Queen Charlotte Islands, but in 1952, it was not recorded there. B. Foster (personal communication) who spent the summers of 1960 and 1961 investigating the fauna of the Queen Charlottes, never saw a Sapsucker during this time. Nothing is known about these population fluctuations. Possibly the density recorded on the study areas represents a "low".

The Red-Breasted Sapsucker tends to choose a dead tree in an "edge" situation for a nest site. The hole will be in the most open side of the trunk and that part of the tree containing the nest will be free of obstructing branches, and will be several feet higher than the immediate surroundings. In this area, dead maples are preferred (Table 4), likely because a few years after death the entire inner portion of the trunk becomes very soft and spongy, the exterior layer remaining relatively hard. Prominent features of suitable habitat will be nesting snags as described, stands of living trees, and possibly nearby clear areas, for when feeding young, these birds may take insects on the wing for hours at a time, demonstrating the importance of this food source. The above conditions are widespread along the edges of the valley, and why the birds are not more common is unknown.

TABLE 4. RED-BREASTED SAPSUCKER NESTS

NEST NUMBER	TREE SPECIES	TREE HEIGHT	HOLE HEIGHT	DBH	DHH	SOURCE	REMARKS
W-2	B. Maple	55* (16.8)	33* (10)	30.5 (77.5)	-	RBS	1961. Bottom SE slope.
W-2	B. Maple	55* (16.8)	30* (9.1)	30.5 (77.5)	-	RBS	1962. Bottom SE slope.
I-2	B. Maple	25* (7.6)	20* (6.1)	12 (30.5)	-	RBS	1961. Lower NE slope.
2-N-1	B. Maple	45* (13.7)	25* (7.6)	12.5 (31.8)	7.5* (19)	U (typ)	1962. Near Reservation. Similar to NE slope.
F-2	B. Maple	55* (16.8)	45* (13.7)	22.3 (56.6)	11* (27.9)	RBS	1962. Area "F".
F-11	D. Fir	65* (19.8)	50* (15.2)	45 (114.3)	30* (76.2)	RBS	1962. Area "F".
HPH 9 Mile	Western Hemlock	60* (18.3)	50* (15.2)	-	-	U (typ)	1962.
HPH 10 Mile	Western Hemlock	125* (38.1)	70* (21.3)	37.8 (96)	20* (50.8)	U (typ)	1962.
HPH 25 Mile	Cotton-wood	70* (21.3)	60* (18.3)	33.2 (84.3)	10* (25.4)	U (typ)	1962.
HPH 40 Mile	Engel. Spruce	80* (24.4)	58* (17.7)	34 (86.4)	23* (58.4)	U (typ)	1962.

Capable of digging their own nests, they apparently always do so (Kilham, 1962a). On the Reservation, this occurs in late April and early May; young fledge during the last week of June. Measurements of typical excavations are given by Bent (1939), and Howell (1952), and apparently the cavities are enlarged during nesting (Kilham, 1962b).

Hairy Woodpecker

In 1960, Horvath (1963) found the species on the Reservation, though no nests were located.

In 1961, only one of the two nesting attempts located on the Reservation was successful. The nests were approximately 3500 feet (1066 m.) apart. Fledging occurred at I-3 on June 9. Activities of the other pair were concentrated at 11-3 on May 14; the hole was later found to be a shallow "start". On May 30, the birds were at a fresh excavation (inaccessible) in 12-3, 230 feet (70 m.) away. Nothing resulted, and the birds were subsequently seen in the area only intermittently.

Three of the four nests located in 1962 supported the generalization of Guiguet (1954) that the young of this single-brooded species usually fledge by June. The fourth nest held fully-developed young on June 29.

Nest-selection and excavation was not seen, as this usually occurs prior to May.

A permanent resident, the Hairy Woodpecker maintains its territory and pair-bond throughout the year (Kilham, 1960; Staebler, 1949). Drumming is considered a courtship activity by Staebler (1949); Kilham (1960) has shown it also functions in pair-formation, and possibly territorialism.

Drumming was heard infrequently during this study, as it becomes rare: - just before excavation starts (Kilham, 1960); - after excavation starts (Kingsbury, 1932); - after the hatching of the eggs (Staebler, 1949).

Two intraspecific conflicts, characterized by prolonged dance display (Kilham, 1960; Skutch, 1955), and presumably territorialistic, were observed, one during each year. The places where they occurred were approximately 400 feet (122 m.) apart - two females were involved in 1961; two males in 1962.

Staebler (1949) found that a Hairy Woodpecker pair ranged over an 800 acre territory in winter, a figure with which Dennis (1951) agrees, and when foraging for their nestlings would travel up to 900 yards (823 m.) from the nest, frequently making 200 to 400 yard (183-366 m.) trips. In the study area, the Hairy Woodpecker was judged to range at least as widely, for even though no birds were marked, they were often seen making flights involving hundreds of yards, and doing this repeatedly, as when foraging for nestlings at a favored but distant location. The species occurred in population densities of 0.5 and 0.75 pairs per 100 acres in the respective seasons.

The experimental results from area "F" concerning this species are reported later, and possible reasons for their inconclusiveness are outlined.

The sighting of one of the color-banded young from I-3 on August 25, 1961, 11 weeks after fledging, provided a little information on dispersal. This bird was in the company of three adults, a male and two females, 3300 feet (1006 m.)

from its birthplace. The two females later became involved in a territorial conflict.

Grinnell and Miller (1944) describe the habitat of Dendrocopos villosus harrisi (the subspecies resident in this area) as edges, logged areas, and burns of coniferous forest, with Douglas fir being preferred for foraging. The nests (Table 5) found during this study were in dead trees, and the appearance of each suggested recent excavation. All of them faced open areas that allowed unobstructed access and they were also alike in that they were positioned at a considerable height above the underlying vegetation.

Capable of digging their own holes, they always do so (no references to the contrary). Typical nest sites are dimensioned in Bent (1939) and Staebler (1949).

After the completion of breeding, it may be common for new roost holes to be excavated. Three such sites were located (Table 5), and although roosting was observed in only one of them, the other two were not watched enough to eliminate the possibility. As little is reported on similar occurrences, greater detail is presented.

21-6. Located on July 16, 1961, because of the fresh chips littering the vegetation beneath. The bird roosted in the hole on July 19, and was frequently heard calling when entering or leaving it in the evenings or mornings during the remainder of the summer. It commonly came from the slopes to the west, and it is believed, though proof is lacking, that it was one of the birds involved in the unsuccessful nesting attempt at 12-3. During 1962, the cavity-bearing portion

TABLE 5. DOWNY AND HAIRY WOODPECKER NESTS

NEST NUMBER	TREE SPECIES	TREE HEIGHT	HOLE HEIGHT	DBH	DHH	SOURCE	REMARKS
Riverside	Pacific Willow	22* (6.7)	20* (6.1)	14.2 (36)	5* (12.7)	U (typ)	Downy woodpecker. 1962. Riverside Study Area.
F-4	Alder	50* (15)	45* (13.7)	16.5 (41.9)	8* (20.3)	DW	Downy woodpecker. 1962. Area "F", unburned portion.
I-3	B. Maple	55* (16.8)	17* (5.2)	13.7 (34.8)	11.2 (28.4)	U (typ)	Hairy woodpecker. 1961. Bottom NE slope.
12-3	B. Maple	45* (13.7)	32* (9.8)	12.6 (32)	9* (22.9)	U (typ)	Hairy woodpecker. 1961-62. Upper open portions. Two nearby holes, one dug each year.
2-6-1	B. Maple	30* (9.1)	18* (5.5)	-	-	U (typ)	Hairy woodpecker. 1962. Upper open portions.
P-1	D. Fir	48* (14.6)	46* (14)	14.1 (35.8)	8.5* (21.6	U (typ)	Hairy woodpecker. 1962. NE slope.
F-8	D. Fir	70* (21.3)	66* (20)	30.2 (76.7)	15* (38.1)	U (typ)	Hairy woodpecker. 1962. Area "F", burned portion.
21-6	Birch	40* (12.2)	37* (11.3)	9.9 (25.1)	7 (17.8)	HW	Hairy woodpecker. 1961. Roost. Lower SE slope.
2-M-1	Alder	40* (12.2)	35* (10.7)	14.5 (36.8)	7* (17.8)	HW	Hairy woodpecker. 1962. Roost(?) Marsh.
HPH 10 Mile	Western Hemlock	23* (7)	21* (6.4)	17.3 (43.9)	15* (38.1)	HW	Hairy woodpecker. 1962. Roost (?)

fell, and the hole was found to be dimensioned as a typical nest.

2-M-2. - was discovered on June 9, 1962, when a pair of Hairy Woodpeckers which had just successfully raised a brood in 12-3 (young in the nest on May 31), were found paying a great deal of attention to the upper dead portion of a 40 foot (12m.) red alder in the western wooded end of the marsh. Excavation had barely started on this date, and eventually a full-sized hole appeared, though the completeness of the cavity was never checked. Once when the female displaced the excavating male, the male left the site in "Floating Flight", a display considered by Kilham (1960) to be connected with pair formation, and then given only by the female. This introduces the possibility that digging of holes at this time is connected with a recrudescence of sexual activity in this single-brooded species.

A male was discovered at a freshly-started hole on June 19, 1962, near Outram Lake. Inaccessible, it was also apparently completed. It was drilled near the top of a 23 foot (7 m.) snag, which was located on the edge of the dense forest in a hollow down below the level of the nearby roadway. Rather than facing the open half of its surroundings, the hole instead was aligned toward a narrow flight path between the branches of two adjacent trees.

All three of these holes were situated in sheltered locations, quite the opposite from those in which nest sites were typically located.

Downy Woodpecker

Horvath (1963) did not find the species on the Reservation in the summer of 1960.

Their occurrence here in the 1961 summer was limited to a few sightings in late July and early August which involved both adult and juvenile birds. A juvenile was seen on July 17 excavating very briefly at 12-26 (Table 8), where a hole had been drilled sometime after the snags in the area were surveyed on June 2. Presumably a roost, it was used the following summer by re-nesting Red-Breasted Nuthatches, who excavated additional material.

Observations scattered throughout the 1962 season suggest that Downy Woodpeckers nested on or near the Reservation, though certainly not on the portions surveyed. Two nests were located, one on the experimental area "F", and the other on the Riverside Study Area (Table 5).

The pair on the experimental area was discovered on May 4, and the male was found excavating a nest (F-4) on May 10 (about five percent complete). No neighbouring Downies were known; that the studied pair was very secretive supported this fact. Very occasionally one of the birds would make a trip down the center of the gulch, stopping to drum on resonant branches; the rest of the time their position was discovered only by accident, and their territorial limits could not be determined. The female of the pair on the study area was shot on May 15, and although the male was intensively hunted during the next two weeks, he was not seen again and the area apparently remained devoid of Downy

Woodpeckers for the rest of the breeding season. On June 7, a drumming and calling Downy was heard in the distant timber to the east of the study area. On July 13, a Downy was heard drumming lightly and briefly on at least three snags in the old nest-site area: identified by an occasional call, it could not be seen to determine its sex, and was soon lost. During a trip on August 9, a Downy was heard calling briefly from the same area - again it was not seen. The absence of any reaction after the nesting disruption was likely due to a lack of neighbours occasioned by unsuitability of the surrounding habitat.

Young were being fed in the nest in the Riverside area when it was discovered on June 10: they had left the nest by June 16, the date of the next visit.

Considered to prefer deciduous woodland, the Downy Woodpecker is more common in the lower half of the Fraser Valley (Brooks and Swarth, 1925; personal observation). It may be termed an uncommon resident of the Hope region. That it is not more abundant in the surrounding mountains is indicated by its rarity in Manning Park (Carl, Guiguet, and Hardy, 1952; Anon., 1960).

Aspects of the species' nest sites are outlined by Bent (1939) and Staebler (1949). The latter author found that nests, averaging 15 feet (4.6 m.) high, were placed in dead trees. One brood per year is raised, always in a cavity freshly excavated by the birds themselves.

Fresh holes are also excavated on an individual basis in the fall for winter roosting (Kilham, 1962c); details on

their size and placement are unrecorded.

The Violet-Green Swallow, Tree Swallow, Starling, English Sparrow, and House Finch, though nesting in the area, did not occur as nesting species on the Reservation or area "F"; therefore a separate section (The Town Study Area) is devoted to their treatment.

Black-Capped Chickadee

The resident status of this species facilitates the early inception of breeding activities. The winter flock gradually disappears as pairs are formed, some of which drift away in search of suitable habitat, and probably not establishing a territory until a suitable nesting site is found (Odum, 1941a). Brewer (1961) refers to a permanent pair-bond. Five territories, four of banded birds, on which most of this study's observational work was done, averaged 8.6 acres (7.4 to 10.4). Territories are sometimes patrolled by the male or the pair, when the territorial call is given more often. Conflicts, always vocal but rarely physical, may occur along mutual boundaries. Of interest were two isolated observations of males, deep within their own territories, alternating "fee-bee" calls with neighbouring males, who were so far in the distance that they could just barely be heard under the prevailing still-air conditions.

Confirmation of the impression that territorialism might limit the area occupied by a chickadee pair was one result of the elimination experiment. The male of the studied pair was the area's only banded bird, making identification of him and his territorial boundaries particularly easy. A

mutual boundary with another pair existed at only one point (Fig. 5), and the possibility of other neighbours was eliminated by the nature of the habitat. The boundary location was approximated on May 4, when the two males vigorously answered one another's territorial calls, being about 100 feet (30 m.) apart, and on either side of a conspicuous snag. Unfortunately, the nest of the studied pair could not be located, but the feeding of the female by the male (seen on May 10) indicated that incubation was likely in progress (Odum, 1943). At 9 A.M. on May 15, this pair was shot. (The male had been banded as a nestling the previous year near the Reservation, a straight-line distance of two miles away.) The next day, at 8 A.M., territorial calls were heard from approximately 150 feet (46 m.) inside the now-abandoned territory, and the neighbouring male was followed, by means of his calls, back past the marker snag into his own territory. Subsequent sightings of the pair and single individuals showed that at least the area (approximately 2.5 acres) indicated on Fig. 5 was added to their territory. On June 7, a pair feeding a recently fledged family was found well inside this newly acquired area, demonstrating that new arrivals had not been involved, as they could not have raised this brood in less than a month. From this time on, little attention was paid to chickadees in this area, as juveniles, and perhaps vagrant adults, confused the observations.

Competition with a small mammal (supposed) for a cavity resulted in the loss of a 1961 brood. This nest was discovered on June 22, when both parents were attending

to follow page 50.

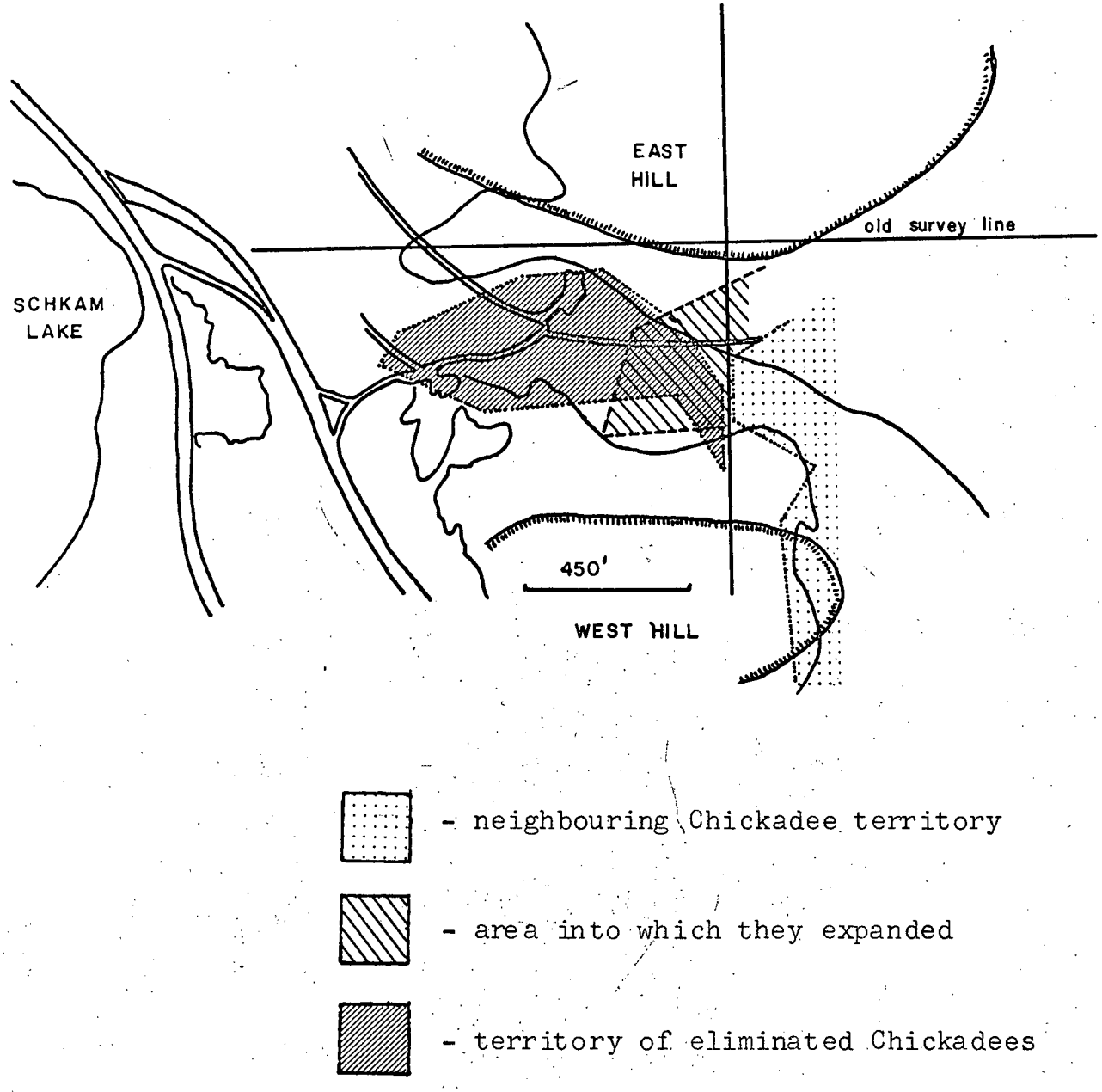

Figure 5. Chickadee Territories. Explanation in the text (page 50).

newly hatched young. This was the pairs' second brood of the season for although the first nest-site was not located, a family group was seen in this territory on June 1. That the cavity had been recently excavated by the chickadees was known from its characteristics, and the fact that the stump had been checked earlier for cavities when searching for their first nest. On June 23, the cavity was full of moss, and the opening was slightly enlarged. The parents were not seen. While the competitor's identity was never established in numerous subsequent visits, a deer mouse is considered the most likely intruder.

The Black-Capped Chickadee occupies deciduous woods, with young second-growth stages preferred when establishing the nesting site. Odum (1941a) points out, and Brewer (1963) quantitatively evaluates, the Black-Capped Chickadee's tendency to locate its nest in stubs in more open edge situations than those which it uses for its feeding and resting activities. The latter author suggests that since suitable stubs in denser forest are not used, this dual habitat preference is not the result of the requirement for soft wood nest trees, but that the characteristics of edge situations, where such trees are more frequent, "--- are merely 'sign posts' used by the birds as an aid in finding such trees."

In 1962, eight pairs occurred on the study area, giving a population density figure of 2.0 pairs per 100 acres.

Since Hope is at the head of the valley, and occupies a transition zone between two biotic areas, with the chickadee resident in only one (the Puget Sound Lowlands) of them, the

distribution of this bird is necessarily limited in this area. Inspection of the mountainsides bordering the valley floor shows that deciduous growth becomes rare (except along moist drainages) above roughly 700 feet (213 m.) elevation, where the coniferous dominants of the Coast Forest predominate. Once the valley floor is left, the habitat becomes more and more marginal for the species. This was illustrated by its occurrence at the areas surveyed along the Hope-Princeton Highway. It was a nesting species at the first stop, at 775 feet (236 m.) elevation 3½ miles from Hope, where that portion of the habitat surveyed was roughly similar to the Reservation. The next stop, at 1100 feet (335 m.), 7 miles from Hope, contained a much higher percentage of Coast Forest species, a limited growth of alder, birch, and maple being confined to the margins of a small river. The Black-Capped Chickadee occurred here, but only after the peak of the breeding season, the first sighting being made late in July. Most likely these records were of wandering individuals. There is only one sight record from Manning Park (D. Dow, personal communication), which this highway enters 17 miles from Hope.

Table 6 presents characteristics of the nests found. Additional data on Black-Capped Chickadee nest sites in other regions, as given by Bent (1946), Brewer (1961, 1963), Nickell (1956), and Odum (1941b) indicates general similarity. Brewer (1963) suggests that height and suitability for excavation are the most important characteristics determining a stub's suitability. Cavities are required for nesting, and

TABLE 6. BLACK-CAPPED CHICKADEE NESTS

NEST NUMBER	TREE SPECIES	TREE HEIGHT	HOLE HEIGHT	DBH	DHH	SOURCE	REMARKS
3-4	Birch	5.5 (1.7)	4.8 (1.5)	6.2 (15.7)	6.2 (15.7)	BCC	1961. Upper wooded portions. Presumed second brood.
11-5	Birch	10* (3)	5.9 (1.8)	6.7 (17)	6.6 (16.8)	U (typ)	1961. Upper open portions. First brood.
W-5	Alder	6.8 (2.1)	6.3 (1.9)	5.5 (14)	5 (12.7)	U (typ)	1961. First brood. Area "S".
2-S-1	Birch	12.5 (3.8)	11.6 (3.5)	4.6 (11.7)	3.9 (9.9)	U (typ)	1962. Area "S". First brood.
2-I-100	Birch	4 (1.2)	3.2 (1)	-	4.6 (11.7)	U (typ)	1962. NE slope. Presumed second brood.
2-I-7	Birch	7.5 (2.3)	5.3 (1.6)	5.2 (13.2)	5 (12.7)	U (typ)	1962. Bottom NE slope. First brood. Second brood in 2-I-2.
2-I-2	Birch	40* (12.2)	37* (11.3)	9 (22.9)	3.3 (8.4)	BCC	1962. Bottom NE slope. Second brood.
2-T-1	Birch	7.1 (2.2)	6.2 (1.9)	3.1 (7.9)	2.8 (7.1)	U (typ)	1962. Area "T". First brood. Second brood in 2-T-2.
2-T-2	Birch	7.8 (2.4)	6 (1.8)	2.5 (6.4)	2.5 (6.4)	U (typ)	1962. Area "T".
Laidlaw	Alder	20* (6.1)	18* (5.5)	10.3 (26.2)	4* (10.2)	U (typ)	1962. First brood.

TABLE 6. Continued

NEST NUMBER	TREE SPECIES	TREE HEIGHT	HOLE HEIGHT	DBH	DHH	SOURCE	REMARKS
Laidlaw	Alder	12* (3.65)	4.8 (1.5)	8.4 (21.3)	8.4 (21.3)	U (typ)	1962. Presumed second brood.
Riverside	Alder	12.5 (3.8)	8.6 (2.6)	4.8 (12.2)	4.1 (10.4)	U (typ)	1962. Presumed second brood.

the bird is capable of digging its own nest. In only 2 cases (of 12) was it definitely established that the bird dug its own, but the appearance of every other cavity, except one, suggested recent excavation by Chickadees. The exception was a soiled cavity in which a second brood (presumed from the date) was raised, and just above its entrance was a freshly started, but incomplete excavation. These observations do not contradict the supposition that the Black-Capped Chickadee has a "psychological need" for excavation (Brewer, 1961; Drury, 1958; Kluyver, 1961), and thus is nearly always responsible for producing its own nesting cavity (Odum, 1941b).

The frequency of second broods, judged from this limited field work, may be much higher in this area than has been reported elsewhere (cf. Brewer, 1961). Of the 12 nests located, 6 contained first broods. Two others had second broods of marked pairs. Two had broods late in the season, in territories where recently fledged young in family groups had been seen earlier, and the remaining 2 nests contained young at a time suggesting second broods. Additional observations would be desireable.

Three color-banded pairs observed closely during 1962 had the following histories. One pair raised their first brood in 2-I-7, and their second in a fresh cavity in 2-I-2, 520 feet (159 m.) away. A second pair nested successfully in 2-T-1, and then raised another brood in 2-T-2, 245 feet (74 m.) distant; the cavity appeared freshly excavated. The third pair raised a brood from 2-S-1, and a second nest, if

any, was not located, although the birds started excavating a hole which was later abandoned, and continued maintenance of their territory, with a territorial conflict with a neighbouring pair last seen on July 16. Odum (1941a) reports that territorial defense stops when the young leave the nest.

Chestnut-Backed Chickadee

Horvath (1963) saw fledglings on the Reservation in 1960, while only one pair inhabited those portions surveyed during this study.

Details of the annual cycle of this species remain generally unknown, with little information available on pair-formation, nest-site selection, and territoriality.

The species was recorded on area "F" only once during the late summer, and was not involved in the elimination experiment.

The birds nesting on the Reservation in both years inhabited a steep rocky slope (Plate 3), and generally confined their activities to the upper portions of the tall conifers, making observations difficult and time-consuming. Nests were located only in 1962. There were no known neighbouring pairs, and no conflicts of any type were detected. Dixon (1954) found territoriality to be exhibited only briefly during the spring.

Though usually found high in the same general situation where Golden-Crowned Kinglets were common, the Chestnut-Backed Chickadee was not limited to this portion of the habitat, and occasionally foraged in deciduous trees. It was not recorded from the valley areas surveyed, (except for a

call heard on July 14 in the Riverside Study Area), but was observed at nearly every stop made along the Hope-Princeton Highway. Grinnell and Miller (1944) describe the habitat of the species as coniferous forest and adjacent mixed growth woodland, with all the conifers of the humid coast belt being frequented to about equal degree. They found an apparent preference for dead deciduous trees when excavating nests.

It requires a cavity for nesting, and is capable of digging its own, which it almost invariably does (Bowles, 1909). Cavities found in use during this study (Table 7) parallel most closely in general characteristics those utilized by the Red-Breasted Nuthatch in firs. How often new cavities are produced is unknown. Existing tree hole cavities, and bird boxes (2 of 11 records in the B.C.N.R.S.), may be used. Both Bowles (1909) and Burleigh (1930) found the nests averaged less than 10 feet (3 m.) in height and were often placed in dead fir stubs.

The pair observed most closely in 1962 used two different cavities (approximately 350 feet (107 m.) apart), but it is not known if they were prepared by these birds. The absence of neighbours, location of the nests, and timing of the broods makes it almost certain that the same unmarked pair was involved. The commonness of second broods is unknown.

Black-Capped and Chestnut-Backed Chickadees

There is the possibility that these two closely related species might affect one another in some way. For instance, they co-inhabit a large part of British Columbia, but on

TABLE 7. CHESTNUT-BACKED CHICKADEE NESTS

NEST NUMBER	TREE SPECIES	TREE HEIGHT	HOLE HEIGHT	DBH	DHH	SOURCE	REMARKS
2-I-2	Birch	40* (12.2)	39* (11.9)	9 (22.8)	3.31 (8.4)	CBC	Bottom NE slope. 1962. Cavity incomplete.
2-I-6	D. Fir	40* (12.2)	17* (5.2)	37.8 (96)	30* (76.2)	U (typ)	Middle SE slope. 1962. First brood. Second brood of this pair in 2-21-2.
2-21-2	D. Fir	95* (28.9)	85* (25.9)	53.8 (136.6)	12* (30.5)	U (typ)	Middle SE slope. 1962. Second brood.
HPH 15 Mile	D. Fir	80* (24.4)	79* (24)	41 (104.1)	20* (50.8)	U	1962.
HPH 10 Mile	Red Cedar	55* (16.8)	40* (12.2)	20.5 (52)	13* (33)	U	1962.
			WINTER WREN NEST				
22	Birch	32 (9.8)	14.3 (4.4)	12.7 (32.3)	9.4 (23.9)	U	Used in 1960. Fell in August, 1960.

those portions of the Province (as Vancouver Island) where the Chestnut-Backed is the only chickadee, it apparently utilizes a wider niche, becoming more of a "backyard garden" type of bird.

Where both species regularly occurred together in the Hope area (on the Reservation and the 3-mile study area), observations, necessarily casual, suggest that each species essentially ignores the other during the breeding season, inhabiting niches which are almost totally distinct, and fulfilled best in separate habitats. The Chestnut-Backed is usually found high in the mature trees of predominantly coniferous stands - the Black-Capped in the lower half of deciduous vegetation, which is frequently second-growth and may be quite young.

In 1962, whenever Chickadees were seen feeding, notes were made on their location. This resulted in numerous observations on the Black-Capped and much fewer on the Chestnut-Backed, from which these generalizations can be made.

The Black-Capped Chickadee restricts its feeding almost entirely to deciduous trees during the breeding season. While conifers are commonly entered, it is only because they happen to be in the bird's line-of-travel. Only three isolated feeding attempts in conifers were observed. S. Smith (personal communication) has seen Black-Capped Chickadees occasionally feeding in conifers during the summer in the Vancouver area. All types of deciduous growth, from shrubs to mature trees, were utilized. No impression of preferences for particular height classes or species was obtained,

though these may exist and change throughout the season. These birds alsmot invariably follow the general rule of confining their feeding activity to the bottom half of the foliage of whatever they happen to be in - whether this is a 4 foot high brush tangle or a 45 foot high alder stand. The upper canopy of a stand, or the crown of more isolated trees is very rarely visited, though feeding up to 3/4 height is occasional. Ground feeding is very rare.

The Chestnut-Backed Chickadee is commonly found high in tall conifers, but is not confined to them and may feed in deciduous growth from low brush piles (rarely observed) to taller trees. Here its' manner of feeding is indistinguishable (to casual observations) from that of the Black-Capped, though it may use all parts of the foliage.

So, while the foraging habits of these two species in this region do overlap, all observations indicated that the amount of overlap is negligible. They were never seen foraging together during either summer.

On April 29, 1962, a pair of Black-Capped Chickadees was being followed (movements are traced on Fig. 6). They were patrolling their territory and the male was giving territorial calls at high frequency and intensity. Moving slowly along the top of the logged-over ridge, the pair stopped at "X", and here the male, perched in the top of a small bush, gave the territorial call repeatedly for several minutes. No other Black-Capped could be heard and there were no immediate neighbouring pairs along this boundary. The pair then started down off the ridge, the male still calling,

to follow page 60.

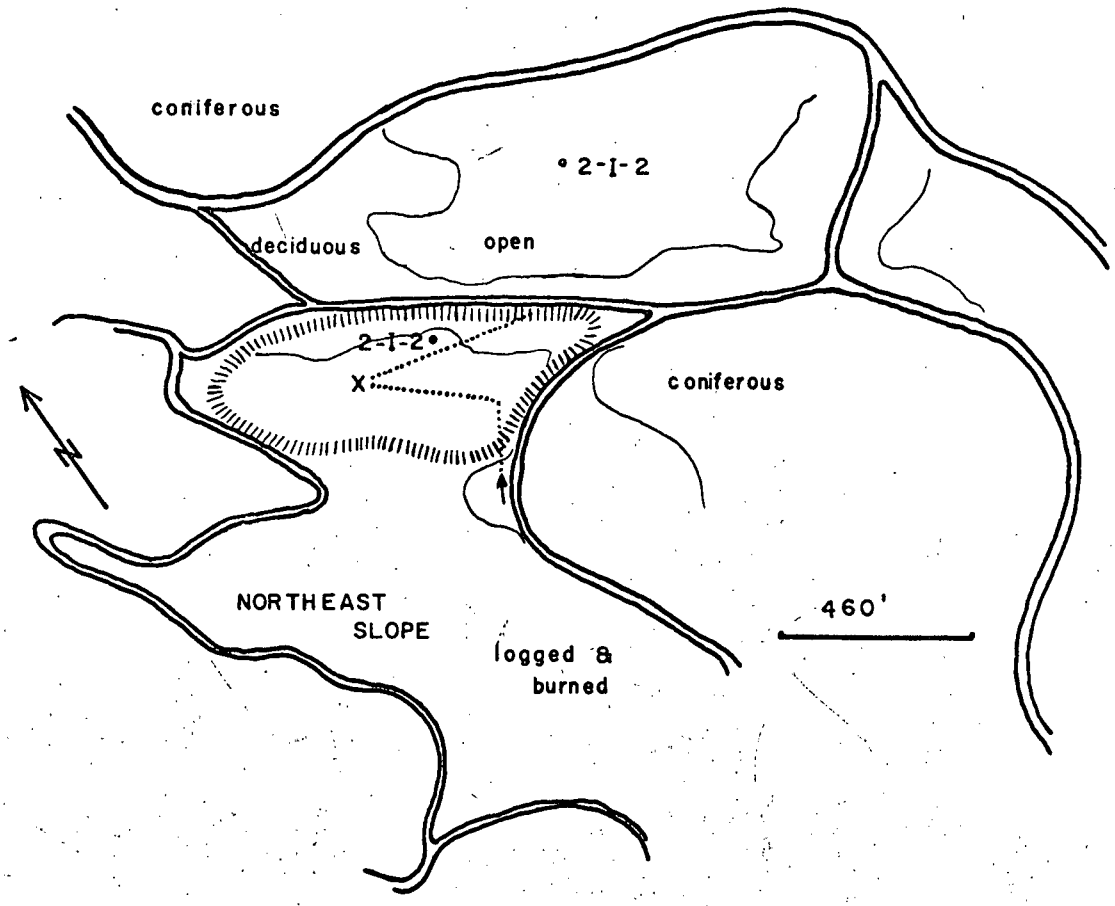

Figure 6. Chickadee Nests. Explanation in the text (page 60).

and in doing so passed within 50 to 75 feet (15 to 23 m.) of 2-I-2 (Plate 9; Tables 6 and 7), at the top of which two Chestnut-Backed Chickadees were excavating a cavity, repeatedly changing places at it and keeping up an excited calling. Each pair apparently ignored the other, the Black-Capped Chickadees continuing on past, the male still calling, until they entered the heavily wooded borders of the narrow road below and were lost. Their first nest (2-I-7) was later located in a low birch stump, 520 feet (159 m.) away from 2-I-2. The eight young fledged before May 30, probably on May 29, and allowing 37 days from the laying of the first egg (Brewer, 1961), on April 29 the nest probably contained seven eggs. The Chestnut-Backed Chickadees were never seen in the area again and their cavity was never completed. Later the Black-Capped Chickadees (which were by then color-banded) raised their second brood in 2-I-2, digging a new cavity 1½ feet (0.5 m.) below the incomplete one, and illustrating that the same portion of the same snag released excavating behavior in both species. Yet the two pairs, at a time when territorialism was intense, each behaved as though the other did not exist.

Red-Breasted Nuthatch

The Red-Breasted Nuthatch was found to be one of the commonest hole-nesting species, with 15 nests located, 13 on the Reservation.

In 1961, three nests were located:

I-11 - On June 15, young were being fed, and the nest was empty on June 18. It was not used again that season,

or in 1962.

W-4 - Two broods were reared in this nest with young being fed early in June, and late in July. The cavity-bearing portion of the tree fell before the 1962 summer.

2-1 - This hole was in the process of being excavated on June 14, the date of discovery, and the two adults involved were accompanied by at least three recently-fledged juveniles. The location of the season's first site is unknown. Excavation had probably started on the 13th and the last young bird left the nest on July 26, 44 days later. The site was unused in 1962.

These three nests illustrate three possibilities. A site may be used for two broods in one season, for the first brood only, or for the second brood only.

The nests located during the second summer generally followed the timing pattern established from the three 1961 nests, with excavation occurring in late April and early May, and fledging of the two broods around the first third of June, and the last half of July.

Table 8 presents information on the types of nest sites chosen. Bent (1948) contains additional data. Preparation (or selection) of the nest site occurs in late April and early May, although this generalization is based on a small number of observations. There is an isolated record from Vancouver Island in the B.C.N.R.S. of excavation by a pair on March 17.

Territorialism was manifested in the Nuthatch's (presumably the male) habit of calling loudly for short intervals

TABLE 8. RED-BREASTED NUTHATCH NESTS

NEST NUMBER	TREE SPECIES	TREE HEIGHT	HOLE HEIGHT	DBH	DHH	SOURCE	REMARKS
2-1	Birch	50* (15.2)	42* (12.8)	11.3 (28.7)	3* (7.6)	RBN	1961. Upper NE slope. Newly excavated for second brood.
I-11	Birch	20* (6.1)	19* (5.8)	7.8 (19.8)	5.9 (15)	U (typ)	1961. Upper NE slope. First brood.
W-4	Alder	36* (10.9)	30* (9.1)	16.5 (41.9)	6* (15.2)	U (typ)	1961. Lower SE slope. Two broods.
15-15	D. Fir	70* (21.3)	55* (16.8)	-	-	U (typ)	1962. Upper W slope. Two broods in two different nearby cavities.
2-12-1	B. Maple	50* (15.2)	40* (12.2)	18 (45.7)	5.5* (14)	RBN	1962. Upper wooded (edge). Abandoned, perhaps for 12-26.
12-26	B. Maple	50* (15.2)	48* (14.6)	13.3 (33.8)	6.5* (16.5)	DW and RBN	1962. Upper open portion. One brood.
1-2	D. Fir	20* (6.1)	18* (5.5)	-	-	RBN	1962. Upper SE slope. First brood.
2-W-1	B. Maple	50* (15.2)	45* (13.7)	19.2 (48.8)	5* (12.7)	U	1962. Lower SE slope. Second(?) brood.
2-H-2	D. Fir	80* (24.4)	35* (10.7)	39 (99)	28* (71.1)	U (typ)	1962. Lower W slope. Second(?) brood.
2-I-5	D. Fir	50* (15.2)	49* (14.9)	-	-	U (typ)	1962. Upper NE slope. First brood.

TABLE 8. Continued

NEST NUMBER	TREE SPECIES	TREE HEIGHT	HOLE HEIGHT	DBH	DHH	SOURCE	REMARKS
I-20	D. Fir	45* (13.7)	42* (12.8)	19.5 (49.5)	13* (33)	U (typ)	1962. Upper SE slope. First brood.
2-8-1	B. Maple	50* (15.2)	45* (13.7)	13.5 (34.3)	8* (20.3)	U (typ)	1962. Upper wooded portions. Two broods.
HPH 15 Miles	D. Fir	55* (16.8)	54* (16.5)	-	-	U	1962.
HPH 40 Miles	Lodgepole Pine	55* (16.8)	15* (4.6)	12.7 (32.3)	11* (28)	U	1962. Living tree.

from the tops of trees in its territory, and sometimes from the nest snag itself. Occasionally, series of calls alternating from two separate areas were heard. These were the only conflicts (presumed) of any type that Nuthatches were found engaged in. Likely the observed spacing of the nests was the result of territorialism but this apparently was determined before observations began at the end of April. Ten pairs occurred on the study area in 1962, giving a population density figure of 2.5 pairs per 100 acres.

Nuthatches did not nest on the experimental area, though they had done so in previous years. They were frequently heard in the denser timber in the distance.

While deciduous trees are frequently used for nesting purposes (Table 8), and occasionally for feeding, conifers are much more commonly used when foraging. This association is very definite in this area (cf. Grinnell and Miller, 1944).

Brown Creeper

This bird is a resident of the area (Brooks, 1917; Brooks and Swarth, 1925; Munro and Cowan, 1947), and a pair spent the summer of 1960 in the wooded upper portions of the Reservation, although no nest site was found (Horvath, 1963). The sighting of a juvenile on June 22, 1961, is the only observation from the Reservation in the last two summers. Four of 11 nests from southwestern British Columbia and Vancouver Island (B.C.N.R.S.) were in holes in trees; the other 7 were built behind loose bark.

Winter Wren

Regional lists agree on its commonness in the Hope

area - Horvath (personal communication) confirms their presence in winter. An established male probably spends the year on the same area - Armstrong (1956) found that territory was defended practically throughout the year. As the species was of minor interest, little effort was expended in marking individuals and determining territorial boundaries. Those males in the study area (at least 5 in 1962) were separated naturally by habitat discontinuity, which makes the population density figure of 1.25 breeding males per 100 acres relatively meaningless, as the birds are much more plentiful in larger areas of better habitat near the Reservation. The following example illustrates not only the effect of habitat discontinuity, but also a possible influence of territoriality upon the bird's spacing.

A small closely wooded area at the bottom of the southeast slope represented preferred Wren habitat, and was occupied by one male and an unknown number of females during the summers of 1960, 1961, and 1962, with three, two and one breeding nests located in it during those years. Only during the 1962 summer was an adjacent area (slightly higher on the slope) occupied, with one breeding nest located. Other unlocated nests may have existed in either territory. The latter territory, with a relatively sparse and unvaried vegetation on a stony dry slope (Plate 3), must have represented poor habitat, and the fact that the two males could hear each other cannot be without significance.

Winter Wrens did not nest on the experimental area "F", although the habitat appeared suitable at the densely wooded

northern end, where a Wren was seen on May 1 - the only observation.

Preferred habitat in this region is found under mature dense stands of mixed coniferous and deciduous trees, where the high moisture and extreme shade promoted by the heavy canopy contribute to the environmental constancy experienced by the forest floor where the Wrens live, which frequently possesses a good deal of litter (fallen trunks and branches) and a heavy moss layer (Horvath, 1963; Phillips and Black, 1956). Winter Wrens were found at almost every area surveyed along the western half of the Hope-Princeton Highway, illustrating their widespread occurrence in this region.

A total of 25 nests[5] was located, mostly by Horvath, during the 1960-1962 summers, and they may be classified as follows:

in tree cavities:	1 breeding nest 1 auxiliary nest[6]
in split upright trunk:	1 breeding nest
on low conifer branches:	4 breeding nests 1 auxiliary nest 11 nests of unknown status
in the ground (banks):	4 breeding nests 1 auxiliary nest 1 (unknown) nest

for a total of 25.

Table 7 includes measurements of the tree cavity used for breeding. Found by Horvath in 1960, it fell after the

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[5] Horvath (1963) lists three additional tree-hole nests that remained unknown to the author.

[6] An auxiliary nest remained unlined (Armstrong, 1950).

breeding season, eliminating the possibility of re-use. No measurements were obtained from the second cavity. Discovered by Horvath in 1961, it was destroyed before inspection.

The Wren cannot excavate a tree cavity, nor does it require one. Published accounts (as Armstrong, 1955, 1956) indicate that the bird is an opportunist regarding the placement of its nest, and it is undoubtedly due to this behavioral plasticity that tree holes are used. A widespread hole-nesting habit could never be expected, for in the habitat types utilized by the Wren in this area, short hole-bearing snags are rare. This is due not only to the uncommonness of short snags, but also to the lack of birds that would dig holes in such situations. Horvath (1963) suggests that the Wren places its nests only in situations providing precise microclimatic conditions. If investigation, currently underway, should show this to be the case, the number of tree cavities actually used by the Wren in an area will likely be much less than the total number of cavities potentially available.

Armstrong (1955; 1956; 1958) states that the suitability of a habitat, primarily as reflected in the availability of food, determines the "vigor" of the resident male. Proportional to the male's "vigor" is the size of the territory (perhaps), the number of nests he will build, the number of females he will serve, and the number of broods (1 or 2) raised in a season by each female. Up to 12 nests may be constructed in a year by one male, though 6 is the average, and poorer territories may contain less. Usually a new nest

is used for each brood. Apparently the analysis of the Wren's breeding biology in any particular area is somewhat involved.

Generalizing from the available data, in this region a first brood is out of the nest by the third week of May (or earlier), and a second fledges in the first half of July.

Bewick Wren

On June 16, 1962, an adult and three young were seen together in the Riverside Study Area, but a nest site was not located. The species was also recorded once in the Chapman Road Study Area. Their multiple breedings (Bent, 1948) start early - young were being fed in a nest at White Rock, B.C., on April 19, 1961. Of 19 records in the B.C.N.R.S., 5 nest sites were in cavities in low stumps, 2 were in bird boxes, and 12 occupied what can only be described as miscellaneous crevices.

Absent from the main study areas, its status as a nest site competitor remains unknown.

Western Bluebird

The single record from the 1960-1962 summers was made by Horvath on June 5, 1962.

Brooks (1917), considered it a "fairly common breeder in the Valley", and Munro and Cowan (1947) call it an abundant summer visitant to the Puget Sound Lowlands biotic area (with a few wintering). There are no records from the Fraser Valley in the B.C.N.R.S. and at present it is essentially absent from this area (Cowan, personal communication).

Mountain Bluebird

During 1960, two pairs frequented the upper portions

of the Reservation from approximately May 13 to July 8, perhaps breeding, although nest sites were not located (Horvath, 1963). Activity centered around the open grassy areas at the top of the south slope. In the following two breeding seasons, only one record from the Hope area was obtained, that of a male seen near the city during a visit on April 9, 1962.

Non-Avian Holes-Users

Various small mammals and insects may inhabit cavities in trees, but this has elicited no more than scattered references in the ornithological literature. An evaluation of the possible competitive effectiveness of the animals to be described is not possible, though a competitive influence could be exerted by the destruction of adults, young, eggs, or nests; by occupancy of a cavity; or by filling the cavity with material so that it becomes unusable for some potential avian occupant.

Insects - (Hymenoptera)

Single large bees were found in two small cavities; one on the Reservation in 1961, and one on the Riverside Study Area in 1962.

Hornet-like hymenoptera were found at four cavities; two small ones (1962), and two of unknown size (1961). Large papery nests filled the two former cavities - none was closely investigated.

Mammals

Chipmunk - Two young chipmunks were seen looking out of an inaccessible medium-sized hole on the Reservation on

June 21, 1961. Specific identification was not made.

Douglas Squirrel - Chickarees were observed at four tree cavities, two during each summer, all on the Reservation. Cowan and Guiguet (1960) state, "Nests are usually in cavities of dead trees --- Outside nests built in the tops of coniferous trees are less common." As squirrels are common, during 1961 all observations made on these and other cavity-inhabiting mammals were recorded, but this procedure yielded nothing and was abandoned. All four instances of cavity occupancy are based on single observations. Each snag was subsequently visited several times, but the animals were never flushed again. The sight of a chickaree on the ground near their nest (which contained young) elicited an alarm reaction from a pair of Black-Capped Chickadees, though the squirrel did not climb the nest snag.

Flying Squirrel - These nocturnal animals were the most frequent non-avian hole occupant detected. Three holes were found in use in 1961 on the Reservation - one of which contained young squirrels on July 21. In 1962, Woodpecker holes used by Flying Squirrels were found in the Chapman Road Study Area (1), in the Riverside Study Area (2), and at Pinewoods on the Hope-Princeton Highway (1). In addition, occupied nests in tree branches were discovered on the Reservation, one during each summer.

Deer Mouse - The destruction of a Black-Capped Chickadee brood in 1961 has been tentatively attributed to this species.

A small Woodpecker cavity (likely a Downy roost) low

in a birch stub on the Reservation, that had been excavated during the winter of 1961-1962, prior to March 18, when it was discovered, remained unused until a deer mouse built a bulky nest in it sometime between May 8 and 16.

The meagerness of these data would suggest that these animals would play a negligible role as nest-site competitors. Tree cavities are indispensible to none of them. No further conclusions seem possible.

The Elimination Experiment

This procedure was conceived as a possible means to detect nest-site competition.

Design - A separate area, distinct from but comparable to the Reservation, would be thoroughly surveyed for hole-nesting birds as early in the breeding season as possible, to obtain data on the numbers, territories, inter-specific relationships, and especially the nest-sites, of the resident species. As soon as such information was reasonably complete, all the hole-nesters would be shot, this also being done as quickly as possible. Special attention would then be given to the detection of new arrivals and their positioning. If possible, these would also be shot, and so on. Observations on the undisturbed control area would be continued throughout.

Some of the following results could be expected: no reaction at all; new arrivals establishing themselves at holes used by their predecessors, or investigating new holes in the same territories; neighbouring territories being expanded into the vacant areas. Depending upon the movements, and

the species involved, these results could then be interpreted in terms of nest-site competition; intraspecific territorialism; interspecific territorialism (which in such a limited experiment would have to be detected before the shooting); or the absence of any of these. Explanations not involving competition could also be advanced.

Execution - Area "F", distinct from, but similar to, the Reservation, was surveyed for 26½ hours on seven days between May 1 and 12, with hole-nesters, their territories and nests, being noted. The following species were present:

Sparrow Hawk - One pair ranged all over and beyond the study area. They were site-selecting on May 10.

Hairy Woodpecker - A pair was feeding young at a nest near the southern boundary on May 1. Another pair made visits irregularly to the northern portions, but their nest-site, presumably off the area, was unknown.

Downy Woodpecker - A pair occupied a territory in the northern portions, and nest excavation had just started on May 10.

Red-Breasted Sapsucker - A pair started two cavities in a tree in the northern half of the area. Excavation had commenced on May 1.

Pileated Woodpecker - Individuals, presumably members of a pair, were seen or detected regularly, but ranged far beyond the study area's boundaries.

Red-Shafted Flicker - One pair ranged all over the study area, and were still site-selecting on May 15. Their nest cavity was not discovered until May 19, when excavation was

in progress.

Winter Wren and Red-Breasted Nuthatch - Single records of these species were obtained within the study area - on May 1 for the former species, and March 31 for the latter (during a preliminary trip).

Black-Capped Chickadee - One pair held a territory in the north half of the area, and had a mutual boundary with another pair at one point only. Their nest was not found, but the pair's behavior indicated incubation was likely in progress on May 10.

Thus a total of 16 hole-nesting birds inhabited the 80+ acres of area "F".

Elimination of these birds was begun on May 14, but hunting conditions, to which both the behavior of the birds and the nature of the habitat contributed, were so difficult that this phase was not abandoned until June 7, by which time 10 of the original 16 hole-nesters had been collected, with a time expenditure of 56½ hours over 14 different days. The collections were made as follows:

May 14 - the nesting pairs of Hairy Woodpecker and Red-Breasted Sapsucker were collected.

May 15 - the male Downy, and the Chickadee pair were collected.

May 16 - the female Hairy of the "northern" pair was taken.

May 28 - the Red-Shafted Flicker pair was collected.

This left a male Downy, a male Hairy, a pair of Pileateds, and a pair of Sparrow Hawks on the area.

The male Downy apparently deserted, and never returned to the nest-site, which was often watched during the late evening and early morning. Elimination of the pair was apparently accomplished.

The male Hairy of the "northern" pair continued to roam this portion of the study area at irregular intervals. An opportunity for collecting never occurred.

The Sparrow Hawks were too wary to permit the relatively close approach necessary for collecting, and eventually nested successfully on the area. During the collecting period, time was not available for the intensive hunting that would have been necessary to shoot these birds. Though they were seen at their nest as early as May 14, the true status of this cavity was not realized until much later.

The Pileateds were so wary, and their occurrences so unpredictable, that an opportunity for collecting never presented itself.

After cessation of the collecting, observations were continued up to August 24, entailing an additional 32¼ hours on 9 days.

Results - Details of the replacements are given in the sections devoted to the appropriate species, and are summarized here.

Hairy and Downy Woodpeckers - No apparent reaction resulted from the elimination of these birds. The Hairy's breeding season was so far advanced that replacement would be unlikely.

Flicker - A mated pair, of which the male was exhibiting intense territorialism, was found on June 7 excavating a cavity well within the range of the pair that had been collected on May 28.

Sapsucker - A mated pair was first seen on June 3 at the nest snag of the pair that had been shot on May 14. The birds were still at this snag a week later, but were excavating in a different snag on June 22. Their breeding behavior appeared abnormal, and no successful nest was discovered.

Chickadee - On May 16, one day after the resident pair had been eliminated, the neighbouring male was detected well within the now-vacant territory, a portion of which was used by this pair up to at least June 7. The rest of the vacant territory remained unused up to this time.

Conclusions - This experiment did not demonstrate that nesting cavities were in great demand among the hole-nesting bird population. It did suggest, for three presumably resident territorialistic hole-nesting species, that the existence of established birds in a portion of suitable habitat in some way, presumably through territorialism, prevented the establishment of other pairs of the same species. That replacement occurred in two species suggests the existence of a floating population of potentially breeding birds, although the possibility of movement of nearby pairs cannot be overlooked in this small-scale work. The fact that the new Sapsuckers attended the holes excavated by their predecessors does not indicate nest-site competition, but more than likely merely illustrates a similarity in habitat selection processes

(cf. Stewart and Aldrich, 1951; Hensely and Cope, 1951).

The Environmental Resources

A consideration of nest-site competition requires that some sort of evaluation be placed upon the types (and numbers of each type) of cavities available. As an initial step in this process, in the latter half of the 1961 season a survey was made of selected areas of the Reservation, which were chosen so as to be representative of all the vegetational types present. Each segment was traversed systematically, so that no snag of any size went unnoticed; each one being inspected from all sides. Every snag that bore an entrance to a possible cavity was numbered, and positioned on a map. The great majority of these holes were not easily inspected, so that whether they represented actual cavities or not remained unknown. Approximately one-half of the Reservation was surveyed in this manner, as were some smaller sections of adjoining woodland. A total of 212 snags bearing one or more holes was located on these areas.

In order to establish a ratio of hole-bearing snags to cavity-bearing snags, during the latter part of the 1962 summer the following sampling procedure was initiated. Sixty snags were picked at random, and the status of those in which the holes were not easily inspected was to be determined by cutting down the snag. This rather time-consuming process was started, but the following considerations led to its abandonment.

It was evident from the types of hole-nesters present

in the area, their relative abundances, and their ecological demands, that there was very little chance for nest-site competition to be occurring. In a situation where the far greater majority of hole-nesters present were capable of excavating their own nesting cavities, often doing so at the start of each breeding season, and usually locating their nests in areas often glutted with potential cavity-bearing snags, it would be expected that a large surplus of unused holes would exist. This is precisely what is happening in the study area. Hole mortality due to the falling of snags is not extensive enough to prevent the formation of a large surplus of cavities, especially since many of the larger snags, which are very long-lived, eventually bear a whole series of cavities that are apparently going unused. (Emphasis is given to "snags" because nests were never found to be drilled through living wood, and a living tree usually bore a cavity only in a large branch or portion of the trunk that had died. Very few cavities were found in living trunks, where they had originated due to a combination of branch loss and rot.) Being able to state how many holes are theoretically available per hole nester, when the bird is very likely not going to use any of an obvious surplus of holes, is essentially meaningless.

However, in the course of previous work, the status of the holes in 22 of the 60 snags had been determined, either by direct observation, by seeing animals entering them, or by inspecting the snags after they had fallen. Nineteen of the 22 snags bore holes representing actual cavities (of

several type and sizes). Two of the 19 also had "false starts", one in one snag, two in the other. Even though the means by which these determinations were made obviously favored the discovery of the true cavities in the sample of 60, the results supported the conclusion that the environment carries a surplus of cavities.

The Town Study Area

In 1961, regular observations did not begin until June 18, when nesting was well underway. This delay was occasioned by the following situation. There are accounts of tree-hole nesting Violet-Green Swallows, and this, in conjunction with their commonness,,led to the expectation that they would be present as a hole-nesting species on or near the Reservation. Initially little importance was attached to the large mixed flocks of swallows often seen coursing over the marsh, lakeshore, or upper slopes. While their rarity on the upper central portions of Little Mountain was noticed, no importance was attached to it, until, as time passed, two facts became obvious: swallows were present in numbers over the marsh only in times of poor weather, and nesting activities were well underway in the town with no such behavior being observed elsewhere. The survey in the town was then initiated.

Violet-Green Swallow

This species has bred in the valley only since 1887 (Brooks, 1917), and is now one of the commonest hole-nesters of the area.

Observations on this species during the first summer were too late in the year to detect any competition which might

have existed during the site-selection process, and only provided some information on the timing of the breeding events, and on the nest-site types utilized by this species.

Twenty-six occupied nests were located in the town in 1961, of which 25 were in crevices, ventilation holes, etc., in buildings, usually under the eaves. The remaining nest was in a bird box.

The first fledglings were seen on July 7, and most of the nests were empty by the end of the second week in July. One nest contained young on July 28, the latest date of this season.

In 1962, the weather throughout the spring and early summer was generally cloudier and cooler than during the previous year. This was reflected in the timing of the bird's breeding cycle (cf. Mayhew, 1958; Johnston and Hardy, 1962). In the University area (Vancouver, B.C.), the first Violet-Green Swallows were seen on March 17, 1961, but not until March 29 in 1962 (personal observation). No swallows were seen on March 18, 1962, when a trip was made up the valley, and the town of Hope and its surroundings were surveyed for several hours.

Of interest was an observation made casually near Vancouver on March 30, 1962, early on a clear, sunny morning. Two Violet-Green Swallows, male and female, were seen fluttering up to, and clinging at, a knothole under the eaves of a building. The next day a trip to Hope was possible, work starting at 7:30 A.M. on a cloudless day. Violet-Green Swallows were present in the town and site selection was

proceeding at high intensity, with a great amount of chattering, flying around buildings, and fluttering to investigate possible sites. Activity was so concentrated around buildings that there can be little doubt that they represent a primary potential source of nesting sites.

Johnston and Hardy (1962) estimate that 25 percent of returning Purple Martins are paired when they arrive at the breeding sites, and that nearly all the birds arriving in the first migratory wave are paired. Eleven of twenty-three notebook entries from March 31, 1962, relating Violet-Greens to buildings or areas, refer to pairs. Considering that pairs may join flocks for a while, as when feeding, and that single birds may represent a pair, it would appear that the pair, if not already established, is quickly formed after arrival, and that many of the birds were paired at this time.

There exists the possibility that the birds seen in late March are transients, eventually moving on to other breeding grounds, as Edson (1943) implies, but engaging in preliminary breeding activities as they pass through suitable habitat. This undoubtedly applies to some of the birds seen in the area, but whether members of a pair apparently very interested in a site should be similarly thought of is more questionable. As observations were short, and no birds were marked, no evidence can be presented on this point, on the permanence of the pair bond, or on the degree of year-to-year site-faithfulness present in these birds. However, it would appear strange that such intense activity by so many birds would result in only a familiarization with the

processes involved in site-selection and pair-formation. Nests were later built in many of the sites investigated at this time. Johnston and Hardy (1962) theorize that the procuring of a nesting site is an important factor influencing the early spring arrival of the Purple Martin, and assume that the general time of arrival is genetically determined. Likely the same factor is operative with these swallows, and many of the birds seen at this time probably remained to breed. In any case, the primary purpose of the birds upon arrival on summer range is to lay claim to a mate (if not already done) and a nesting site, even though they will not lay eggs for another two months.

Observations continued in the city until 2 P.M. on March 31, and from 1 P.M. on no swallows were seen. None was found over the marsh by the Reservation (Fig. 3, a favorite feeding area in poor weather) shortly after 2 P.M. The city was not visited again until 5:45 P.M., at which time the sun was just setting behind a mountain, and a large flock of swallows (unidentified) was seen high over the nearby Fraser River. A nest site at which a pair of Violet-Green Swallows had been observed earlier in the day was then watched until 6:30 P.M., when quite dusk, without a sign of swallows in the vicinity. Apparently the swallows had not entered the city to roost at the newly-chosen nest sites (though much more observation is needed). The marsh was again visited in the semi-darkness, and the borders stoned, without results. These observations might be taken as indicative of the swallows' transient status, with the integrity of the flock

being maintained for further migration. However, Johnston and Hardy (1962) noticed that the intensity of breeding preliminaries in the Purple Martin decreases toward nightfall, with possible disintegration of new pair-bonds and residence-bonds that seemed strong during the morning - something the same may be happening here. Detailed later are the movements of feeding flocks (involving up to five species of swallows) in times of poor weather that leave the town deserted for hours at a time. This is mentioned, not as an explanation for the above events, but to emphasize the gregariousness and mobility that undoubtedly contributed to them.

A third trip was made to Hope on April 9, work starting at 6:30 A.M. on a cold rainy day - the showers continuing into the early afternoon. No swallows were seen in the town during the day, or over the marsh when it was visited at 10 A.M. Whether they had left to continue migration, or to visit more suitable feeding grounds, is unknown.

Regular observations began on April 29, and whenever possible the presence of swallows over the marsh was noted. A brief consideration of these weather movements will be inserted here, since the Violet-Green was the commonest swallow in the town.

In 1961, systematic observations were not initiated until June 18, which was too late for useful work on weather movements. Noted casually earlier in the season was the occurrence of mixed flocks over the marsh only in times of poor weather. These birds were never seen expressing interest in the holes visible in the snags around the marsh. The

possible importance of these movements in terms of the Violet-Green Swallow's effectiveness as a nest-site competitor was realized, and in 1962 they received more attention.

When a swallow flock was seen over the marsh, the total number and species composition was estimated (greater accuracy was impossible to achieve - the birds fly constantly), and the time and general weather conditions were noted. Whenever the weather was poor, with rain, and often wind and comparatively low temperatures, a flock would be feeding over the marsh, usually just above the vegetation. Up to the third week of May, usually 75 to 100 birds were involved; those movements occurring in late May and June were composed of 50 to 75 individuals; and in July about 25 birds would respond to the occasional periods of bad weather.

Rough-Winged were the most common swallows during the first two periods, with Violet-Greens contributing 20 percent to 50 percent of a day's total. Sometimes up to one-third of the birds seen during May were Tree Swallows - later this species was represented by but a few individuals. Barn Swallows appeared in small quantities in late May and early June; the remainder of the summer this species, and the Cliff Swallow, contributed very little to the totals. One Bank Swallow was seen on June 3. July movements were composed almost entirely of Violet-Greens.

In the absence of more quantitative data, the following examples are offered as illustrations of this phenomenon.

On May 3, it rained throughout the morning, and it had been raining most of the previous week. Periods of clearing

were restricted to a couple of hours - usually light drizzle and showers alternated with the heavier rain more common during the night and early mornings. An estimated 150 swallows (90 percent Violet-Green Swallows) were feeding over the marsh at 11 A.M. , when it began to clear. At 1 P.M. and 3 P.M. (rain again) this situation was apparently unchanged. Between these last two checks, every area in town where swallows might be expected was visited, with negative results.

On May 7, the temperature was near-freezing when the sun first began to break through the clouds at 7 A.M. On the edge of the town study area, a flock of 56 Violet-Greens was found on telephone wires - another flock of 15 was similarly situated a few hundred feet away. The birds were sitting motionless, occasionally calling, with heads drawn in and feathers greatly fluffed. As the sun's warmth increased, the birds became more active, calling and making short flights to change position. The activity increased, and soon birds started to leave the flock, which ceased to exist a few minutes after 7. The weather remained fine, and throughout the day pairs attended their chosen nest sites. Besides illustrating the bird's response to this weather, the occurrence of flocks under these conditions suggests that the birds do not roost at the nest site. Unfortunately the fluffed feathers of the sitting birds made sex determination difficult and unreliable.

The morning of May 8 was sunny and no swallows were over the marsh at 9:30 A.M. It soon clouded over, and rain

started around noon, continuing into the evening. When the marsh was checked at 4 P.M., about 100 birds, mostly Violet-Greens, were feeding there.

On May 9, two pairs each of Rough-Wings and Violet-Greens were site-selecting at a rock face by Schkam Lake (Plate 10). The level of activity was high, and about 40 minutes had been spent in observation when a sudden heavy 10 minute shower hit the area. The birds then began coursing low over the lake surface, not approaching the nest-sites until the rain slowed to a steady drizzle, when activity resumed as before.

On May 18, when swallows spent the afternoon over the marsh, in the evening an attempt was made to detect a movement into the town. At dusk, 12 swallows were seen coming from the appropriate direction, singly and in small groups, but only one was low enough to be identified as a Violet-Green Swallow. Two Cliff Swallows were seen going to roost in a half-finished nest.

On May 24, a light rain fell all day, and an attempt was made to locate other feeding areas. About 50 swallows were at the marsh, and an estimated 60 birds were over Schkam Lake. A third favored location was at the entrance of the Coquihalla River into the Fraser River (Fig. 2), where about 40 birds were coursing low over the water. About 80 Violet-Greens were in these groups, and perhaps more were at other areas. These three areas are all within easy flying distance of Hope.

The early morning of May 28 was chilly and dull, and at

8 A.M., the marsh was surprisingly free of swallows. However, at 8:20, a large (60) loose flock slowly drifted down from the east, and began to break up over the marsh, the main portion seemingly moving slowly toward the town. Immediately driving into the town, only isolated individuals, usually coursing high, could be sighted at nesting areas. Around 8:55, waiting at its eastern end, a slow movement into town could be detected; first a loose flock of eight, then two, then a single individual. Though too high for species determination, there can be little doubt that these birds had just been seen over the marsh.

Some detail has been presented on this subject because of its possible importance to a population of hole-nesting swallows. Lack (1956) found that food and nest site requirements were of the greatest importance to populations of the European Swift - here probably the same situation exists. Johnson (1951) warns against interpreting aerial insect populations in terms of the weather conditions on a particular day, but still a tremendous influence is present, of which Mayhew (1958) presents a brief summary.

Poor weather, by affecting the swallow's food supply, and causing it to move (in this case) to a more favorable source, can reduce the bird's effectiveness as a nest-site competitor. If the intensity of competition was high enough, the population would suffer because this fulfilling of the more immediate needs of the individual required a temporary abandonment of the chosen site, allowing members of another species to lay claim to it. While there was no evidence

that this was occurring during the study, it could happen in other areas, or possibly in this area if the population levels of the competing species should increase (the Starling and House Finch are recent arrivals). Unfortunately it could not be determined if roosting occurs in the chosen sites before the start of serious nest-building in June. Edson (1943) found that this often happened. Such a habit might be important in a competitive situation. Combellack (1954) found that the female, but never the male, roosted in the nest after the start of construction. Surveillance of individual sites in the town at nightfall was not considered practical.

A smaller portion of the town was surveyed in 1962 (Fig. 2). A definite handicap was the impossibility of viewing the contents of any of the nests, though the actual number of nesting pairs can be approximated. A total of 62 "possible" nest sites were seen being investigated by Violet-Greens. Of these, 16 were dismissed for various reasons (the opening obviously too small; there was no opening in the portion of the building being investigated; the interest in the site was of brief duration, or was never detected subsequently, etc.). Of the 46 remaining possibilities, 21 later contained young birds, nest-building or copulation was observed at 7 others, and at an additional 11, birds were seen either entering or leaving the cavity. Considering the known histories of all these sites, it is estimated that there were between 25 and 30 pairs in breeding condition on the study area.

Nest-building was seen between May 17 and June 29, with

the peak of this activity occurring in the first week of June. Very little was seen before the end of May, when breeding activities were judged to have advanced little over the situation observed on March 31. On July 2, audible young in a nest were first detected, and the first fledglings were seen on July 18. Most of the nests were empty by the fourth week of July - the latest fledging date was August 13. Allowing approximately 42 days from the laying of the first egg until fledging (Bent, 1942; Combellack, 1954), construction of this nest could have been continuing during the first days of July. In comparison with the previous year, the 1962 breeding season was approximately 10 days late. The obvious influencing factor was the weather - Johnston and Hardy (1962) have demonstrated that the Purple Martin's breeding is similarly affected.

It is difficult to assess territorialism in this species, as certain behavioral traits, analysis of which time did not allow, tend to complicate it. Generalizing from observations, active fighting for sites rarely occurs - but this is only an impression. The complicating factors referred to arise from the fact that these birds may breed colonially, and are always socially inclined - though they do not require others of their own species nearby for successful nesting. This potential colonialism is probably related to the defense only of the nest site (possibly its surroundings - Gullion (1947) describes territorialistic defense of a flyway "--- not more than fifty feet long nor less than eight feet wide, "-- that opened"--- into a large area from which

the birds could climb into the sky in any direction."). Nest-site selection is an unknown process. It seems to involve a great deal of flight around the general area, often in company with other Violet-Greens, all keeping up a continuous calling. Individuals flutter at, or cling near, potential sites. Sometimes this appears to stimulate others to fly in close, and the original bird is lost from sight as it joins them. When an apparently suitable site is located, single birds or pairs will sit on wires nearby, frequently leaving to fly about the neighbourhood, join a calling flock, or course higher up. The presence of one or two birds on a wire almost invariably indicates a nest-site nearby, usually within 50 feet (15 m.). Since many sites may be investigated simultaneously in a small area, and a bird rarely perches for more than a minute or two when activity is high, without marked birds it is impossible to follow an individual for any length of time. Intraspecific fights involving physical contact, or persistent interruptions of a pair at a site, were never seen; actually interspecific conflicts were more frequently observed. There are several possible explanations: an important one being that the behavior of this species has never been described, so perhaps threat, attack, retreat, etc., is occurring without being recognized (though some elements of aggressive behavior can be identified). Another possibility is that the birds respect the choices of others, preferring to avoid, rather than attack, an established pair. Additionally, an abundance of nest sites could contribute to this situation, especially if they were of equal suitability,

or even of "super-suitability", in both quantity and quality, in comparison with ancestral nesting places.

Territoriality would likely have little effect upon the spacing of the nests, though the habitat would, through the positioning of potential nest-sites in relation to one another. Another possible habitat influence, relatively unexplored, is mentioned by Lack and Owen (1955), who found that breeding colonies of the European Swift were spaced about ¼ to ½ mile apart in the city of Oxford, and that this spacing was not due primarily to the distribution of nesting holes. Whittle (1926) makes an early reference to a similar phenomenon in the Tree Swallow, and in addition suggests the food supply to be the determining factor. In many colonial birds, the size and spacing of colonies characteristically varies with the food supply (Lack, 1954) - a possible mechanism whereby this is accomplished is presented by Wynne-Edwards (1962).

The intensity of interspecific competition can be indicated only relatively as "uncommon". In terms of the local Violet-Green populations, a limiting effect is difficult to imagine, though rarely individual pairs may be severely inconvenienced, as the following examples will illustrate.

Violet-Green Swallow v/s Starling - No encounters between these two species were detected in 1961, and only two isolated brief conflicts at nest sites were observed during the 1962 breeding season.

Violet-Green Swallow v/s English Sparrow - In only one instance was prolonged competition for a nesting site between these two species detected. At five other locations conflicts were

seen, but these were brief in duration, appeared inconclusive even at the time, were never seen repeated, and were without apparent long-term results. Since it also illsutrates interesting behavioral traits, the prolonged conflict is detailed below.

The site, a small hole in the wall of a cement-block building, had been used by Violet-Greens in 1961. On March 31, 1962, an English Sparrow pair was here, perching near and frequently entering the site. As a favorite feeding place was close by; these birds did not have to desert the site for long periods. A nearby sparrow nest was being built, but the status of the site in question remained unknown as no visible material was carried in during the observation period. A Violet-Green pair was perched on wires over a lane 50 feet (15 m.) away, and as soon as the sparrows flew out of sight, demonstrated their intentions by flying to wires by the opening. Shortly, they left for a minute or so, presumably feeding, and soon after their return, the sparrows re-appeared, the female sparrow driving the female swallow from its perch with a short threatening rush. The swallows returned to the wires over the lane. When the sparrows left the nest again, the swallows immediately returned to the wires by the site, which the female entered, leaving shortly but returning to cling at the entrance, when the male sparrow returned. The sparrow chattered loudly from near by but neither swallow moved. It then flew at the female, which left immediately, and was followed by its mate back to the more distant perch. The swallows were not present when the

site was revisited at roosting time.

On May 7, the nest apparently contained very small sparrows. A Violet-Green pair came to the wires by the opening three times during a short morning observation, but did not remain long, and no encounters occurred. In the late afternoon, the female sparrow was seen in the nest opening, and the swallows were perched over the lane. Once the sparrow left, the swallows again investigated the site more closely, though not attempting to enter.

On May 27, swallows were seen to express interest by a brief visit to the wires by the site. Sparrows later attended the site- incubation was in progress.

A swallow pair was found perched by the site on June 23. No sparrows were seen during the short observation period, a brood having fledged a few days before.

As late as July 2, a lone swallow was seen perched by the opening. At this time either the egg-laying for, or the incubation of, a third sparrow brood was in progress.

Clearly only isolated occurrences are reported from what may have been an intense conflict. However, several points are illustrated. The persistence of the swallows at an occupied site early in the season suggests that one or both of the birds nested here the previous year. In all the movements toward the nest site, the female always took the initiative, and appeared to be followed by the male. Combellack's (1954) observations on a single pair also suggested that choice of the site was chiefly the female's. Even when the swallow's attendance at the site is permitted

by the weather conditions, it is not constant, as one or both birds frequently leave for minutes at a time, not coursing in the immediate neighbourhood as is more commonly done when feeding young. Presumably feeding is the purpose of these flights, or perhaps flight is a part of courtship activities, but whatever the reason, they do take the birds from the nest's vicinity. If feeding is their purpose, presumably the duration of the absences could be related to the general weather conditions. Emlen (1952) describes flights by the Cliff Swallow, especially in the pre-incubation periods, and during the warmer parts of the day, when they may forage up to four miles away, leaving their colony deserted for hours. It is generally true that swallows are much less frequently observed during the early afternoon, but whether this is associated with similar social behavior, a lessening of activity, or the stiff breezes that almost invariably prevail during this time, is unknown. In any event, the birds are not faithfully attending their nest sites, which would be significant in a competitive situation. The last point is the apparent willingness of the birds to remain subordinate to the sparrows, only approaching the nest closely whenever they were absent. The other brief encounters seen between these two species indicate that the swallow may be more aggressive - a generalization cannot be made.

Violet-Green Swallow v/s Tree Swallow - No interspecific competition for nest sites between these species was detected. Apparently the Tree Swallow's preference for bird boxes, and their low numbers, was sufficient to preclude such activities

in the small study area.

Violet-Green Swallow v/s Rough-Winged Swallow - All observations were made at a rock face created by highway construction (Plate 10) on the edge of Schkam Lake, one mile north of Hope where the birds investigated not only crevices and niches, but also several three inch (7.6 cm.) diamter holes drilled into the rock during construction. The following generalizations resulted from the many inter- and intraspecific incidents observed.

Two pairs of each species nested here - this was also the number of birds present on the first visit on May 9, 1962, though later "extra" birds of each type, particularly Rough-Wings, were involved. The Violet-Greens were attending their nest sites on this date, but the Rough-Wings appeared less well-established, and tended to investigate many possibilities. Both drilled holes and cracks were investigated by each species - one Violet-Green and both Rough-Wing nests were eventually built in the circular drillings.

During May, when the weather was fine, inter- and intraspecific incidents were fairly common. This was especially true when "surplus" birds of either species were present. On some occasions up to four or five additional Rough-Wings and one or two extra Violet-Greens participated in the site-selection process, but how seriously cannot be judged. Since swallows are quite social, even interspecifically, it cannot be determined whether those birds flying up and down the rock face are doing so because of the nest sites, or because they were stimulated into action by the sight of others investigating

cavities. One swallow alighting at a cavity, or swooping about in front of one, appears to incite others to behave similarly, even though they may be of a different species, and are already associated with another nest site. The owner may alight at the entrance, and snap its bill at birds fluttering near; it may join these birds, apparently participating; or it may attack a more persistent investigator. Short chases, with one bird right behind another, were frequently seen, and were in some cases definitely territorialistic. One fluttering combat between a Violet-Green and a Rough-Wing was observed, both birds falling to the ground before separating. Whenever a chase involved both species, it was always a Rough-Wing which was pursued. This may be due to a basic behavioral difference, or possibly to the fact that the Violet-Greens had advanced farther into nesting activities, and were therefore more intense. If a Violet-Green happened to alight at a Rough-Wing site, Rough-Wings would flutter near, but would never attack as a Violet-Green would if positions were reversed. Despite Gullion's (1947) description of interspecific (with Tree Swallows) and intraspecific territorialistic defense by Violet-Greens of a flyway in front of the site, the impression remained that only the site itself was of importance. It is true that the sight of several birds swooping and fluttering by its cavity will cause a Violet-Green to leave its perch, join them and perhaps chase one, without any having alighted at the entrance, but this is likely only because the presence and behavior of these intruders is recognized by the owner as a threat to its posses-

sion. Most of the time birds may pass through the flyway, close to the site, without eliciting hostility. One Violet-Green male for a short while defended other cracks and drill holes near its nest. In spite of this a Rough-Wing nest was built in one of these holes, eight feet (2.4 m.) away from the Violet-Green site.

Despite the limited survey of the Hope area, these two species were also found nesting close to one another at a rock face 16 miles west of Hope, and in the tiled drain holes of a concrete bridge foundation (Plate 7), 8½ miles up the Hope-Princeton Highway, indicating that this is not due to chance, but may occur commonly.

This competitive situation was not anticipated, and is of interest only because it involves the Violet-Green Swallow. During this study, the Rough-Wing was found nesting only in holes in sandy or rocky banks, or in their artificially-constructed equivalents. Bank and Tree Swallows also may use the latter (Hollom, 1943), but these species are rare.

In this region, only one brood per year is raised. Bent (1942) found no reports of second broods though Gullion (1947) commonly found two broods per pair per year in western Oregon.

The Violet-Green Swallow is a potential inhabitor of several cavity types (Bent, 1942), but in no case does it prepare its own. Human activities have greatly increased this species' nesting sites. This

was illustrated again by its occurrence at Pinewoods, 41 miles east of Hope, at 4000 feet (1219 m.) elevation. Now commonly nesting in the buildings, it was absent from the area in 1949, before this small resort was established (R.Y. Edwards, personal communication).

Such a variety of cavities are used that their physical measurements likely have very little influence on desireability, provided they are within certain very wide limits of tolerance. Only 6 of 127 records in the B.C.N.R.S. were provided by tree cavities, with 48 each by nest boxes and cavities in buildings (where the birds are much more conspicuous). The remaining 25, most of them from one observer, describe nests in rock bluffs. This species' ancestral nesting site is thought to be tree cavities. (Kalmbach and McAtee, 1957; though Johnston and Hardy (1962) apparently disagree), but the above figures, and the observed situation could suggest otherwise.

The wide habitat tolerance of this species is noted by Johnston (1943) and Grinnell and Miller (1944), and the latter, never mentioning nests in buildings, describe two basic habitat types: one of them the vicinity of cliff faces, where nests are built in crevices, the other being broken or open woods, or the margins of heavy forest, where hole-bearing trees are present. No preference for the presence of water was found; and the species is termed "--- solitary or weakly colonial, apparently as according with the number of nesting sites available in any one place."

The situation observed at the marsh illustrates a facet

of the bird's site-selection processes. The birds were here constantly whenever the weather was poor, usually remaining an hour or two after it cleared. Yet on only one occasion in two summers was a pair seen briefly investigating two unused cavities in the only large snag in the middle of the marsh. (Later in the summer, when Starlings roosted in numbers in the marsh, individuals would sometimes be seen exploring these cavities, thus demonstrating their spaciousness). None of the other holes visible in snags beyond the marsh's east end were utilized, nor was at least one true cavity in shorter snags on a bank above the eastern margin ever seen to be investigated. Yet Violet-Greens nested in the outbuildings of a trailer court approximately 500 feet (152 m.) from the marsh's west end. On May 23, ten bird boxes (dimensions given in Appendix A) were erected on trees at the marsh's west end (Plate 11). Site selection by Tree Swallows was first seen on May 28, and by Violet-Greens on May 30, and four nests (two of each species) were eventually built. Only one was successful, a re-nesting attempt by Violet-Greens occasioned by vandalism. In both Tree Swallow boxes, the approximately three day old nestlings died due to unknown causes, and an unknown predator destroyed the fourth nest. This small experiment suggests that, as far as the birds were concerned, suitable nest sites (other than the nearby buildings) did not exist until the bird boxes were erected. This could be further investigated by erecting boxes on the hole-bearing snags themselves, most of which were further back (around 100 to 800 feet)(31 to 244 m.)

from the marsh.

Koskimies (1956), theorizing on the overall wide nest-site tolerance shown by the European Swift (tree holes the ancestral site), and the fact that different population segments have different site preferences, offers the opinion that breeding in a human environment resulted from a non-genetical experimentation by part of the population. Such a habit was continued as a "tradition", with the young being conditioned to their nest habitat by an imprinting - like psychological habituation. Perhaps initiated by population pressure, the process has resulted in segments of the population being apparently relatively separated from both ecological and genetical points of view. Something similar may be occurring in the Violet-Green Swallow population, and while evidence on this question would be difficult to obtain (as by banding), still it introduces an additional complicating possibility that would need consideration if the role of competition for nest sites in the population dynamics of the Violet-Green Swallow was ever to be described completely.

Tree Swallow

Brooks (1917) found it a common breeder in the Fraser Valley.

The 1961 season, with its late start, yielded no observations on nest-site competition. Five nests, all in bird boxes, were located. The first fledglings were seen on July 11, and the middle of July is the approximate average fledgling date.

On the smaller 1962 study area, 3 nests were found, all in bird boxes. Sixteen additional nests were located, 2 in boxes erected at the marsh, and 14 at other areas studied. Again the end of the second week of July was the average fledgling date estimated from the few nests followed closely.

A migrant, the time of its spring arrival in British Columbia is apparently roughly coincidental with that of the Violet-Green Swallow (Munro and Cowan, 1947). Little is known about the processes of site-selection and pair-formation (Chapman, 1955). He found that few, if any, swallows arrived at his colony as mated pairs. However, some birds bred with mates of the year before, occupying different boxes, or in some cases, their old nests, allowing the conclusion that a pair bond may exist between certain pairs, and that re-mating in other cases may be caused by no more than the birds returning to the same box, and meeting there. As with the Violet-Green, pairs were found at sites (in which nesting subsequently occurred) on March 31, 1962, shortly after their arrival. Their early selection of nest-sites was noticed by Gullion (1947) and Weydemeyer (1934), who found this behavior exhibited immediately after the birds' arrival.

Johnston and Hardy (1962) believe the Purple Martin's early spring arrival is influenced by the search for nest-sites - possibly the same factor operates in this species. Up to the end of May, the weather movements to the marsh occasionally involved large numbers of Tree Swallows - these were very likely migrants, or at least transient in the

area. For instance, on May 3 a flock of 30 was seen going to roost in the marsh vegetation. Tree Swallows apparently participated in the weather movements to the same extent as the Violet-Green Swallow, and presumably the same implications can be drawn. Too few nesting birds were present to allow a more accurate generalization. Such responses to poor weather by this species are mentioned by Chapman (1955), and Paynter (1954).

Intraspecific territorialism is difficult to evaluate, as these birds are relatively social, may nest colonially, and have not been adequately described in terms of the behavioral mechanisms employed. Apparently only the nest site is defended, all other areas being open to communal use (Gullion, 1947, describes defense of a flyway by this species also). During May, conflicts were observed at all three nests in town, but, lacking marked birds, any changes resulting from them remained unknown. No persistent interruptions or physical contacts were seen. The impression sometimes received was that the sight of birds attending a box would stimulate others to similar behavior. Song has a definite territorialistic role, as the chirruping of an established bird, already paired, becomes particularly intense when a rival of the same species nears the nest.

Possible interspecific conflicts involving Tree Swallows (versus English Sparrows and Starlings) were detected at three locations, and in each case swallows bred in the site. The status of their opponents, and consequently the intensity of their involvement, is unknown. For instance

at the Laidlaw Study Area, on May 24 a pair of English Sparrows had apparently become recently established (behavior was "nervous" (Summers-Smith, 1958)) at a cavity in a snag, from the vicinity of which the male sparrow was seen to chase a pair of Starlings. Tree Swallows, present in the area, paid no attention. During the next visit on June 1, no sparrows were seen and a Tree Swallow pair was at the cavity, where swallows eventually nested. While it is difficult to predict when and where sparrows are going to breed, site-selection at this time, and in this location, is not what would commonly be expected, and they may have left of their own accord.

The Tree Swallow appears to differ from the Violet-Green in its behavior at the nest, as the following impressions illustrate. The Violet-Green's attendance at the site during the preliminary breeding stages is far from constant even when the weather is fine, being broken by frequent periods of absence, perhaps for feeding. The Tree Swallow appears more faithful to the nest, with at least one bird regularly perched in its vicinity. Gullion (1947) makes a similar observation. Also, its habit of waiting in the nest entrance is seldom duplicated by the Violet-Green. Generalizing from a limited number of observations, the Tree Swallow seems more aggressive toward potential nest-site usurpers.

Apparently territoriality has no effect upon the spacing of the nests, though the habitat has, through its supplying of both food and cavities. An effect of favorable habitat

upon the establishment and size of a colony is suggested by Chapman (1955), and Paynter (1954), among others.

One brood per year is normal for this region, and it must be raised in a pre-existing cavity. So much material may be used in the nest that a tree cavity is made unsuitable for use by other species (McLaren, 1963). (While the Violet-Green and Rougn-Winged Swallows behave similarly, the other species in this region that utilize the types of sites that these three species favor would probably be little affected by this habit.)

In town, only bird boxes were utilized by the small Tree Swallow population, though on two occasions birds were seen investigating small circular holes in the sides of buildings. Outside the town, besides bird boxes, only tree cavities were found in use. The Tree Swallow will nest in cavities that differ widely in dimensions and preferences within these tolerance limits are not demonstrable (McLaren, 1963). Though use of other cavity types is reported (Bent, 1942), in this region the Tree Swallow appears to restrict itself when choosing nest sites (B.C.N.R.S.).

Roosting in the nest cavity is done by the female only, and generally not until after the nests are nearly completed (Weydemeyer, 1934).

English Sparrow

The English Sparrow is a sedentary permanent resident around concentrations of humans, and usually occupies buildings. It has recently colonized the area, arriving in Vancouver around 1890 (Brooks and Swarth, 1925), and in

Hope about 1902 (Thacker, 1922).

Sunny days will elicit interest in potential nest sites anytime from January on, though the lack of observations in the months preceding May prevents generalizations on the average times of site-selection and nest-building. A trip to Hope on March 31, 1962, found high intensity territorialism common with many pairs apparently stabilized at suitable breeding locations and some birds building nests.

The following nesting activity outlime is taken from Summers-Smith (1958). Young birds show interest in potential sites in the early fall, but there is no serious attempt to adopt a permanent site. They apparently learn about suitable cavity types and locate vacant roosting places. A young male will take up a permanent site early the next year, advertise from it, and may soon attract a mate. Once they have bred, a pair is relatively permanent, each bird remaining attached to the original site for the rest of its life. Up to three broods per year may be raised in one site.

The sparrow is a colonial nester, and territorialism is limited to defense of the nest site (Summers-Smith, 1958). Owen (1957) found territorial sizes to be inversely proportional to the abundance of available nesting sites, and to range from 18 in. (46 cm.) to 20 ft. (6 m.) in diameter. All other areas are subject to communal use. The sparrow is frequently successful in interspecific competition for nest sites if it is established at the site before conflict starts (no instances to the contrary were recorded). The few pertinent observations made suggest that if the sparrow

is new to the site, it is much less effective as a competitor, but since nothing is known of the status of the participants or the desireability of the site, no conclusions are possible. For instance, in March a male had claimed a portion of a building where no cavities even existed. Once it was courting three females here, when another pair arrived. The courting bird grappled with the other male, both fell to the ground, and finally the intruding pair was chased out of sight across the street. Why this spot was selected initially is puzzling and though the other pair may have been attracted by the displays, such an occurrence casts doubt on the validity of conclusions drawn from other observations on unmarked birds.

The possible intensiveness of nest-site competition was indicated when a bird box with a trap door was erected in place of a double compartmented bird house at which sparrows had been expressing interest. This was on March 20, 1962, in White Rock, B.C. Put up at 8:30 A.M., the males of two pairs were trapped and destroyed by 9 A.M. At 9:05 A.M., two additional males, apparently unpaired, engaged in a short battle at the box. Then from 10:30 A.M. on, no sparrows were seen, and a few days of poor weather apparently suspended nesting activities, with investigation of the box next seen on March 25.

The spacing of nests of this potentially colonial species is little affected by territorialism, though it is by the placement of suitable nesting sites, which were in surplus in the study area. There is the possibility

that some potential sites go unoccupied because the food resources of the immediate surroundings are inadequate for the support of a larger population. This is suggested by the tendency of the birds to concentrate feeding activities at a few good sources, as pigeon coops, the public park, etc. Residential blocks devoid of such feeding areas had few, and often no, sparrows, although swallows and starlings found nest sites there. Summer-Smith (1959) offers a more sophisticated explanation. In Britain, the food supply appears to exercise the greatest limiting effect when the population is at its maximum in the summer, the young suffering more than the adults. At the beginning of the breeding season, control is exercised in some way by the colonial behavior of the bird. Available habitat is not filled uniformly, the birds tending to congregate in colonies. In these colonies, non-breeding adults of either sex exist, even though potential nest sites are abundant. "Presumably it must be a psychological factor that limits the colony size. Observations suggest that in good feeding areas there is a greater density of colonies rather than an increase in colony size."

The habitat of the English Sparrow is buildings and their immediate surroundings. While it may build nests in trees (Kalmbach, 1940), and in ivy or similar growth on buildings (B.C.N.R.S.), in the Town Study Area only cavities in buildings (38), bird boxes (5), and Cliff Swallow nests (1) were utilized (1962 data only). The variety of cavities used indicates a wide tolerance concerning nest-site dimensions. A definite preference was indicated for sites having perches

in front of them. This was illustrated on several buildings (as Plates 12 and 13), where, in a series of otherwise identical cavities, only the ones with perches were used. This contrasts with the selections of Violet-Green Swallows and Starlings, as these birds usually choose the corner cavity of a series, perhaps because it is easier to orient to, or offers greater freedom of approach.

Direct observation of the contents was not possible at any nest, so that data on the extent of utilization of individual cavities is often vague. Of the 44 nests discovered in 1962 (1961 data, being incomplete, are not included), 1 was destroyed, in at least 2 others laying apparently never occurred, and 7 others were so situated as to preclude satisfactory observations. In 13 nests, at least one brood was raised; 15 nests had at least two broods; and three broods occurred in each of 6 sites (cf. Weaver, 1943). Since the existence of young had to be determined by sound, or by the bringing of food by the parents, obviously the number of multiple-brooded nests must have been higher than the weekly observation trips indicated. This is additionally illustrated by the fact that at 26 sites, sparrows were recorded in at least three different months. Also, no allowance can be made for nestings which did not achieve the success of live young. From these considerations, up to 40 pairs in breeding condition are estimated to have occupied the study area.

A new cavity is not required for every brood (though a pair may hold and breed in two sites, especially when sites are plentiful (Summers-Smith, 1958)), and broods follow one

another at approximately six week intervals. Fledging generally occurs in the third week of May, the last half of June, and the first week of August, but how many pairs raise three broods is unknown. More than three broods per year has not been proved in North America (Bent, 1958). The end of the main breeding season is indicated by the formation of adult-containing flocks by the middle of August. Many of these birds are obviously in molt.

Bulky nests are constructed in March and April, and may be added to between broods. The presence of nest material may make a site less desirable to future occupants of the same or different species. An English Sparrow nest apparently discourages a site-selecting Purple Martin (Allen and Nice, 1952).

Starling

The history of the Starling in British Columbia up to 1957 is reviewed by Myres (1958) and as predicted (page 47, ibid) has since that date established itself as a breeding species throughout the length of the Fraser Valley (B.C.N.R.S., and personal observations). Up to 1957, the status of the Starling on the coast was that of a winter visitor; "--- only the development of a non-migratory habit in certain individuals can alter the present situation. Probably during the next ten years this will happen" (Myres, 1958). A nest found in 1962 in a building at Pinewoods, Manning Park, in which two broods were raised, represents a range extension not predicted by Myres. The species was first recorded from Manning Park in 1960 (D. Dow, personal communication).

Its establishment as a resident in Hope has been recent. Some of the town's inhabitants, questioned in 1961, were not familiar with the species, although some Starlings reportedly wintered in the town in 1960-1961. Seven nests were located during the abbreviated 1961 summer observation period (from June 18 on), and it is possible that up to half a dozen pairs nested in the town the previous year.

The following summary is taken from Kessel's (1957) observations on a resident population in New York. Starlings display an interest in nesting sites throughout the autumn and winter months, and tend to choose nest sites close to the ones they used the previous year. A nesting territory includes a 10 to 20 inch radius about the nesting hole. Starlings will nest in close proximity to other Starlings and other species. They often have communal singing perches and feeding areas.

Davis (1959), also studying a resident population, found that defensive behavior, usually exhibited in conflicts between a stranger and the owner of a nest hole, "--- begins in August, at least for some birds, increases till November, decreases in December, and then increases greatly from January to April. --- The defense revives before renesting--". He summarizes the annual cycle: "During July and August the birds moult and are reproductively inactive. By October most males have obtained nest holes which they defend. The females also defend holes but the fighting is not vigorous and hence is inconspicuous. Defence of the holes becomes less active in winter but by February becomes more active.

Copulation occurs in early April and eggs are laid in late April".

Without regular observations before the beginning of May, this increasing interest in nesting sites could not be traced. It is assumed that the local population is basically resident. If migration does occur, the usual SSW to WSW direction taken in the fall (Myres, 1958) would allow only a few miles of movement to the lower Fraser wintering grounds. In 1962, display at some nests was seen on March 18, and this advertising was more common on March 31. April 9 had the highest activity, with many pairs established at nest sites, some of them building nests. Working backward from the average first brood fledging date of the end of the third week in May, and allowing 38 days (Dunnett, 1955; Kessel, 1957), the average laying date of the first egg must have been around the end of the second week in April.

From the limited observations, late in the spring, the intensiveness of territorialism is impossible to judge. Identification of individuals, permitted by marking techniques, would allow the intentions of the participants, and any replacements at a site, to become known. Confusing this situation is the presence of unmated birds that may become involved at established nests (Kessel, 1957).

For example, the most intensive intraspecific conflict seen occurred on May 25, at a site from which one brood had already fledged. It involved five birds, of which at least the defending two were paired, and perhaps two of the intruders. A rapid series of short chases occurred, with the

defending bird always the pursuer. As soon as pursuit stopped, about 70 to 80 feet (21 to 24 m.) from the site, the intruder would return, only to be chased again. Sometimes the defending bird would leave the site to displace one or more of the other Starlings even though they happened to be perched up to 50 feet (15 m.) away from the nest. The intruders left after about ten minutes and the defending male then sang and displayed briefly at the site before also leaving. However, the nest site went unoccupied for the remainder of the summer.

The possible vagueness of such observations was illustrated again on July 14, in the Laidlaw Study Area, where an independent young-of-the-year was watched for at least a half hour as it investigated holes in the area. Many of the snags bore deep irregular scars created by feeding woodpeckers, some of these were up to two inches deep in places, and the Starling would frequently perch at them and then try to enter the non-existent cavity, pushing and straining until its head was bent back over the top of its back. It was only a matter of time until a nearby Tree Swallow nest containing large young was visited and when the Starling did so, the male Swallow flew at it, striking it and driving it away. The few additional interspecific conflicts seen were similarly inconclusive.

In the last week of May and first week of June there is a recrudescence of the preliminary sexual activities prior to the laying of the second clutch. Singing and displaying near sites is common, occasionally exploration of sites not

previously used by Starlings occurs, and nest-building is seen again.

Excellent Starling habitat, described by Kessel (1957) consists of scrubby pasture and hayfields, bordered by hedgerows and scattered trees in a primarily agricultural district. The lack of this habitat in the surroundings of Hope will limit the bulk of the area's Starling population to the town itself. It is possible that in the future, up to half a dozen pairs will nest on the Reservation, but at present they visit only the marsh for roosting. The floor of the Fraser Valley, as typified by the Laidlaw and Chapman Road Study Areas, would appear to offer ideal habitat, which is not yet being fully exploited.

The normal Starling nest site is a cavity in a tree or building, and no deviations from this were observed. It cannot provide its own cavity, although an old one may be cleaned out (Kessel, 1957).

Thirty of the 34 nests located within the study area in 1962 were in buildings, 2 were in bird boxes, and 2 in holes in trees (of the 7 nests found in 1961, 5 were re-used in 1962 and 2 were sealed off). Thirty-three nests were followed closely: at 2 nest-building occurred, but no young resulted; 9 were used for two broods; and 22 contained one brood. Twelve of the latter had first broods and 10 contained "second" broods. The histories of these 10 are uncertain. Possibly they represent initial breeding attempts of the season, or perhaps there were first broods raised in them that went undetected (considered likely at 3 sites).

Also, especially since site-selection occurs during the interval between broods, it is possible that new cavities were chosen from the surplus of sites for the rearing of second broods. Kessel (1953) reports that many of the same nesting sites are used twice and Dunnett (1955) states that second broods usually occur in nest-sites used for the first broods; banding studies would be required for clarification of this point. The broods fledged by the end of the third week in May and the end of the first week in July. An estimated 35 breeding pairs occupied the study area in 1962. Starlings are rare in the town toward the end of July.

An indication of the increase in the town's Starling population over these two years is given by comparing the 19 nests occupied on the reduced study area from June 18, 1962 with the 6 nests located on the same area during the same time in 1961 (when the season's weather was more favorable).

House Finch

The current range expansion of the House Finch is reported by Edwards and Stirling (1961). From its first appearance on the coast around 1951, it has slowly advanced up to Hope at the head of the Fraser Valley, where a singing male was recorded in 1961.

During this study, single birds were seen on two occasions during June, 1961.

In 1962, the species was much more common, being recorded irregularly throughout the summer. All the sightings were made in the town, with the four following exceptions. On April 30 and May 30, single birds were noted on the top of

Little Mountain and on June 12, a male, female, and one juvenile were seen here. In the Laidlaw Study Area, a male, female, and one juvenile were seen on June 16.

In the Hope Study Area, one, likely more, pair contributed to the sightings. The few observations indicate that they roam freely over a neighbourhood (cf. Evenden, 1957; Salt, 1952). No successful nests were located but the presence of young birds indicates breeding.

On May 27 one nesting attempt was discovered. As the circumstances indicated competition, and this is the only such instance noted, the details are presented. In the late afternoon, four birds were seen from a distance to be perching near, and fluttering up to, a point under the eaves of a little-used building. Two of them fell to the ground in fluttering combat. When close enough to identify the birds, two of them, now sitting on nearby wires, were seen to be English Sparrows and the other two were House Finches, engaged in nest-building (Plate 14). The English Sparrows left the area shortly and the female House Finch, accompanied by the singing male, made four trips to gather nest material. As the female was working one load of dried coarse grasses into the nest, an English Sparrow returned to the area. The male House Finch, which had been singing from the peak of the roof, immediately moved to perch closer to the nest site. The sparrow then made a fluttering attempt as if to land at the nest, but turned without alighting and left the area. The House Finches, which had kept to their respective positions, resumed nest-building, but shortly after left the area

themselves, about half an hour having elapsed since the birds were first noticed. This site was visited on every subsequent observation trip and although a bit more material was added to the nest, no birds were seen here again. While it is difficult to judge if such a site would be chosen by Violet-Green Swallows or Starlings, because of its shallowness and open aspect, it is significant that English Sparrows successfully nested in a similar site in a building several hundred feet away.

The above attempt almost certainly represented a second nesting of the season, as two days later, a male House Finch was seen feeding two begging juveniles a few hundred feet away. On June 13, an uncounted flock of about a dozen, mostly young, was feeding throughout the same area. Isolated sightings in which no pattern can be found filled out the summer. On July 24, a flock of 13, mostly juveniles, was seen at the study area's southern corner.

The House Finch has risen markedly in numbers in the Hope area in the past two years, and following the pattern of its establishment in British Columbia, it can be expected to become one of the commoner residents of the area. Edwards and Stirling (1961) report that in the late fall of 1961, this bird was the commonest passerine observed in the Fraser River delta area. They conclude, "Man with his buildings and gardens, fields and irrigation, appears to have created new and suitable physical habitat for the House Finch in both the valleys extending northward from the Columbia Basin and the dry parts of the Pacific Coast."

There are 52 House Finch records in the B.C.N.R.S. - all of them describe nests built in shrubby trees and bushes, many of them ornamental evergreens. Cant (1962) reports that the nests of an introduced and expanding House Finch population in New York state are about equally divided between such evergreens and buildings. "The single reguirement which appears to be satisfied in all such situations is that the nest be either covered or shaded by vegetation or some other structure." (Salt, 1952). The House Finch is an early breeder and usually builds a new nest for the second brood (Bergtold, 1913; Thompson, 1960). It may nest semi-colonially, and has indefinite, relatively narrow, territorial boundaries (Thompson, 1960).

Just what effect the rising population may have upon the already established hole-nesters is unpredictable. The House Finch starts nesting early, but not as early as the English Sparrow, which also raises more offspring per year. The presence of a large House Finch population in Denver, Colorado, did not prevent the rapid increase of English Sparrows around the turn of the century (Bergtold, 1913). Nor has the presence of English Sparrows prevented House Finches from expanding through British Columbia (Edwards and Stirling, 1961) and the eastern United States (Elliott and Arbib, 1953). Perhaps only in residential and suburban areas (as in Hope) will the habitat be suitable enough, and the preferred nest sites plentiful enough, to allow the population to build up to the extent that a significant amount of intra- and interspecific competition might occur (as described by Bergstrom,

1913; Evenden, 1957). How drastically a high House Finch population could affect populations of other cavity nesters is unknown.

DISCUSSION

There are two sections in the discussion, that present: a) the possible mechanisms through which nest-site competition may be effected, with a summary of some related studies; and b) a synthesis of this study's data.

The Process of Nest-Site Competition

Andrewartha and Birch (1954, pp. 23-25) illustrate the process of competition with an imaginary example, consideration of which indicates that competition involves many elements:

- a plurality of organisms
- these organisms overlap in their demands on an environmental resource
- their demands are made together, indicating spatial and temporal contiguity
- the environmental resource is so limited that the demand exceeds the supply
- the implication of harmful effects as a result of competition.

A definition incorporating these elements, taken from Udvardy (1951), is essentially similar to those given by Birch (1957); McLaren (1963); and Milne (1961); "Competition is the demand at the same time by more than one organism for the same resources of the environment in excess of immediate supply." This discussion is limited to competition for nest-sites among hole-nesting avifauna that utilize holes in trees, or equivalent cavities.

Consideration must first be given to the restrictions imposed by the quantity of holes available, which by itself

will limit the population of hole-nesting birds, and thus establishes the basic framework within which competition must operate.

Prerequisite to the existence of such competition is the presence together of hole-nesting birds that are potentially inhabitors of the same cavities. If competition exists, it has already, through the harmful effects implied, been affecting the populations of the birds involved. It is not possible to observe the process in its entirety, although when an area is invaded by a previously absent species, its effect as a competitor upon a relatively stabilized hole-nesting bird population could be evaluated.

The absence of certain hole-nesters from areas where they "should" be (as in Table 1) is difficult to explain. With attention focussed on competition, it is tempting to advance this process as an explanation of their exclusion. The possibility exists that severe competition for nest cavities can operate as one of many factors limiting a population, but whether such competition (necessarily interspecific) could be the factor determining a species' absence from an area is highly debatable. Hardin (1961) illustrates the impossibility of proving whether competitive exclusion can occur between species of identical ecology. Later, Cole (1961), in reviewing Skellam's theoretical example in which even complete competitors can coexist, theorizes that it can easily be applied to hole-nesting birds "--- where the availability of 'spots' suitable for reproduction limits population size." If it is impossible to prove competitive ex-

clusion between species of identical ecology, and competitive exclusion is not even a necessary result of the co-existence of complete competitors, then the situation in a hole-nesting avifauna of widely divergent evolutionary backgrounds and ecological demands (as McLaren, 1963, points out) must be vague regarding the concept of competitive exclusion. However, the fact that only one environmental resource, of the many required for the perpetuation of the competing species, is sought in common, would facilitate the analysis of competition per se, provided that the other ecological demands of the species involved were thoroughly understood. Results obtained would necessarily remain relative. Working from theory, Patten (1961) concludes that competitive exclusion should be regarded as only a small segment of a broad class of interspecific phenomena. In practise, habitat selection mechanisms will almost invariably intervene before the advent of significant interspecific competition (Bond, 1957; Dixon, 1961; Udvardy, 1951). McLaren (1963) suggests "--- that the reason for their /ie.- several hole-nesting birds/ apparent scarcity might more profitably be sought in considerations related to aspects of the niche other than nest-site competition."

Hole-nesters are either able to excavate their own cavities or not (primary and secondary hole-nesters of McLaren, 1963). That primary hole-nesters are able to provide their own cavities does not mean that they will always in this way add to the environmental resources. Also, many hole-nesters (often but not always secondary) have such broad nest-site requirements as to permit nesting in situations

other than tree holes. (Thorough knowledge of the life histories of the species involved is essential for the complete analysis of a competitive situation.

First, the most important aspects of the "demand" will be outlined; this will be followed by a consideration of possible effects.

In competition for nesting cavities, the "demand" is made through the behavioral reactions of two or more birds, oriented toward a particular nest site, and occasioned by their need for it. Excluded is all behavior directed toward other environmental elements, or the whole habitat, although these demands are always interrelated in varying degrees. The habitat selection mechanisms, and the bird's behavior towards its habitat as a whole, once selected, are often closely related to its reactions at the nest-site, and for this reason will be considered later.

The demand for a hole may be made by birds of one, or two or more species. It is possible that a hole may not be suitable for the nest of a species, yet individuals of that species may exhibit a need for it, this behavior being released by certain aspects of the cavity, and the level of the individual's motivation. This behavior would have validity only from the point-of-view of the bird exhibiting it, and would be allowed by the imperfections necessarily involved in a relatively simple site-selection mechanism.

Intraspecific competition occurs between individuals that presumably make the same demands, in much the same way, from the environment, and thus react identically to a

potential nest-site. However, the possibility exists that all the members of a species do not react in this way, but that, possessed with a degree of plasticity regarding nest-site requirements, and allowed by the existence of sites of differing types, certain individuals, or segments of the population, become psychologically accustomed or conditioned to one type of site, thus producing an isolating effect between population segments, or individuals (cf. Koskimies, 1956; Svardson, 1949; Thorpe, 1945). Such a phenomenon could alleviate or intensify nest-site competition, depending upon the conditions, and would require separate analysis in each individual case.

The demand for a particular nest hole is expressed through the behavior of individual birds. Intraspecifically, this competition could be implemented in two different ways. First, individuals might compete actively, reacting toward one another with behavior drawn from presumably identical repertoires. Or, the actions of one bird or pair at a cavity might change it in such a way that other individuals prospecting during the same breeding season would find it less attractive than it was in its original condition. The birds would never have to meet. The existence of this possibility would require separate determination for each species. This more passive aspect is classified as competition, rather than a form of environmental conditioning, as the condition of "same time" appears to apply. Such actions extending their effects from one breeding season to the next cannot be termed "competition". Milne (1961) points out that even

though the participants might never meet, still a competitive process can exist between them, provided that their "endeavour" is considered to occur within a proper temporal interval.

Interspecific competition for nest-sites might also be "active" or "passive". When two birds of different species actively compete, one or both behaving aggressively, one species will likely win more often than the other, since their behavioral repertoires, and hence their competitive effectiveness, will likely not be identical. The more passive competitive process is probably more common interspecifically than intraspecifically - the introduction of nest material by one bird preventing the establishment of another type of bird is an example (cf. Busse and Gotzman, 1962). This being "nest-site" competition, "same time" would apparently apply to such interactions occurring within the time from the start of site-selection in one species to the end of this process in the other.

Competition necessarily implies a harmful effect, and must be considered as a possible population-controlling factor. If it exists, it becomes interrelated with all other population-controlling factors, influences their action, and in turn is influenced by their effects.

Such a population-controlling factor, which enters this discussion, is territorialism (cf. Tompa, 1962). One reason for its inclusion is that a potential nest-site is involved, at least indirectly, when a bird selects its breeding habitat, and once a bird defends a portion of suitable habitat, it is, at least indirectly, defending its nest-site. Some birds

defend only the nest-site and its immediate surroundings, allowing communal use of all other areas; this behavior is also referred to as territorialistic.

With species of the latter type, establishment of a territory depends on the presence of a nest-site (cf. von Haartman, 1956) - there are indications that the presence of potential nest-sites is indispensible to territory establishment even in hole-nesting species that defend a large area (as the Black-Capped Chickadee, Odum, 1941a). Territorialism may be intraspecific or interspecific. An interspecific conflict concentrated at a particular part of the territory is not interspecific territorialism (Simmons, 1951), and this allows the creation of examples like the following: a bird of one species (which defends only the nest cavity) is competitively involved with a bird of another species (which defends a large area around the nest) at a nest cavity. The former would be exhibiting interspecific territorialism, but the latter would not. This distinction, although not of importance, is the reason that "nest-site competition" is to be preferred in reference to such situations.

Kluyver and Tinbergen (1953) proposed that territorial behavior produced a density-limiting effect through the habitat selection mechanisms on populations of European Tits. The number of nesting cavities per se would have permitted a denser population - some nest sites went unused. Birch (1962) notes that organisms which have large requirements for space, and defend their space as a territory, are less likely to be limited directly by absolute shortage of environmental

resources than non-territorial animals. Territorialism is thus potentially highly involved in studies of nest-site competition; the extent of involvement can be expected to differ in each species.

It is a fact that the size and spacing of colonies of colonial birds (several hole nesters show colonialism) varies with the "excellence" of the environment (Lack, 1954). This effect may perhaps be accomplished with the aid of epideictic displays (specially-timed communal display sensu Wynne-Edwards, 1962, p. 16), through which the total population, and the number of breeders, in an area is evaluated, and related to the environmental resources, then to be regulated accordingly. Whether the number of potential nest-sites is directly involved in the assessment of the environment is unknown, though the process will certainly affect the initial demand made upon the existing cavities.

The various aspects of competition having been presented, next its effects will be considered. Harmful effects are implicit in the definition given; other definitions, essentially similar, specifically mention harmful effects (Andrewartha and Birch, 1954; Birch, 1957).

From the competitive processes themselves, there is first the possibility of physical harm. This is occasionally reported (as loss of eggs, young, or injury to, or death of, the adult participants), but is probably rare, and seldom is quantitatively evaluated. An exceptional case is reported by Bergtold (1913); a loss of 16 percent of House Finch eggs and young due to destruction by the

the English Sparrow - this interspecific competition for nesting sites between dense urban populations of these species was the largest single factor in the loss of House Finch eggs and young.

Another harmful factor, difficult to evaluate, is the expenditure of energy in competitive processes. It is essentially wasted, not contributing to the well-being of the individuals involved.

Partially a function of energy waste is the loss of time, which may assume great importance. The timing of breeding activities of birds is often rather delicately adjusted to seasonal changes. A delay in the start of breeding, as might occur under severe competitive conditions, could result in no brood at all; a brood reduced in number; less success in raising a brood to independence; or reduced success in, or absence of, additional broods during that season. As an example, Kessel (1953) found that successful second broods could be expected, in an Ithaca, N.Y. Starling population, only from those females that had raised the first brood successfully and without interruption. This loss of time affects both birds (or pairs) participating (Udvardy, 1951). Even the dominant species in interspecific conflicts may enjoy a Pyrrhic victory (Ripley, 1959, 1961), and the term "aggressive neglect" now describes such situations (Hutchinson and McArthur, 1959). This coverage of the main theoretical points of nest-site competition illustrates its potential complexity, and points out the need for thorough life-history knowledge of all species involved. Brief consider-

ation is now given to examples of North American hole-nesting birds involved in competitive relationships, though not necessarily for nest-sites (as this has not been extensively studied), in order to illustrate related aspects of competition which have been found to be represented in nature.

In southern Wisconsin, Bond (1957) surveyed the breeding birds of 64 upland hardwood stands, which represented a gradient of vegetational differences. One of his conclusions is quoted: "Differences in distribution of the various bird species along this vegetational gradient are but one expression of their ecological dissimilarity. Even though several species may be similar in one or more of their requirements (e.g., nest sites), there are other differences which separate them ecologically and, hence, reduce possible competition. Using the hole-nesters as an example, the four woodpeckers in the study have different trends along the vegetational gradient, different nest-sites, and different feeding habits, while the remaining hole-nesters, the Crested Flycatcher, Black-Capped Chickadee, and White-Breasted Nuthatch differ from each other and the Woodpeckers in response to the gradient, nest construction and, mainly, in feeding habits."

Dennis (1951) censused the Woodpecker populations of different plant communities in Florida, during the non-breeding season. He found significant differences in the feeding habits of all eight species involved, some of which were migratory. Interpsecific conflicts between Woodpeckers, while noted, could not be associated with population changes in any habitat (as of a local species when a migrant species

arrived), and were considered to be seldom serious enough to cause any unbalance. Intraspecific competition, and interspecific competition with birds other than Woodpeckers, were uncommonly observed.

Staebler (1949) studied the life histories of the Hairy and Downy Woodpeckers comparatively, and concluded that there was no ecological competition, any associations between the two being purely passive. Believed among the more important isolating factors were the differences both in the nest-sites used, and in the times of breeding. No interspecific conflicts for nest-sites or nesting territories were observed. Feeding behavior of the two species was found to be markedly different. Bond's later (1957) study showed that the two species demonstrated opposite trends along a vegetational gradient, for while both occurred in woods representing any point of the gradient, the Hairy was more common in the denser, more mesic types, and the Downy's abundance was greatest in xeric woods. Considering Staebler's work, Bond concluded that this difference would have to be explained by habitat selection mechanisms.

McLaren (1963) studied nest-site competition among the 17 hole-nesting bird species occurring in the Cariboo region of British Columbia (Fig. 1). The cavities available in this predominantly aspen-parkland type habitat were divisible into three natural groups on the basis of entrance size: small, medium (excavated by Flicker), and large. The large hole "cycle" of primary and secondary hole-nesters was too poorly known, and too difficult to work with, to be general-

ized upon, and the small hole cycle was composed mainly of primary hole-nesters, among which competition was difficult to envision. In the medium-hole cycle, only six species were common: Tree Swallow, Sparrow Hawk, Bufflehead, Mountain Bluebird, Starling (which occurred as a nesting species only in the 10 years or so preceding the start of the study in 1958), and the hole-producing Flicker.

The study was based mainly on data collected concerning the ecological and physical characteristics of the medium holes, and it was clear that, in terms of the parameters considered, the requirements of the species involved showed an impressive degree of overlap. This demonstrated quantitatively the possible occurrence of competition, but since selection for different cavity types had not occurred among the native species, the existence of significant competition could be argued against. The greater majority of cavities available were found to be in use, with the recently-arrived Starling occupying roughly one-quarter of them, which allowed the conclusion that the hole-nesting bird population was being limited by the number of holes, and that, especially since the advent of the Starling, comparative competitive ability might be determining the proportion of the total population taken up by each component species.

Selander and Giller (1959) found that two closely related, morphologically similar Woodpeckers, the Red-Bellied and the Golden-Fronted, were sympatric only within a narrow zone in central Texas, which coincided with a marked east-west faunal and floral "break". Within this overlap zone,

differences in habitat occurrence limited contact and competition, but where both species occurred together, they held mutually exclusive territories, this interspecific territorialism illustrating the competition for space and nesting sites. Details of feeding and nesting, and vocalizations and displays, were found to be similar in both species. They demonstrated ecologic differences elsewhere than in the zone of overlap, where there was no conspicuous narrowing of habitat. "The overlap in habitat occurrence is sufficiently extensive, however, to warrant the hypothesis that either species would, in the absence of the other, occur in greater density in the overlap zone. ...Reproductive isolating mechanisms, the nature of which are unknown, have evolved, but the species have not made ecologic adjustments which would permit extensive sympatry." The territories of a pair of Red-Bellied and a pair of Red-Headed Woodpeckers, observed in the same area, overlapped broadly, and no interspecific antagonism was seen. Suggested as factors in permitting extensive sympatry of these species were their differences in foraging habits and habitat occurrence. Yet when presented with dummy mounts of Red-Bellied Woodpeckers, the Red-Headed exhibited vigorous aggressive behavior (this near their nest). "These tests help account for the fact that the pair of carolinus avoided perching in the vicinity of the nest-tree of erythrocephalus." Ripley (1961), apparently referring to all three species, comments on this work, "It seems conceivable that, should the nesting territories of these species in a zone of overlap become accidentally compressed, the phenomenon of aggres-

sive neglect might come into play."

From this consideration of the implications theoretically inherent in a study of nest-site competition, and the examples of comparative study of some North American hole-nesting birds, it would appear that such competition, though always possible, is probably never severe, and is perhaps non-existent, for many of the species composing the hole-nesting avifauna of any region. The conclusion of Bond (1957), quoted on page 128, undoubtedly typifies the situation in many biotic areas, with the overall results of the bird's habitat selection processes, and their living habits, keeping them so ecologically distinct that such competition, though perhaps occurring occasionally, can generally be disregarded as a population limiting factor. The value of even a slight amount of competition as a factor in selection is unknown.

Synthesis of Data

The region in which the study was conducted is basically a temperate rain forest that has a heavy growth of predominantly coniferous vegetation on a mountainous terrain. Much of the accessible forest has been logged and this disturbance is continuing. Fire may have affected any portion. These processes have resulted in large portions of the mountains bordering the valley being covered by variously aged successional stages. The valley floor has been extensively modified for use as farmland, and supports a high human population. All these factors of human or accidental disturbance, and topography, contribute to produce a relatively varied habitat. Most of the Reservation has had a recent

history of fire and logging, and is representative of a substantial portion of its surroundings in that it supports successional vegetational stages of different ages.

Either logging or burning of timber may produce a quantity of dead snags that soon become suitable for nest-excavation by hole-nesting birds. Logging may result in an area bearing scattered tall thin snags, as the felling of marketable timber damages smaller trees. Forest fires may produce an area covered with snags. Larger fir snags may be very long-lived, supported by a hard core, while the outer portions are soft enough to be excavated easily. Other vegetational conditions do not supply the abundance of accessible snags found on logged and burned areas.

Southwestern British Columbia supports a varied hole-nesting avifauna (Table 1), but only a fraction of the potentially-present species were actually observed to be nesting in any abundance in wooded areas (Table 9). The majority of species, and of individuals, found to be present are potentially primary hole-nesters, with the ability to excavate their own cavities in suitable locations. In the preceding sections, it has been shown that the individuals of all the potentially primary hole-nesting species usually do produce nesting cavities each season. Consequently it is very likely that there is no absolute need for the presence of nesting cavities in a portion of suitable habitat in order to make it acceptable. Suitable places in which cavities could be excavated are more likely to be a determining factor, but it has been shown that many suitable unexploited locations for nests

TABLE 9. HABITAT PREFERENCES AND POPULATION DENSITIES OF THE COMMON HOLE-NESTING BIRDS

BIRD SPECIES	HABITAT PREFERENCES	AVER. POPULATION DENSITY IN 1962 PAIRS/100 ACRES
Wood Duck	Tree-lined sluggish streams and sloughs that provide both cover and food. A suitable nesting cavity must be nearby. Non-territorial.	-
Sparrow Hawk	Requires open terrain, with perching places, that affords an adequate prey supply. A suitable nesting cavity must be nearby. Non-territorial.	0.5
Red-Shafted Flicker	An "edge" bird, preferring generally open areas, that also provide places for nest-excavation. Territorial.	1
Pileated Woodpecker	Little known. Presumably prefers heavy woods. Territorial.	-
Red-Breasted Sapsucker	Prefers "edge" situations, not dense forest. Nests in maples if available. Territorial.	0.5
Hairy Woodpecker	Margins, burns, and logged areas of forests. Territorial.	0.75
Downy Woodpecker	Deciduous woodland. Perhaps "edge". Territorial.	-
Black-Capped Chickadee	A dual habitat preference in deciduous woodland, with young open second growth stages used for nesting, and more mature growth preferred for other activities. Territorial.	2

TABLE 9. Continued

BIRD SPECIES	HABITAT PREFERENCES	AVER. POPULATION DENSITY IN 1962 PAIRS/100 ACRES
Chestnut-Backed Chickadee	Mature coniferous forest and adjacent mixed growth woodland. Territorial.	-
Red-Breasted Nuthatch	Mature coniferous and mixed growth forests. Territorial.	2.5
Winter Wren	Under mature dense stands of mixed growth. Territorial.	-

exist in the habitat types common to the study region.

A consideration of the characteristics of the nest-sites found in use (some of which have been presented in tabular form in the sections dealing with individual species) indicates that the nest-site requirements of most of these birds often differ widely. This implies the production of many different cavity types in some habitats. From these points it follows that habitat types in this region with many potential nest-sites, and a population of hole-nesting birds, will shortly possess a surplus of abandoned nest cavities, theoretically useful to hole-nesters in other breeding seasons. This was the condition observed on the main study areas. The snag survey, although not completed, nevertheless had progressed far enough to support this conclusion. The elimination experiment, limited in extent, produced no result for which the presence of nest-site competition could be advanced as an explanation.

There exists a population of secondary hole-nesters obligated to use prepared cavities, that consequently makes a demand in this regard upon the environment. These birds, and any potentially primary hole-nesters that do not initially excavate their own cavities, are indispensible to the existence of nest-site competition. However, many of the secondary hole-nesters that could inhabit the region were absent from, or rarely seen on, the study areas, and were essentially absent in terms of the concept of nest-site competition. Other secondary hole-nesters, abundant in the region, concentrated their nesting activities in the town, and ignored the supposedly suitable nest-sites available in

the nearby woods. This situation is discussed in a later section.

Several reasons may be advanced for the absence of nest-site competition involving those secondary hole-nesting species found nesting on the main wooded study areas. The Winter Wren is not obligated to build its nest in tree cavities, and rarely does so. It is territorial, and its occupancy of a tree cavity is likely due more to the chance presence of a suitable cavity in its territory rather than an active searching for these potential nest-sites at the time of territory establishment. The non-territorial Sparrow Hawks occurred in such densities, and in different ranges each summer, as to suggest that all the potentially-suitable habitat was not being utilized, to which situation a shortage of nest-sites, and possible nest-site competition, was very likely not a contributing factor. The non-territorial Wood Ducks' apparent failure to nest during the last two summers is likely related to habitat unsuitability (to which a shortage of nest-sites could contribute) rather than competition for any available sites. This is suggested by the limited feeding areas available, and the fact that suitable habitat is more common in the lower Fraser Valley.

The following points are presented in conclusion. Most of the hole-nesting avifauna of the region is composed of primary hole-nesters, and many of these excavate their own nest cavities. All of the primary hole-nesters, and some of the secondary, are territorial, and this tends to lessen the probability of intraspecific nest-site competition ever

occurring. The nest site types preferred by some species are quite different from those used by other hole-nesters. The demands made upon environmental resources other than nest-sites are in many cases completely separate, and best fulfilled in different habitats, or different parts of the same habitat. These latter two points will tend to reduce the possibility of interspecific nest-site competition.

A consideration of these habitat conditions and the hole-nesting avifauna found to exist under them, plus the fact that regular observations of this situation over two breeding seasons did not provide any evidence of nest-site competition, allows the following statement. Under the conditions which have been defined above, there is no competition for nest-sites among hole-nesting birds. This means that this type of competition is not responsible in any way for the determination of the observed population densities. These must be determined by other population-regulating factors, which, at the present state of knowledge, can only be speculated upon.

All the hole-nesters nesting on the Reservation during this study were observed in the summer of 1960, when there also were present two pairs of Mountain Bluebirds, and one pair each of Brown Creeper, Lewis Woodpecker, and Pygmy Owl; the latter species was known to breed, while the others may have (Horvath, 1963). The absence of these species in the following two summers suggests that they be considered as irregular residents of the Reservation. What the situation was when they were present is unknown, and the possibility

exists that nest-site competition may be present under conditions other than those outlined.

The limited surveys that it was possible to make allows the following generalization, which must be regarded as tentative. Conditions roughly similar to those found on the Reservation exist on the lower portions of the mountains bordering the valley (some of which rise above timberline), and on any wooded parts of the valley floor. It is suggested that nest-site competition is absent or negligible in these regions. Additional ornithological surveys in these, and other sections of the Coast Forest, are needed to provide a more substantial basis for comparison.

The town study area, with a distinct set of conditions, is considered separately. Five species, all obligatory secondary hole-nesters, inhabited the buildings and bird boxes, where they occurred in much higher densities than in the surrounding countryside. The possible reasons for these concentrations may vary with the species, but likely include: habitat unsuitability of the surrounding regions (as in the English Sparrow); "tradition" (perhaps in the swallows); preferred habitat in conjunction with a low population level (Starlings and House Finches may be expected outside the town in lesser densities as their populations expand). The buildings in the town may provide nesting sites superior in both quality and quantity per unit area to those found in less artificial habitats.

These five species have certain traits that tend to reduce nest-site requirement overlap. These have already

been detailed, and are briefly summarized here in an attempt at synthesis.

The English Sparrow nests comparatively early, and is faithful to one site throughout the year. Crevices in buildings (which may be only partially enclosed), preferably with perches, are most often utilized. It is pugnacious, may destroy the nests of other species, (though this was not observed), and is considered to be dominant over the swallows and the House Finch. It is distinct in being found only around human habitations.

The Starling is a recent arrival, and is increasing rapidly. It normally nests in holes or crevices, and though more open sites may be used under extreme conditions, this has not yet been reported in British Columbia (B.C.N.R.S.). It may concentrate around human habitations. Its serious nesting activities start at roughly the same time as those of the English Sparrow. It may remain attached to one site through the winter and spring, and use it to raise two broods. Due to its size, the cavities available to it are limited, with smaller crevices being more common in the study area. It is reported to raid the nests of other hole-nesters, though this was not observed, and its size and persistence have given it the reputation of an effective nest-site competitor.

The House Finch, while reportedly not the English Sparrow's equal in competition, nevertheless has been able to expand into areas where the Sparrow is already established.

It seems to prefer the vicinity of man. Its independence of buildings when nesting has been noted, and this in itself would contribute to its success. The available records in the B.C.N.R.S. (52) indicate that its nest site requirements in British Columbia are almost completely separate from those of the English Sparrow. Whether this indicates a characteristic of this population segment, or merely reflects the small sample, remains to be seen. It is an early nester, but the timing of its broods cannot yet be worked out in this region.

In town, the small population of Tree Swallows nested only in bird boxes, and this lack of adaptability makes this species the most likely to suffer if competition should increase in the future. When nesting in trees, this swallow may use oddly-shaped cavities that are not completely enclosed, and why the birds in the town should show such a restriction is unknown.

The Violet-Green Swallow chooses crevices in buildings, which do not have to be completely enclosed, and does not particularly concentrate on bird boxes. It has become conditioned to this artificially-created habitat, and its numbers in the area have risen as a consequence. The effectiveness of both swallow species as nest-site competitors is presumably affected by weather conditions.

There was obviously no practical method of determining how many potential nest sites existed in the study area. Usually sites would be discovered only because birds were using them. However, it is certain that potential sites far outnumbered the combined populations of the hole-nesters.

This was judged not only from the existence of buildings containing many unused sites (see Plates 12 and 13), but also from the fact that many cavities not used the first summer were occupied during the second, and "new" ones were used for re-nestings and second broods. Several bird boxes were not utilized.

Succession of occupancy by different species at one nest occurred only once during each summer, and both times circumstances were such as to cause doubt that competition had occurred. Competition was seen at only a few sites, and rarely was it judged to be severe. That which did exist seemed often to be due to what might be termed "behavioral irregularities" on the part of one of the participants, as the defending of a part of a building where no cavities existed, or the investigation of a nest seemingly prompted by curiosity at seeing another bird entering it, and so on. When severe competition did occur, it was due to a failure on the part of the birds to "realize" that other suitable cavities existed. In other words, the "demand in excess of the immediate supply" did not exist in actuality, but only in the minds of the birds involved. This psychological factor, which can include the choosing by an individual of a nest-site to which it is accustomed, rather than any of those which it might potentially inhabit, could be important in a problem of this type, and yet would be very difficult to evaluate.

The situation at present is not static, as two new species are invading the area, and what will happen in the

future may be speculated upon. The Starlings will presumably increase until the scarcity of preferred sites begins to limit the population's growth (Kessel, 1957), although observations by Anderson (1961) suggest otherwise. Cavities large enough for Starlings are not too plentiful in buildings, and territoriality might limit the number of birds occupying a series of cavities in one building. Additionally, Starlings may be unwelcome due to their noise and filth, and some cavities will be sealed to prevent re-use. This has happened at only two sites on the study area. Even assuming that the Starling is victorious in all competition for suitable sites, there remain the many smaller cavities which Starlings can never enter, and of which the English Sparrow will presumably have first choice, by reason of its resident status, and early inception of breeding activities. The House Finch is as yet an unknown, though from data presently available, it should not make great demands on the available resources. Although they arrive early, the Swallows are slow to begin actual nesting, and usually will have second choice of sites. But if the Sparrow was going to utilize all the smaller cavities, it would have done so by now. Something other than cavity availability limits the Sparrow population - this may be food. So the Violet-Green Swallow population (which, it should be noted, has not increased to the size allowed by nest-site availability) is not likely to suffer because of an actual lack of cavities. In addition, this species can utilize other cavities in rock faces, and their constructed concrete equivalents, here entering into competition with another

species, the Rough-Winged Swallow, over which it appears dominant. The Rough-Wing, in turn, utilizes other sites the Violet-Green doesn't, so neither species is likely to be driven from the area because of increased nest-site competition.

However, the Tree Swallow, already in low numbers (for unknown reasons), and apparently limiting itself to bird boxes in the town, and tree cavities throughout the valley floor - sites particularly vulnerable to use by other species - may become absent as a nesting species in this area.

To conclude: At present, as far as the supply of nest sites is concerned, all the species breeding in the town could increase their populations. The House Finch and Starling undoubtedly will do so. Some of the possible results of this expansion are presented speculatively. At present competition for nest sites does occur, but in terms of the populations of any of the species involved, it very likely is of negligible importance.

A visualization of the process of nest-site competition must include something permitting a high population of non-hole-producing birds (these could be either primary or secondary hole-nesters) in relation to the amount of potential nest holes available, and being made available by primary hole-nesters (which are predominantly "forest" birds). A high proportion of obligatory secondary hole-nesters is likely to be involved in such a competitive situation. There must be present the environmental resources, other than nest-holes, required by these species to allow the maintenance of relatively high populations. However, many of the

secondary hole-nesters have widely differing ecological demands, and are brought into association primarily through the hole-nesting habit. This implies that a varied habitat is the most likely to support nest-site competition; a further implication possible is that an "edge" habitat will often be varied enough to allow fulfillment of the differing modes-of-life.

Another possibility could be conceived: a comparatively very simple ecosystem in which the requirements of one or two secondary hole-nesting species are well-supplied, except for suitable nest-sites. Such a situation does actually exist in planted forests and orchards in Europe (Udvardy, in litt.).

Areas intermediate to these two are likely to have fewer such competitive situations, and these, when they exist, will likely have less importance as population-regulating factors. Compared to either of the above postulations, a wider array of nest-hole producers will probably be present, with proportionately fewer secondary hole-nesters, as the habitat is more uniform, and cannot cater as well to the divergent modes-of-life implied.

The Cariboo region of British Columbia which has been recently studied and invites comparison, and in which nest-site competition apparently exists, possesses a great deal of semi-open countryside with many small exposed stands of aspen. None of the birds among which competition may occur are dependent upon the trees when foraging, but rather upon the ground surface (and water), or air, allowing development

of relatively high populations in relation to the amount of edge where nest-sites are available, and thus creating a situation in which nest-sites are more likely to be a limiting factor. The birds concerned, only a part of the total hole-nesting population, overlap broadly in nest-site requirements, and most lack the ability to excavate their own nest-cavities.

The wooded areas studied at the head of the Fraser Valley did not support nest-site competition. It has been suggested that a similar condition exists in wooded areas elsewhere in the valley and on the surrounding mountainsides. Some of the secondary hole-nesters concentrated their nesting activities in the town of Hope - here competition was observed but its infrequency, and the attendant circumstances, allowed the conclusion that its effect as a population - regulating factor was negligible. The Starling and House Finch are recent arrivals, and their population densities will increase greatly, perhaps modifying the above conditions.

In the lower Fraser Valley, which is much wider, this separation of two hole-nesting populations is much less distinct, as species nesting mainly in the town in the vicinity of Hope may be found around the farms throughout the valley, in company with other birds such as the Red-Shafted Flicker, Downy Woodpecker, and Black-Capped Chickadee. As the habitat conditions here are more closely allied to semi-open countryside with a large amount of "edge", it is suggested that nest-site competition is more likely to occur here, especially as the Starling increases (though the scarcity of the Tree

Swallow, and the almost complete absence of the Western Bluebird, which was common 15 years ago, cannot be attributed to competition with the Starling). The limited surveys carried out do not permit more definite predictions.

SUMMARY

A study was made of the species composition, numbers, and habits of a hole-nesting avifauna in southwestern British Columbia. The birds were considered in relation to the habitat they occupied, with the purpose of explaining an observed presence or absence of nest-site competition.

The study areas, surveyed over two breeding seasons, were near sea level in forested mountainous terrain. They represented a major portion of their surroundings in that they contained successional vegetational stages, which may often support large quantities of snags suitable for use by hole-nesters.

Each hole-nesting species found on the studied areas is considered separately, and those aspects of its breeding cycle pertinent to the concept of nest-site competition are detailed.

Nest-site competition is defined, and a review made of its possible results, and of the mechanisms that could be involved.

A snag survey illustrated a surplus of abandoned nesting cavities.

A limited experiment involving the elimination of hole-nesting birds gave no result for which nest-site competition could be advanced as an explanation.

Non-avian hole-users appeared to play a negligible role as nest-site competitors.

Primary hole-nesters nearly always excavated their own nest cavities, for which activity the habitat usually provided ample opportunity. These nest cavities often differed

widely in type and placement.

Secondary hole-nesters either concentrated their nesting activities around the buildings in the nearby town, neglecting the more "natural" sites available; were not obligated to use cavities when nesting; or occurred in such low densities, and were so positioned in the available suitable habitat, as to suggest that nest-site competition had no effect upon their populations.

Four species nested in crevices in buildings and in bird boxes in a small town, where their breeding population densities were much higher than in the surrounding countryside. Nest-sites were judged to be present in excess, and nest-site competition, observed infrequently, was so rare, and apparently without significant harmful effect, that it was judged to be of negligible importance as a population-regulating factor.

The overall absence of nest-site competition is contributed to not only by the preferences of the species regarding their nest-sites, but also by the fact that the results of their habitat selection processes, and their living habits within these habitats, tend to keep them ecologically distinct.

The factors regulating the populations of these hole-nesting species remain for the most part undetermined. The possibility that nest-site competition could operate as such a factor under conditions other than those observed must be allowed.

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Plate I. The southern slope of the Reservation. The marsh is in the foreground.

Plate II. The southeast slope of the Reservation. Kawkawa Lake is in the foreground.

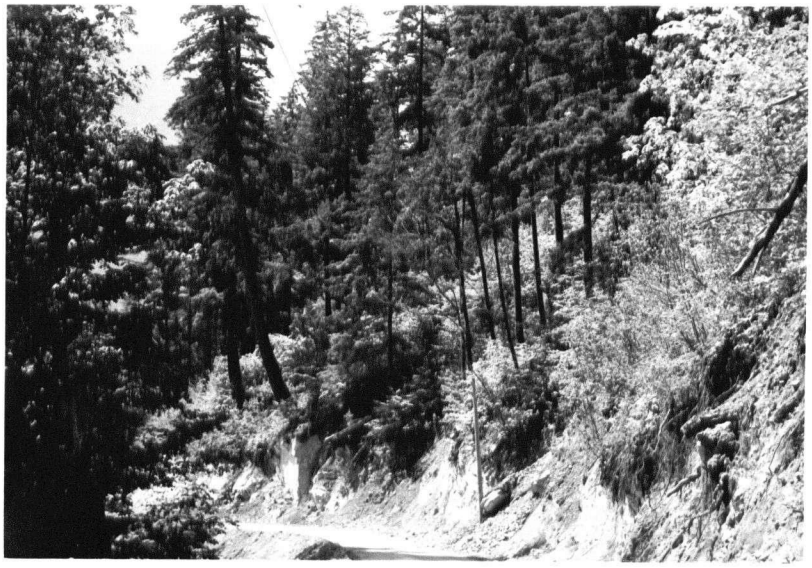

Plate III. The upper southeast slope of the Reservation. This was preferred Chestnut-Backed Chickadee habitat, and poor Winter Wren habitat. A wren nest was built in roots at the top of the roadside bank during 1962.

Plate IV. The northern portions of area "F", as seen from the west hill.

Plate V. The southern half of area "F", as seen from the top of the west hill. Little Mountain is the low hill in the background.

Plate VI. The town of Hope: population 2,500. The view is to the north, over the center of the study area. Little Mountain, on which the Reservation was located, is the small hill to the right.

Plate VII. The Hope-Princeton Highway crosses this bridge at the Old Mining Camp. Of the three drains in the cement foundation, the middle one was unoccupied, Rough-Winged Swallows nested in the one on the left, and Violet-Greens in the one on the right.

Plate VIII. The open portion of the Laidlaw Study Area.

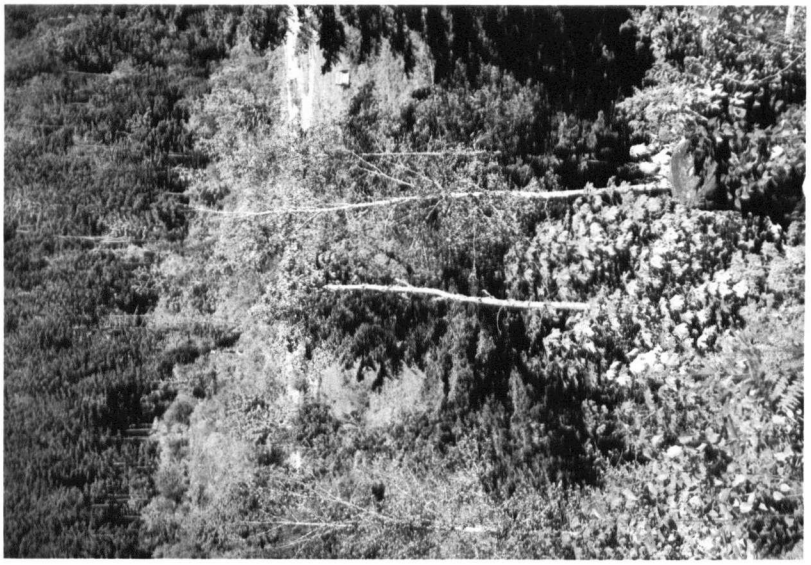

Plate IX. The birch snag 2-I-2, at the bottom of the northeast slope. Both Chestnut-Backed and Black-Capped Chickadees excavated in the same portion of this snag during the same season, though at different times.

Plate X. The rock bluff by Schkam Lake that provided nesting sites for Rough-Winged and Violet-Green Swallows.

Plate XI. Two of the ten bird boxes erected over the marsh. Swallows fed at the marsh during poor weather.

Plate XII. Under the eaves of this building is a series of identical cavities. English Sparrows nested only in the cavity above the wires, which were used as perches. On the opposite side of the building, Violet-Green Swallows nested in a cavity at a corner.

Plate XIII. A series of cavities is under the overhang. English Sparrows nested both years in the corner cavity by the support cable, which was used as a perch. Other cavities were utilized by Starlings, (1 pair, 1962), and Violet-Green Swallows, (1 pair, both years).

Plate XIV. The House Finch nest. Nest material is visible above the arrow.

APPENDIX A

Dimensions of Bird Boxes

Bird boxes were constructed to dimensions slightly modified from those given by Kalmbach and McAtee (1957) as suitable for swallows.

Lumber 3/4 inch thick was used: all measurements are external.

Floor - 7½ inches square

Front - 6-3/4 inches high

- 1-3/4 inches in diameter. Hole centrally located both horizontally and vertically.
- A perch 2 inches long of ½ inch dowel was placed 2 inches to one side of, and 2 inches below, the center of the entrance.

Rear - 9½ inches high.

Top - removable.

- projected 3/4 inches over the front.

Sides - each had 2 - ½ inch diameter ventilation holes 1 inch below upper edge.

Color - white

APPENDIX B

Scientific nomenclature for species mentioned in the text. Sources used:

Plants - Henry, J.K., 1915. Flora of southern British Columbia and Vancouver Island. Gage, Toronto. 363 pages.

Carl, G.C., C.J. Guiguet, and G.A. Hardy, 1952. A natural history survey of the Manning Park area, British Columbia. Occas. Pap. B.C. Prov. Mus. No. 9:1-130.

- among others.

Birds - A.O.U. Check-List of North American birds, 1957. Fifth Ed. Baltimore Press, Baltimore. 691 pgs.

Mammals- Cowan, I.McT., and C.J. Guiguet, 1960. The mammals of British Columbia. B.C. Prov. Mus., Handbook No. 11:1-413.

Plants:

Red Cedar	Thuja plicata Donn.
Lodgepole Pine	Pinus contorta Dougl.
Grand Fir	Abies grandis Lindl.
Alpine Fir	Abies lasiocarpa (Hook.) Nutt.
Douglas Fir	Pseudotsuga menziesii (Mirb.) Franco
Western Hemlock	Tsuga heterophylla Sarg.
Mountain Hemlock	Tsuga mertensiana Carr.
Engelmann Spruce	Picea engelmanni Engelm.
Sitka Spruce	Picea sitchensis Carr.
Willow	Salix sp.
Pacific Willow	Salix lasiandra Benth.
Black Cottonwood	Populus trichocarpa T. and G.

Hazel	Corylus cornuta Marsh., var. californica (AD.C.) Sharp.
White Birch	Betula papyrifera Marsh., var. commutata (Regel.) Fern.
Red Alder	Alnus rubra Bong.
Oregon Grape	Berberis nervosa Pursh.
Mock Orange	Philadelphus gordonianus Lindl.
Ocean Spray	Holodiscus discolor (Pursh) Maxim.
Saskatoon Berry	Amelanchier florida Lindl.
False Box	Pachystima myrsinites Raf.
Broadleaf Maple	Acer macrophyllum Pursh.
Vine Maple	Acer circinatum Pursh.
Flowering Dogwood	Cornus nuttallii T. and G.
Salal	Gaultheria shallon Pursh.

Birds:

Wood Duck	Aix sponsa (Linnaeus)
Common Goldeneye	Bucephala clangula (Linnaeus)
Barrow's Goldeneye	Bucephala islandica (Gmelin)
Bufflehead	Bucephala albeola (Linnaeus)
Hooded Merganser	Lophodytes cucullatus (Linnaeus)
Common Merganser	Mergus merganser Linnaeus
Pigeon Hawk	Falco columbarius Linnaeus
Sparrow Hawk	Falco sparverius Linnaeus
Screech Owl	Otus asio (Linnaeus)
Great Horned Owl	Bubo virginianus (Gmelin)
Hawk Owl	Surnia ulula (Linnaeus)
Pygmy Owl	Glaucidium gnoma Wagler.
Spotted Owl	Strix occidentalis (Xantus)

Boreal Owl	*Aegolius funereus* (Linnaeus)
Saw-whet Owl	*Aegolius acadicus* (Gmelin)
Yellow-Shafted Flicker	*Colaptes auratus* (Linnaeus)
Red-Shafted Flicker	Colaptes cafer (Gmelin)
Pileated Woodpecker	*Dryocopus pileatus* (Linnaeus)
Red-Bellied Woodpecker	*Centurus carolinus* (Linnaeus)
Golden-Fronted Woodpecker	*Centurus aurifrous* (Wagler)
Red-Headed Woodpecker	*Melanerpes erythrocephalus* (Linnaeus)
Lewis' Woodpecker	*Asyndesmus lewis* (Gray)
Yellow-Bellied Sapsucker	*Sphyrapicus varius nuchalis* Baird
Red-Breasted Sapsucker	*Sphyrapicus varius ruber* (Gmelin)
Hairy Woodpecker	*Dendrocopos villosus* (Linnaeus)
Downy Woodpecker	*Dendrocopos pubescens* (Linnaeus)
Black-Backed Three-Toed Woodpecker	*Picoides arcticus* (Swainson)
Northern Three-Toed Woodpecker	*Picoides tridactylus* (Linnaeus)
Violet-Green Swallow	*Tachycineta thalassina* (Swainson)
Tree Swallow	*Iridoprocne bicolor* (Vieillot)
Bank Swallow	*Riparia riparia* (Linnaeus)
Rough-Winged Swallow	*Stelgidopteryx ruficollis* (Vieillot)
Barn Swallow	*Hirundo rustica* Linnaeus
Cliff Swallow	*Petrochelidon pyrrhonota* (Vieillot)
Purple Martin	*Progne subis* (Linnaeus)

Black-Capped Chickadee	Parus atricapillus Linnaeus
Mountain Chickadee	Parus gambeli Ridgway
Chestnut-Backed Chickadee	Parus rufescens Townsend
White-Breasted Nuthatch	Sitta carolinensis Latham
Red-Breasted Nuthatch	Sitta canadensis Linnaeus
Brown Creeper	Certhia familiaris Linnaeus
House Wren	Troglodytes aedon Vieillot
Winter Wren	Troglodytes troglodytes (Linnaeus)
Bewick's Wren	Thryomanes bewickii (Audubon)
Western Bluebird	Sialia mexicana Swainson
Mountain Bluebird	Sialia currucoides (Bechstein)
Golden-Crowned Kinglet	Regulus satrapa Lichtenstein
Starling	Sturnus vulgaris Linnaeus
House Sparrow	Passer domesticus (Linnaeus)
House Finch	Carpodacus mexicanus (Muller)

Mammals:

Chipmunk	Eutamias sp.
Douglas Squirrel	Tamiasciurus douglasi mollipilosus (Audubon and Bachman)
Northern Flying Squirrel	Glaucomys sabrinus (Shaw)
Deer Mouse	Peromyscus maniculatus (Wagner)