# NESTING AND ROOSTING HABITAT AND BREEDING BIOLOGY OF THE BARN OWL (*Tyto alba*) IN THE LOWER MAINLAND OF BRITISH COLUMBIA.

by

Lorraine A. Andrusiak

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF SCIENCE

in

THE FACULTY OF GRADUATE STUDIES

Department of Zoology

We accept this thesis as conforming

to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

March 1994

ABSTRACT

Nesting and roosting habitat use and breeding biology of the barn owl (*Tyto alba pratincola*) in the Lower Mainland of British Columbia were studied over 3 years from 1990-92. A total of 236 sites used by barn owls were located, all but 9 of which were man-made. The majority of the sites (72%) were barns, then silos (11%) and industrial buildings (4%). Natural nest sites were located in both live trees and snags. It is suggested that barn owls choose man-made sites over natural sites because of the increased thermal cover and increased security from predators.

Yearly variations in brood size and the mean number of young fledged per nest were observed, with the lowest values for both recorded in 1991. Poor environmental conditions are thought to be responsible for lowered breeding success in this case. The 3 year mean clutch size, brood size and number of young fledged per nest and their standard deviations were 6.5 (± 3.5), 3.3 (± 2.0) and 2.6 (±2.1), respectively.

Taxidermy data provided information on mortality of adult barn owls. Road kills were found to account for the largest proportion (62.9%) of the carcasses, with starvation (16.7%) and unknown causes (14.6%) making up most of the remainder. Mortality in general was lowest in the summer and highest in the winter. Examination of banding records revealed an average age of 28.1 months at death, with most birds being recovered less than 20 km from their place of banding. Contrary to published hypotheses, no evidence of southward migration could be found.

Six adult barn owls were radio-tracked and each was found to have a favoured roost site at which it could be located most of the time. The barn owls roosted at both man-made and natural sites, the choice of which seemed to depend on the preferences of the individual.

Several barn owl nestbox programs have been initiated in the Lower Mainland and preliminary results from 2 of the programs show occupancy of the boxes at 31-57% about 2 years after the installation of the boxes.

Examination of the history of agriculture in the Lower Mainland reveals that acreage of prime barn owl hunting habitat such as pasture and unimproved pasture are declining. The future of the barn owl in the Lower Mainland depends upon the efficacy of farmland conservation programs such as the Agricultural Land Reserve in preserving farmland from urban development.

## TABLE OF CONTENTS

## LIST OF TABLES

Table Page

## LIST OF FIGURES

## ACKNOWLEDGEMENTS

I would like to thank my thesis supervisor, Dr. Kimberly Cheng, and my committee members Dr. Fred Bunnell, Dr. Jamie Smith, Dr. Maryanne Hughes, and Dick Cannings, for their invaluable advice and criticisms and for the loan of equipment during the study. Special thanks also go to Dr. Douw Steyn, Geography, U.B.C.; Monika and Frank Tolksdorf and volunteers at Monika's Wildlife Shelter; staff and volunteers at O.W.L. Rehabilitation Centre; Bill Munro, Mike Chutter, Dave Dunbar, Tom Plath, Doug Wilson, Rod Olsen and Jack Norie of the B. C. Ministry of the Environment for their advice, practical help and data on barn owl mortality; the Canadian Wildlife Service; Joanne McLarty; Terry Sullivan; Laurie Kremsater; Bill Dove; Glen Ryder; Don Brandys; Mike Mackintosh and volunteers from the Stanley Park Zoological Society; John Ireland; Dr. Mary Taitt; Cristoph Rohner; Frank Beebe; Jack Lay; the Surrey-White Rock Naturalists; Don Blood; Dr. Rob Butler; Doug Docherty; and all the property owners and tenants who graciously allowed me access to their property.

I thank the Natural Sciences and Engineering Research Council (NSERC), the World Wildlife Fund's Endangered Species Recovery Fund, and the B. C. Habitat Conservation Fund for financial support.

For their everlasting support and love, I thank my mother Stella and my husband Bob.

# 1. INTRODUCTION

The barn owl (*Tyto alba pratincola*) is classified as "uncommon to very rare" throughout British Columbia (Campbell *et al.* 1992). The species was first recorded in the province in 1909 and there were no breeding records until 1941 (Cowan 1942), making the barn owl a relatively recent addition to the province's fauna. The barn owl favours open habitat and is often closely associated with agricultural areas (Bent 1961; Campbell and Campbell 1983; Marti 1992a). It is probable that the clearing of forested lands and the development of agriculture in the Lower Mainland provided the open habitat necessary for the barn owl to expand its range northward into British Columbia.

Today the British Columbia population of barn owls is estimated to be about 1000, with the species breeding from southern Vancouver Island through the Lower Mainland as far east as Hope (Campbell and Campbell 1983). Barn owl populations are declining in many parts of the world due to changes in agricultural practices and changes in climate (Bunn 1982; Shawyer 1987; Marti 1992a). Locally, an expanding human population putting pressure on the rural areas of the Lower Mainland conflicts with the barn owl's need for open, agricultural-type habitat. Research on the barn owl in British Columbia has been confined mainly to food-habits studies (Cowan 1942; Dawe *et al.* 1978; Campbell 1983; Campbell *et al.* 1987). Without data on the owl's reproductive and mortality patterns or its preferences and use of habitat within the Lower Mainland it is difficult to devise management options to conserve the species. The objectives of this study were (1) to qualify and quantify the amount of nesting and roosting habitat available to barn owls in the Lower Mainland, (2) to investigate the barn owl's use of this habitat, (3) to gather baseline data on reproductive success, mortality, and movements, (4) to investigate the use of nestboxes as a management tool for barn owls in the Lower Mainland, and (5) to examine changes in British Columbia agricultural practices and how they may affect the barn owl population.

## 2. STUDY SITE

The Lower Mainland region of British Columbia constitutes approximately 300,000 ha in the extreme southwest corner of the mainland of the province (Fig. 1). This area includes the districts and municipalities of Vancouver, Burnaby, Richmond, Delta, Tsawwassen, Surrey, Langley, Aldergrove, Matsqui, Abbotsford, Clearbrook, Port Coquitlam, Pitt Meadows, Mission, Maple Ridge, Sardis and Chilliwack. The Lower Mainland is bordered by the North Shore Mountains to the north, and the United States boundary to the south. Westward the area is bounded by the Strait of Juan de Fuca, while to the east the mountains of the Coastal and Cascade ranges form a natural barrier. The Fraser River travels a sinuous course through the middle of the Fraser Valley and is a major influence on topography and vegetation. The uplands consist of relatively level terraces interspersed with undulating areas with up to several hundred metres of relief (Winter 1968). Glacio-marine and glacio-till soils are found in these regions. Floodplains of the Fraser, Nicomekl, Serpentine, Pitt and Chilliwack Rivers form the lowlands, characterized by silty and clayey soils. The draining of Sumas Lake in the 1920's provided an additional 3,642 ha of fertile lake bottom to the region's farmers.

The climate of the region is moderate, with cool summers and mild, wet winters

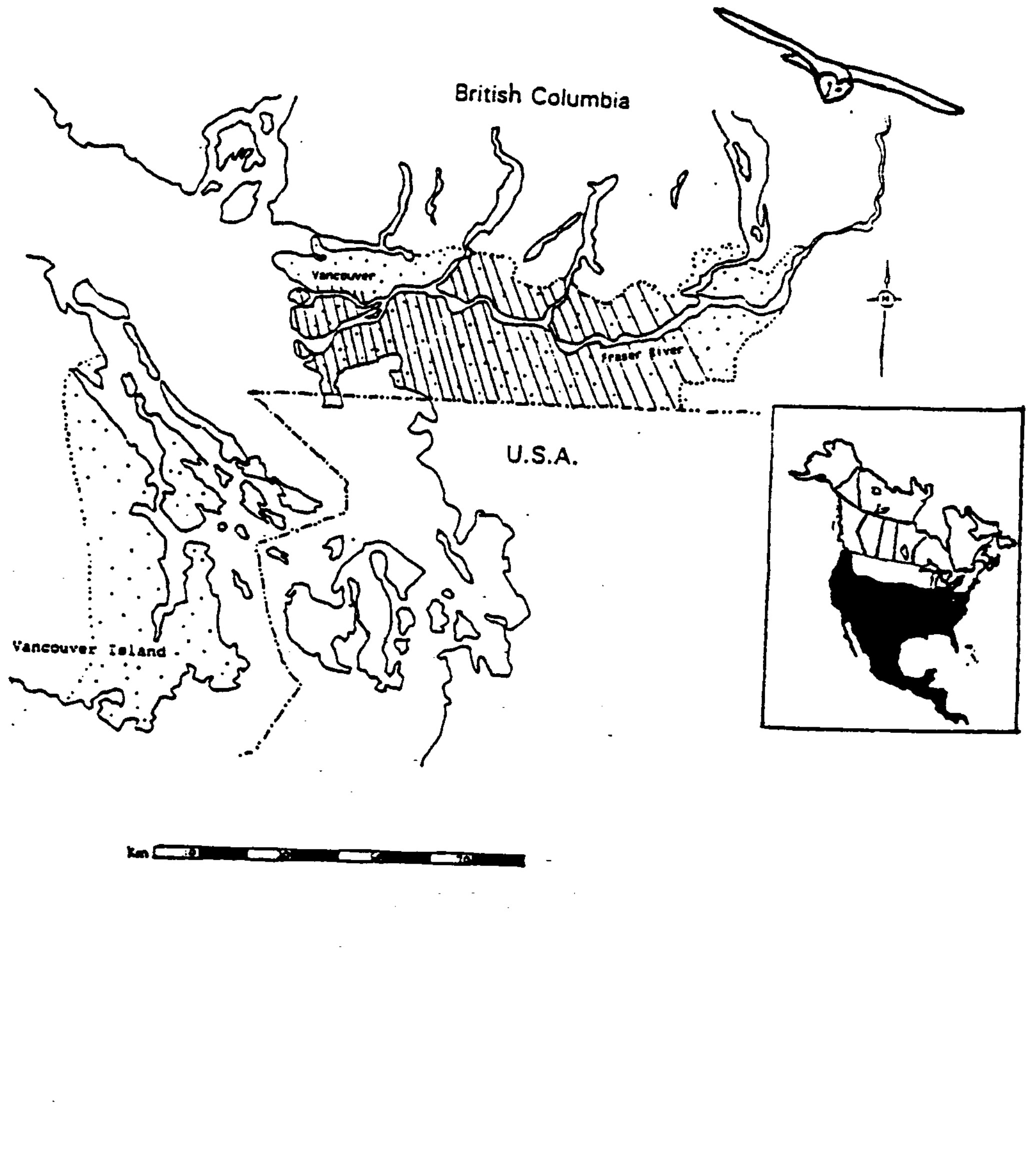



Figure 1. The study area (hatched) and the barn owl's British Columbia breeding range (stippled). Inset: the barn owl's North American breeding range (redrawn from Marti 1992a).

(Stager and Wallis 1968). The mean annual temperature is approximately 10° C, with January temperatures usually above freezing. The number of frost-free days per year is usually well above 200. Between 750 to 1,016 mm of precipitation falls per year, with 30-40% occurring during December, January and February. Only 4-6% of the precipitation occurs as snow (Stager and Wallis 1968).

Very little of the original virgin coniferous forest now remains in the Lower Mainland, but extensive areas of second-growth forest exist in the uplands. The predominant tree species are Western Redcedar (*Thuja plicata*), Douglas-fir (*Pseudotsuga menziesii*), Western Hemlock (*Tsuga heterophylla*), Red Alder (*Alnus rubra*), Broadleaf Maple (*Acer macrophyllum*) and Black Cottonwood (*Populus trichocarpa*). Considerable foreshore area with grassland and low shrub vegetation exists along Boundary Bay and the other coastline areas in the southwest.

In 1986 approximately 1.5 million people resided in the Lower Mainland (Statistics Canada 1988). Urban areas cover approximately 91,000 ha, and land classified as undisturbed makes up a further 72,000 ha. Most of the remainder is agricultural land (94,000 ha) (Moore 1990). Mixed farming predominates, with large dairy farms being common in all farming districts. Small hobby farms are also numerous. Berry farming (especially raspberries, blueberries and strawberries) is a fast-growing industry in areas such as Richmond, Langley and Clearbrook. Human activities in general have greatly modified the vegetation and landform of the entire Lower Mainland.

# 3. METHODS

## 3.1 Nest and Roost Sites

Sites used by barn owls were located by a variety of methods. Drive-by surveys began in January of 1990 and were conducted in rural areas to locate structures that might be used by owls. Posters explaining the project were distributed to farm supply, feed and pet stores, and were posted at agricultural exhibitions and shows. Many people responded and reported barn owls in their buildings. Two local wildlife shelters also provided addresses of persons bringing in orphaned or moribund barn owls. Television and newspaper reports publicizing the project resulted in more addresses, and the local Ministry of the Environment office referred others to me.

If the property owners or tenants could be located, and if they gave permission to search the site, the structure was examined for signs of barn owl use. Barn owl use of a structure was determined by sightings of 1 or more owls and/or the presence of barn owl feathers or pellets. Sites utilized by owls were characterized by type, age, style (in the case of barns), material of construction, and the presence or absence of suitable nesting structures. Owners and tenants were shown photographs of barn owls and asked if they had ever seen owls on the property, and if so, if the owls had ever nested.

Natural sites were much more difficult to locate and an accurate estimation of their numbers could not be made. The extensive wooded areas in the Lower Mainland make tree-by-tree searches impractical. As barn owl eggs have been found in B.C. during all months of the year (Campbell and Campbell 1983), the technique of locating nests by listening for the calls of the young is also inefficient. Three natural sites were confirmed when owls flushed from them after the trunks of the trees were gently rapped (G. Ryder, pers. comm.). Locations of 2 more natural sites were passed on by wildlife shelters. One was located when calls of begging juveniles were heard during drive-by searches of likely-looking trees. The other natural sites were reported by property owners. Natural sites were characterized by tree species, condition (living or dead), and height of the nest.

### 3.2 Nest Visits and Banding

Nest inspections were done periodically from January 1990 to May 1993. Sites where nesting had occurred or could potentially occur were monitored. Efforts were made to visit each site monthly during the prime breeding season (March to September) and every 2-3 months during the rest of the year, but in practice this schedule had to depend a great deal on the attitude and habits of the property owner. On each visit the nest site was checked to determine if nesting had been initiated. As the majority of the nest sites were on pulley platforms 20 to 30 feet from the floor of the barn, it was necessary to climb up to the nest to check it. If inspection of the nest site caused an incubating female to flush, I quickly counted the clutch and then left. On some occasions the property owner was able to report that incubation was underway. When this happened, I did not climb to the nest site to avoid possible desertion by the incubating female. Under these precautions, only 1 case of nest desertion from the nest inspection procedure was recorded. This occurred when a female was inadvertently disturbed before completing her clutch.

Nestling owls were large enough to band after the age of about 3 weeks. The normal procedure was to climb to the nest, one by one place each nestling into a deep plastic bucket and lower it by means of a rope to an assistant. Once on the ground the nestlings were placed in cardboard boxes or buckets to prevent them from wandering away. Older nestlings often displayed aggression to their siblings, and as a result were placed in separate containers. Standard measurements (wing chord, tarsus length, tarsus width, talon length and beak length) were taken, and weight was determined with a spring scale. Blood samples (50 $\mu$L) were taken from some birds for DNA analysis for a concurrent research project. The number of nestlings in the brood at the time of banding was recorded (brood size). All nestlings were banded with Canadian Wildlife Service standard numbered aluminum leg bands. To maintain good public relations with the property owners (who usually watched the banding procedure), several obviously sick or injured nestlings were taken to wildlife shelters for treatment. (Whenever possible, treated nestlings were replaced in their natal nest.) Each nestling was then hauled back up by the bucket and replaced at the nest. A few nest structures were quite unstable, and it was necessary to minimize the number of trips up and down. In these cases the young were banded up at the nest site, and weights and measurements were not taken.

Premature fledging is a distinct possibility when attempting to band older fledglings at platform nests. When mobile fledglings were known to be present at such a nest, assistants stood below the nest with a large outstretched sheet of plastic to catch any bird that jumped from the nest. Broods in nest boxes could be banded up to and past the age of fledging by blocking the entrance hole of the box with a wadded towel and removing the young one by one through the hinged side door. After banding, the brood was replaced in the box and given a few minutes to settle down before the entrance hole was unblocked. This procedure prevented flushing of the juveniles and even allowed capture of several roosting adults. Handling and banding of nestlings was assumed to have no effect on fledging success (Taylor 1991).

Each banding site was revisited after the young had fledged. Nestboxes were cleaned of accumulated pellet material and the nest site and the area for 50 m around it were searched for the remains of any owls which failed to fledge. Several bands were recovered in this way. If no remains were found, all nestlings were assumed to have fledged successfully.

Barn owls admitted to a local wildlife shelter were also banded before release.

### 3.3 Adult Barn Owl Mortality

Information on mortality patterns of wild, fledged barn owls was obtained from B. C. Ministry of the Environment (Region II) taxidermy permit records. Members of the public finding dead owls brought them to the Ministry office for taxidermy permits. Staff biologists examined, weighed and measured each carcass, and assigned a probable cause of death based on the condition of the carcass (i.e. broken bones, emaciation) and on information from the finder. If there was no obvious cause of death, it was listed as 'unknown'.

A total of 341 records dating from May 1982 to the end of February 1993 were used in the analysis. As some records were incomplete, not all were used for every calculation. Observations of nestling mortality were not included here, but are discussed in Section 4.2 (Reproduction).

## 3.4 Telemetry

Adult owls proved to be very difficult to capture outside of buildings, with only 12 in total being trapped during the study. We tried to avoid capture within buildings as this would bias the data to be collected on roost site choice. Mist nets were ineffective except within buildings. Although other researchers reported good success with bal-chatri traps (Colvin and Hegdal 1986; Bloom 1987), we found that barn owls showed very limited interest in bal-chatri traps lined with dead leaves and pieces of cellophane and baited with mice, gerbils, rats or quail, although 1 owl was captured in this way. Two owls were captured when they were flushed into long-handled hoop nets placed over the owls' normal exit from the barn. Another owl was captured with a padded leghold trap (Oneida jump trap No. 0) set on the top of a portable 4" x 4" post which could be positioned in the middle of a field (F. Beebe, pers. comm.). Owls were attracted to the vicinity of the trap with playback of tape-recorded barn owl vocalizations or by live rodents in bal-chatri traps.

Captured owls were banded, weighed, measured, tentatively sexed on the basis of size and coloration (Colvin 1984), banded and fitted with backpack radio-transmitters (Biotrack, Great Britain). Each transmitter weighed 13 g and was attached to the owl by an individually fitted elastic harness. Thereafter the owl was located 3 times a week (once in early morning, once at noon, and once in late afternoon) until the signal failed or the owl lost the transmitter. Daytime roost sites were described and mapped on 1:50,000 scale topographic maps.

### 3.5 Nestboxes

Two separate barn owl nestbox programs were undertaken in the Fraser Valley during the course of this study. The first was sponsored by the B.C. Gas Project and resulted in 30 nestboxes being placed in the municipality of Delta in February 1991 (Blood and Dueck 1992). Four styles of nestbox were used, including an open, double compartment tray, an A-frame style, a chimney style box for mounting on trees, and a rectangular plywood indoor box. The nestbox sites chosen were those which lacked suitable nesting structures for barn owls. Three boxes were placed in trees and the remainder in or on farm buildings.

The second nestbox program is an ongoing one which began in 1990 and is sponsored by the Stanley Park Zoological Society (Andrusiak 1992). The Society provided nestboxes and volunteer labour to install them. Property owners interested in having a nestbox installed contacted either the Society or myself. The property was surveyed and, if it was deemed suitable barn owl habitat, a nestbox was installed in or on barns or in large trees. Sites which were inhabited by barn owls but lacked suitable nest structures were given first priority, then sites which were not inhabited by owls. Nestboxes were also situated to replace existing nest sites that had been destroyed. Under this program a total of 62 nestboxes were been placed in Surrey, Delta, Richmond, Langley, Aldergrove and Vancouver. Nestboxes were checked several times a year for nesting activity and active boxes were cleaned once or twice a year, depending on use. The nestboxes used were simple enclosed plywood boxes with a 15-cm entrance hole and a hinged side door. Boxes for outdoor placement also had styrofoam insulation and shingles on the top of the box. Five boxes were placed in trees and the remainder in or on buildings.

### 3.6 Climate Data

Information on local weather patterns was obtained from published Environment Canada records from the meteorological station at the Vancouver International Airport.

### 3.7 Agricultural Changes

Detailed information on changes in agricultural practices in the Lower Mainland had not been compiled (see Moore 1990). Canadian Censuses of Agriculture provided periodic data on agriculture (Dominion Bureau of Statistics 1947; 1953; 1957; 1963; 1968; Statistics Canada 1973; 1978; 1982; 1987; 1992). Censuses were prepared every 5 years dating from 1941 through 1991 (excluding 1946). Up to 1966 the census was based on the division of British Columbia into 29 regions. Data from Region 4 (Lower Mainland) were used in this study. In 1971 the province was divided into smaller census regions. Data from 4 of these regions, the Central Fraser Valley, Dewdney-Allouette, Fraser-Cheam and Greater Vancouver were pooled to give information on farming in the barn owl's prime B.C. range. Due to these census region border changes, however, data pre- and post 1971 are not fully comparable.

### 3.8 Data Analysis

Data were entered into a microcomputer and analyzed and graphed with the use of QuattroPro software.

## 4.0 RESULTS

### 4.1 Nest and Roost Sites

#### 4.1.1 Characteristics

Two hundred thirty-six sites used by barn owls were located in the Lower Mainland. All but 9 of these were man-made (Table 1). Barns made up the greatest proportion of barn owl sites, comprising 72% of the total. Silos were also favoured sites, with industrial buildings ranking third. Most of the man-made sites were made of wood or a combination of wood and metal (Fig. 2), and the majority of the barns used were old structures (Fig. 3), with 57% being over 50 years of age. In contrast, all but 1 of the industrial sites used by barn owls were less than 20 years of age.

One hundred eighteen of the total number of sites were known to have been used for nesting at least once. The most popular nesting site within barns was on pulley platforms located at the ends of the barns high above the haymow. These platforms are usually good-sized (0.8 $m^2$) and form a nest site which is inaccessible to most predators. However, the platforms are usually open on 3 sides, and nestlings often fall to their

**TABLE 1. TYPES OF BARN OWL NEST AND ROOST SITES**

| TYPE | NUMBER |
|---|---|
| BARN | 170 |
| SILO | 25 |
| INDUSTRIAL | 10 |
| SHIPYARD | 3 |
| ARENA | 1 |
| SCHOOL | 1 |
| HOUSE EAVES | 1 |
| CHIMNEY | 1 |
| ATTIC | 2 |
| SHED | 3 |
| FEED MILL | 2 |
| HANGAR | 1 |
| FAN HOUSING | 1 |
| BRIDGE | 2 |
| TREE NESTBOX | 4 |
| NATURAL CAVITY | 9 |
| **TOTAL** | **236** |

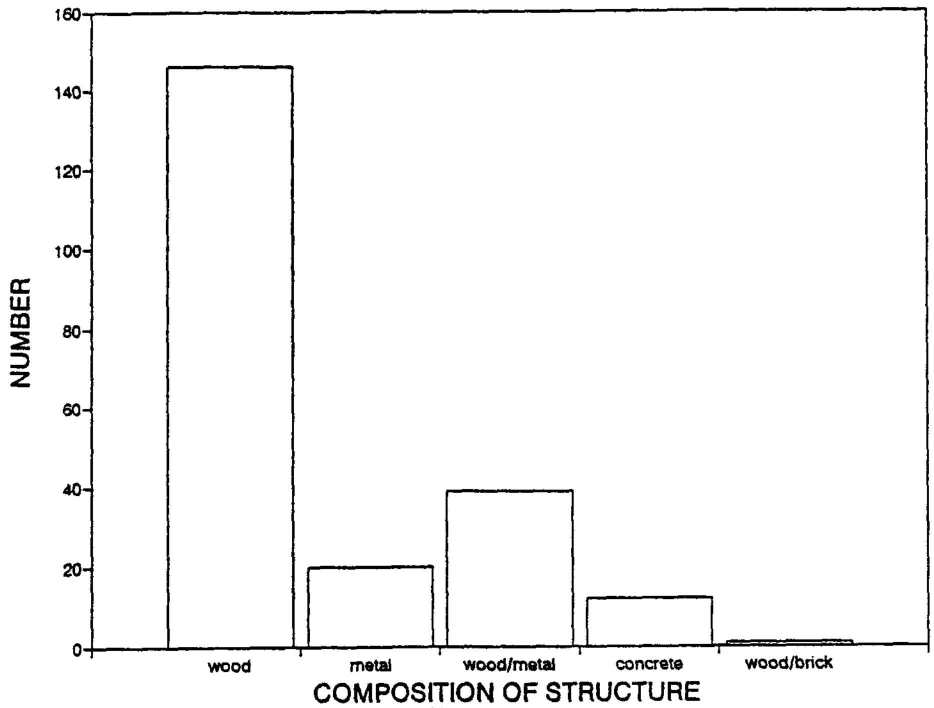



Figure 2. Composition of Man-made Sites Used by Barn Owls.

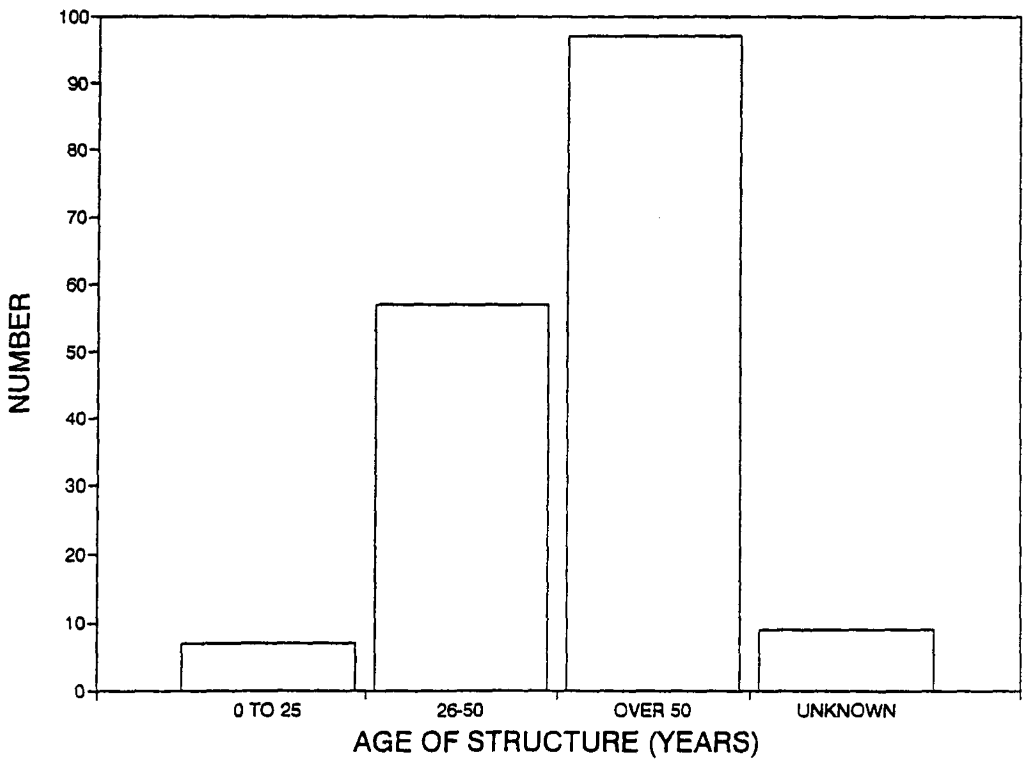



Figure 3. Ages of Barns Used by Barn Owls.

deaths. Some farmers attempted to prevent this by erecting low wooden barricades around the platforms, and in most cases this worked very well. Nestboxes placed by farmers or placed during the course of this study were readily used and were usually very secure. Several nests were located in crevices between stacks of bales. These nests were also quite well-protected initially, but were often unsuccessful due to disturbance by farmers periodically removing bales. Owls also nested in the joists between the ceiling of the lower storey of barns and the floor of the upper storey. Silos were less frequently used as nest sites, probably because of the lack of sufficient horizontal area for nesting in the silo top. In older silos with square wooden tops nests were often found in the corners of the tops. One nest was located on top of a derelict silage spreader in the peak of the silo. This nest proved insecure, and at least two nestlings fell to their deaths. Occasionally two or more silos were joined to form a single unit. At these sites nests were often located on flat areas at the passage between the tops of the silos. One pair of owls nested on a flat board wedged in the ladder chute of an abandoned silo which had lost its top. The board was wedged at an angle, and during a hard spring rain 3 nestlings slid off the nest and two of the nestlings subsequently drowned in the flooded silo bottom.

The several nests found in industrial sites were difficult to locate due to the size of the buildings and the reluctance of factory managers to allow searchers near dangerous machinery. They tended to be located in crevices in walls and beams or behind insulation. In all but one situation the factories were in full use, and the owls roosted and nested apparently unperturbed by the sights and sounds of heavy industry below.

Other buildings occasionally provided nesting habitat. An attic in a Delta secondary school was used for many years as a nest site. This building has now been demolished. Barn owls nested in the eaves and attic of 3 houses, to the dismay of their human tenants. Following the demolition of the barn on one farm in South Surrey, a pair of owls moved into a chimney on the farmhouse. Nests under bridges or highway overpasses were inaccessible to mammalian predators but again, tended to have low success due to nestlings falling from the nest. Open fan hoods on poultry barns are also attractive as nest sites. However, moving fan blades have caused injuries or death to both parents and young (M. Tolksdorf, pers. comm.).

The 9 natural nest sites found were all located in cavities in living or dead trees (Table 2). One was an isolated snag in a school yard, 4 were in a group of 5 or fewer trees, and 4 were located within thickly forested areas. All but 1 were at least 10 m off the ground. Unfortunately, due to the height of these nests, their location in public parks, or the poor condition of the tree or snag, none were accessible for close examination or the evaluation of nesting success. Two of the natural nest sites (both in live trees) have since been destroyed due to high winds, and 1 site in a hollow cottonwood snag was destroyed when the floor of the nest chamber disintegrated after heavy rains.

Barn owl nest and roost sites tended to be closely associated with agricultural land. The high density areas were in the farmland of south Delta and Ladner, where approximately 90% of the open barns surveyed showed signs of barn owl presence. Active nests were often found in close proximity, with up to 4 simultaneous nests in

**TABLE 2 - NATURAL CAVITIES USED BY BARN OWLS**

| TYPE | NAME | NUMBER |
|---|---|---|
| **LIVE TREE** | | 6 |
| COTTONWOOD | *Populus trichocarpa* | 4 |
| BROADLEAF MAPLE | *Acer macrophyllum* | 1 |
| DOUGLAS-FIR | *Pseudotsuga menziesii* | 1 |
| **SNAG** | | 3 |
| COTTONWOOD | | 1 |
| WESTERN REDCEDAR | *Thuja plicata* | 1 |
| UNKNOWN | | 1 |
| **TOTAL** | | 9 |

nestboxes in the corners of a warehouse. Four simultaneous nests were also discovered in 3 barns and 1 bridge along a 3.5 km stretch of road in Surrey. In more heavily-forested regions such as northeast Langley and northwest Matsqui barn owls were much more widely spaced.

### 4.1.2 Nest Site Fidelity

No direct evidence of nest site fidelity was obtained due to the difficulty of recapturing banded adults. However, inferences of strong site fidelity can be made from the following case histories:

Case 1. This pair occupied a platform nest at one end of an abandoned barn. Although a fire destroyed the roof over the nest platform in 1988, it continued to be used successfully as a nest site in 1989 and 1990 despite the fact that there was an identical platform, with roof intact, at the other end of the barn. The nest platform was completely open to the elements and as a result was observed to remain soggy for several days after a rain.

Case 2. This pair occupied a barn in Delta, where they produced unusually large clutches of eggs. Through the years of 1989-90 and 1992, respectively, 14, 13, and 18 unhatched and infertile eggs were found on the platform nest.

Case 3. A single owl has occupied a barn in Langley for at least 5 years (M. Barichello, pers. comm.). The owl is recognizable by its almost total lack of fear of human presence as it roosts some 7 m off the ground in a working dairy barn.

## 4.2 Reproduction

Results are summarized in Tables 3 and 4. Due to the possibility of disturbance causing an incubating female to abandon her nest, observations on clutch size were not a high priority. Differences in clutch size over the 3 years (Fig. 4) were non-significant, probably due to the small sample size. Clutch sizes varied from 2 to 18, with 5 eggs being the most common (Fig. 5). Included in the data are the observations of 2 unusually large but unsuccessful clutches (14 and 18 eggs) produced at the same site. These were probably laid by the same pair of adults. It is possible that both members of the pair were females, though same-sex pairs have not been documented previously in the literature for this species. Clutch size was plotted against the number of nestlings fledged for 1992, the only year for which sufficient clutch size data was obtained (Fig. 6). Although the regression line was significant at the 0.05 level ($t = 2.958$, $df = 9$), the regression of the number of young fledged on the initial clutch size was only moderately predictive ($r^2 = 0.493$).

The number of juveniles observed at banding (brood size) ranged from 0 to 8 (Fig. 7). Mean brood sizes (Fig. 8) and mean number of young fledged per nest (Fig. 9) were not significantly different over the 3 years. The lowest mean brood size and the lowest mean number fledged were both recorded in 1991. The year of 1991 was also notable for unusually high levels of snowfall (Fig. 10) and rainfall (Fig. 11). There seemed also to be less variation in the brood size during 1991. Brood size varied from 0 to 7 in 1990 and from 0 to 8 in 1992 but only from 0 to 5 in 1991 (Fig. 7).

**TABLE 3. BARN OWL REPRODUCTIVE SUCCESS - ALL NESTS**

| YEAR | MEAN CLUTCH ± S.D. | N | MEAN BROOD ± S.D. | N | MEAN # FLEDGED ± S.D. | N |
|---|---|---|---|---|---|---|
| 1990 | 7.4 ± 4.0 | 5 | 3.2 ± 2.3 | 18 | 2.9 ± 2.2 | 18 |
| 1991 | 4.0 ± 1.6 | 3 | 2.2 ± 1.3 | 17 | 2.1 ± 1.2 | 15 |
| 1992 | 6.7 ± 3.4 | 15 | 3.8 ± 2.0 | 35 | 2.7 ± 2.3 | 29 |
| **TOTAL** | 6.5 ± 3.5 | 23 | 3.3 ± 2.0 | 70 | 2.6 ± 2.1 | 62 |

**TABLE 4. BARN OWL REPRODUCTIVE SUCCESS - SUCCESSFUL NESTS**

| YEAR | CLUTCH ± S.D | N | BROOD ± S.D. | N | # FLEDGED ± S.D. | N |
|---|---|---|---|---|---|---|
| 1991 | 4 | 1 | 2.5 ± 1.2 | 11 | 2.4 ± 0.9 | 13 |
| 1992 | 6.0 ± 1.8 | 9 | 4.1 ± 1.9 | 20 | 3.8 ± 1.9 | 21 |
| **TOTAL** | 5.8 ± 1.8 | 11 | 3.7 ± 1.8 | 45 | 3.4 ± 1.8 | 48 |

NOTE: because fledging data could not be collected for some nests, Tables 3 & 4 are not additive.

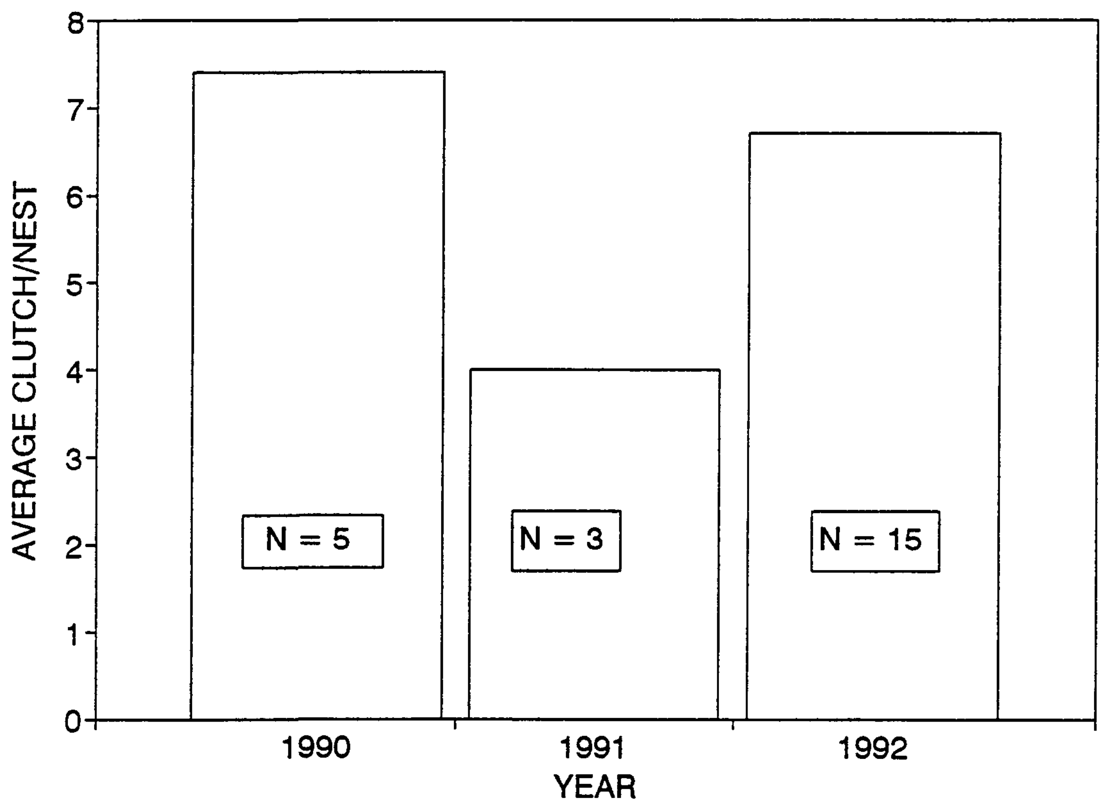



Figure 4. Mean Barn Owl Clutch Size 1990-92.

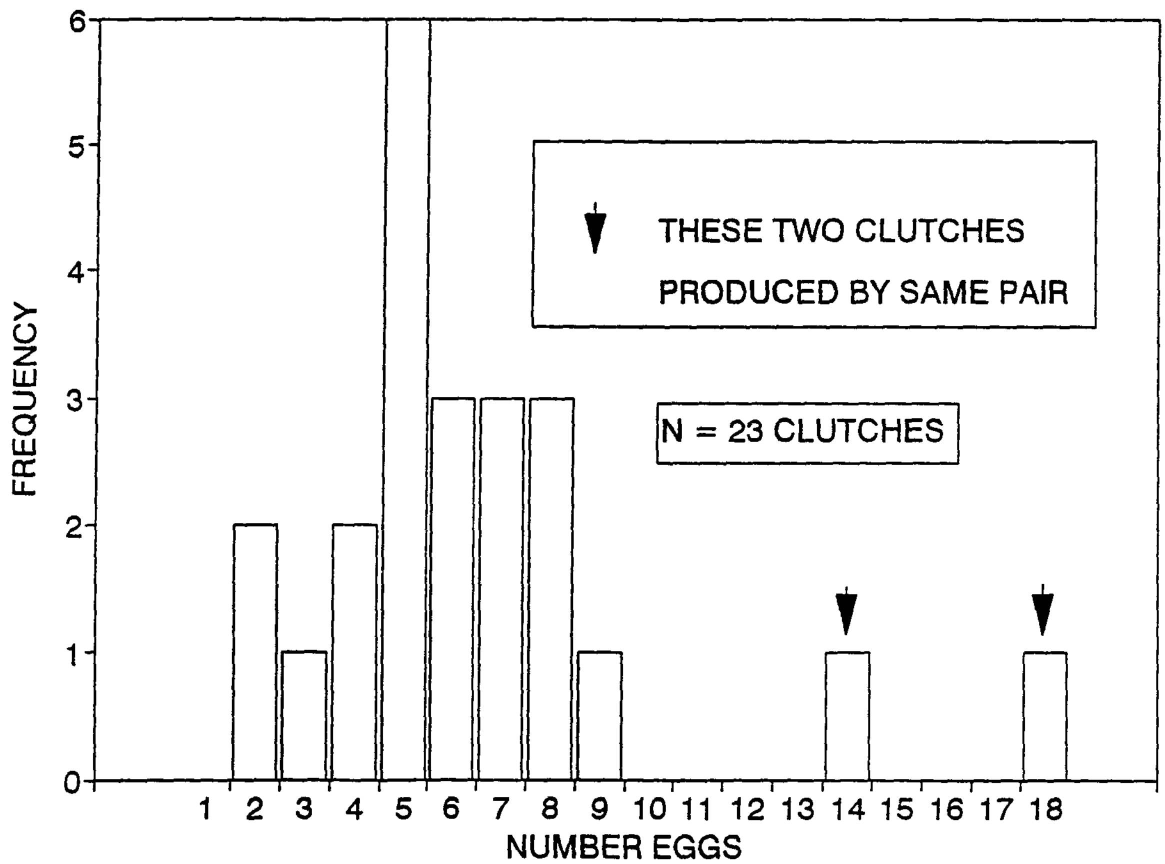



Figure 5. Barn Owl Clutch Size Frequency 1990-92.

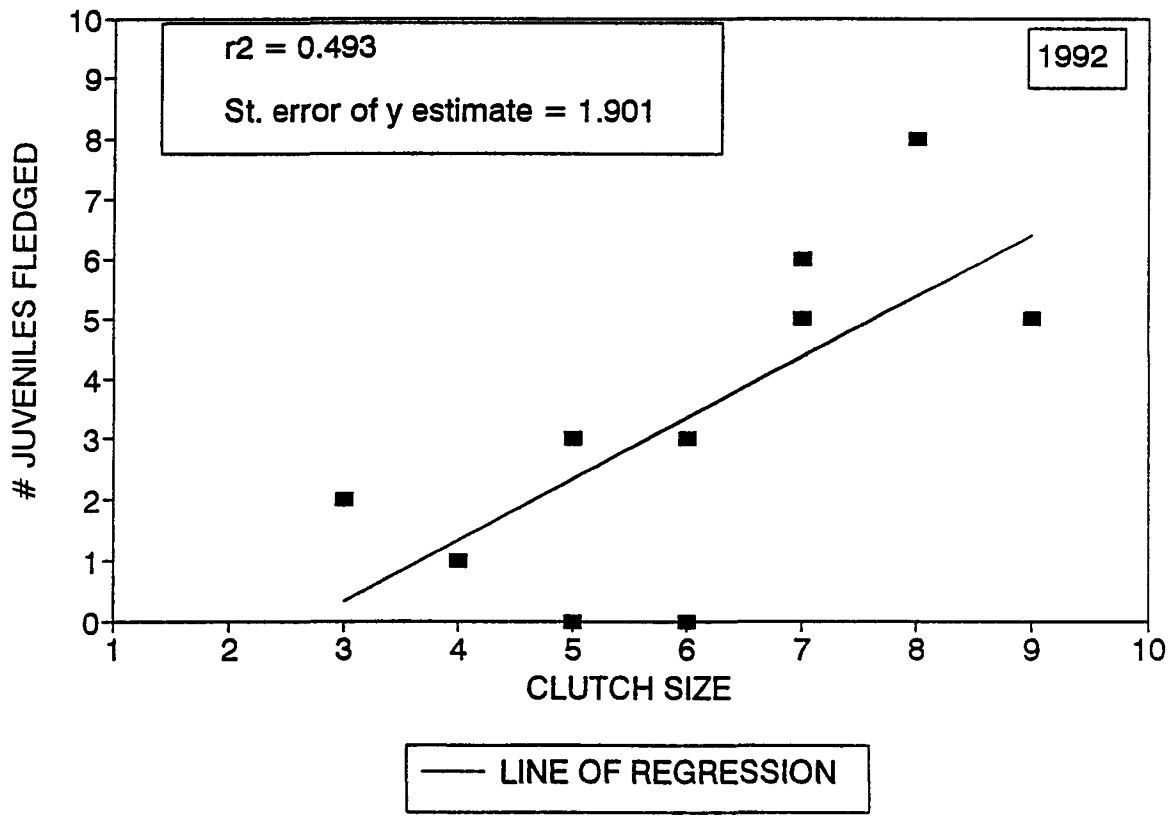



Figure 6. 1992 Barn Owl Clutch Size and Number Fledged.

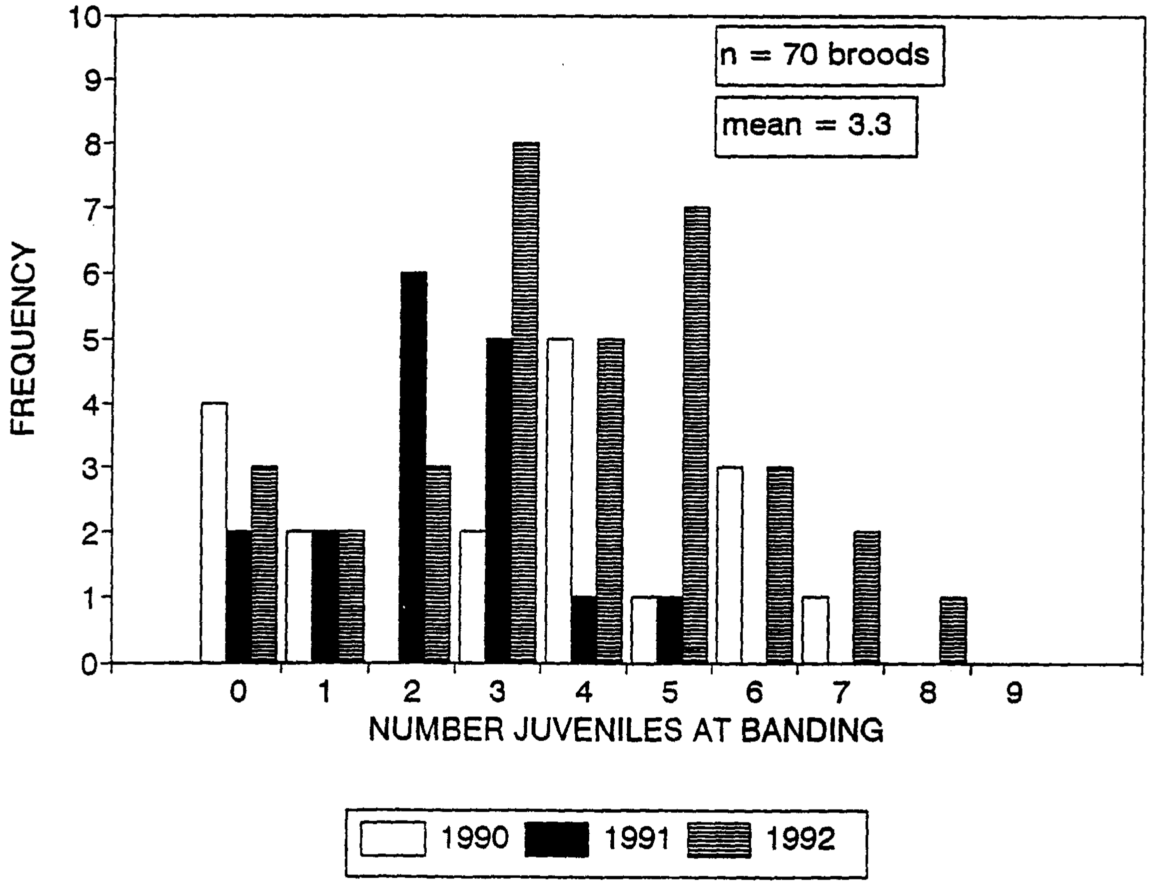



Figure 7. Barn Owl Brood Size Frequency 1990-92.

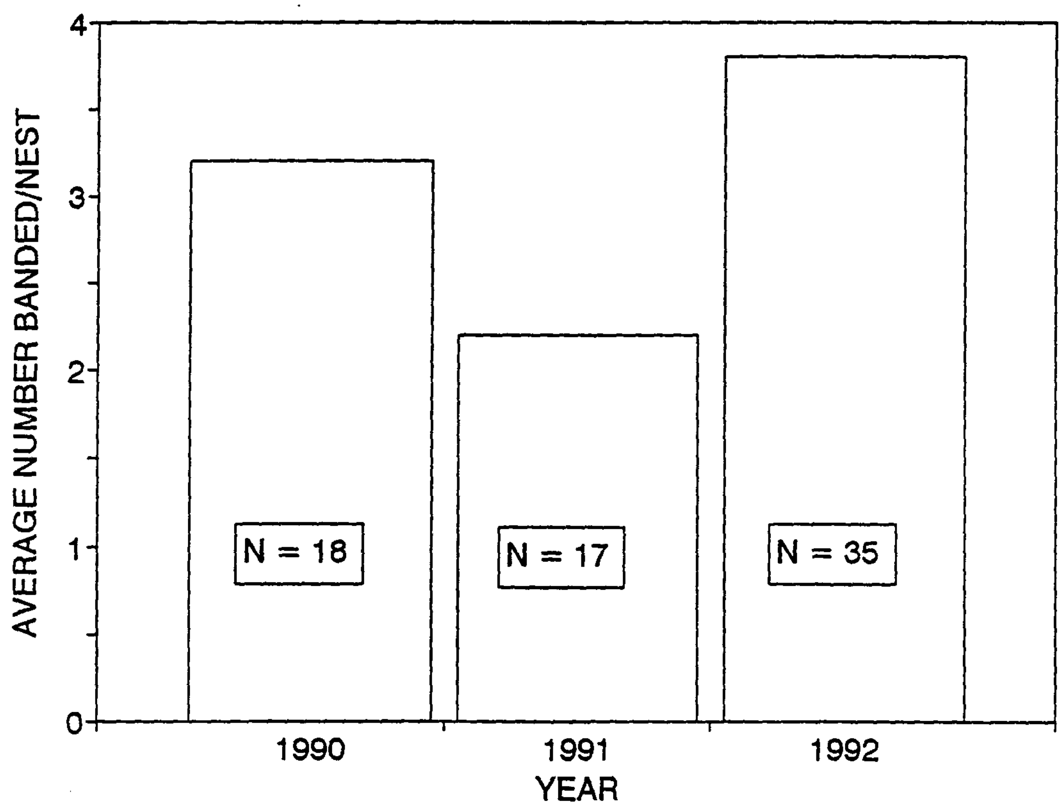



Figure 8. Mean Barn Owl Brood Size 1990-92.

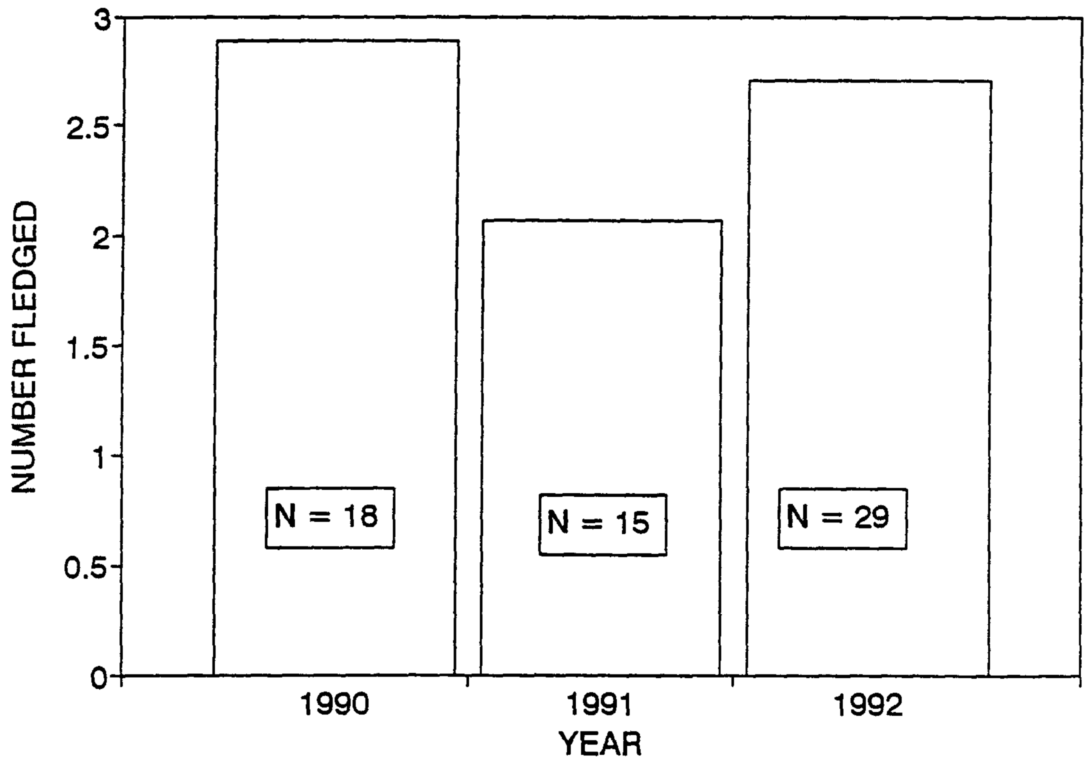



Figure 9. Mean Number Barn Owls Fledged/Nest 1990-92.

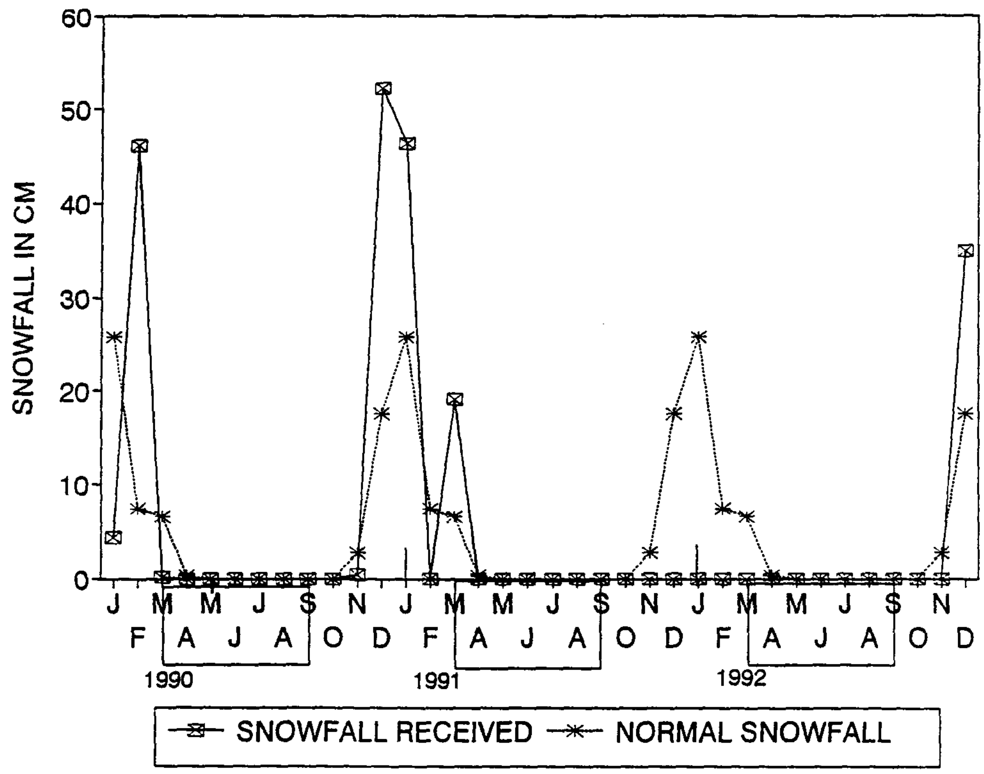



Figure 10. B. C. Lower Mainland Snowfall 1990-92 (Environment Canada data). Boxes on x-axis indicate prime barn owl nesting period.

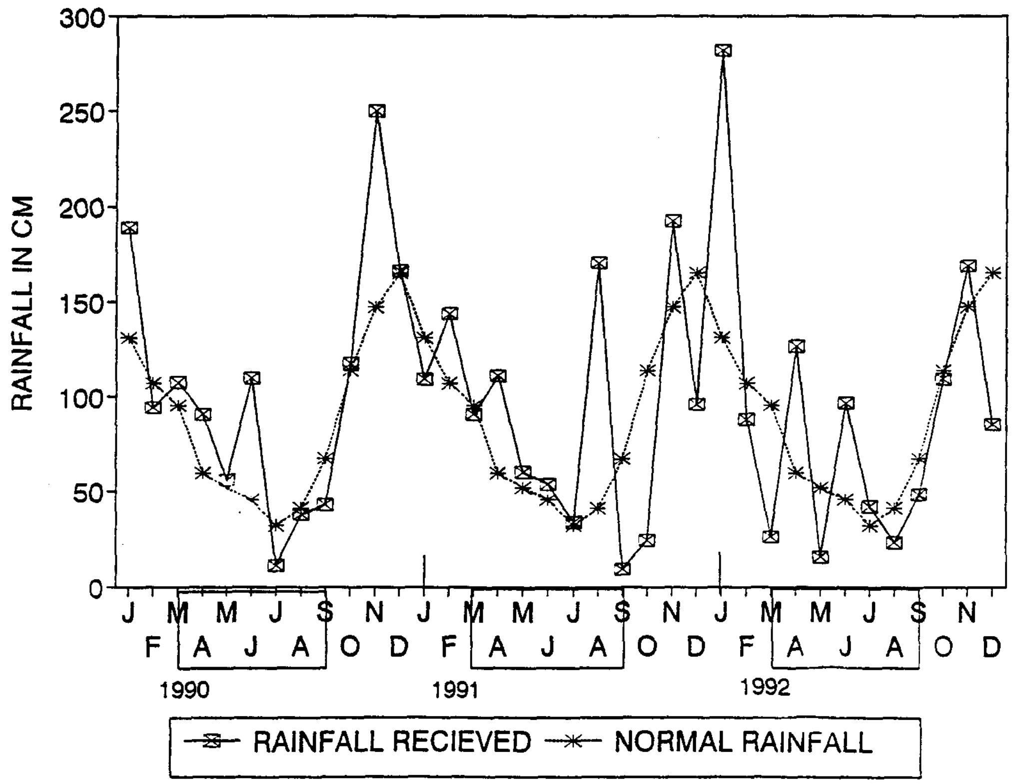



Figure 11. B. C. Lower Mainland Rainfall 1990-92 (Environment Canada data). Boxes on x-axis indicate prime barn owl nesting period.

If the number of young seen/year is used as an index of productivity and the number of carcasses turned into the Ministry of the Environment used as an index of mortality (Fig. 12), the year of 1991 has both the highest mortality ($\chi^2 = 11.58$, $p < 0.05$, df = 2; Bonferroni z test, Appendix II) and the lowest productivity of the 3 years ($\chi^2 = 38.01$, $p < 0.05$, df = 2; Bonferroni z test, Appendix II). However, the greatest proportion of successful nests also occurred in 1991 (Table 5). Seventy-seven percent of the observed nests over the 3 years successfully fledged young, and the overall percentage of nestlings fledged was 80%.

## 4.3 Mortality, Longevity, and Dispersal

### 4.3.1 Causes of Adult Barn Owl Deaths

The 341 barn owl carcasses of fledged owls examined at the Region II Ministry of the Environment office were classified by 15 different causes of death (Table 6). Road kills accounted for the largest proportion (63%) of deaths. Many road-killed barn owls were also found to have low body weights (under 400 g). It is difficult to determine precisely how starvation would affect the number of owls killed on roadways, but it seems likely that an owl suffering from lack of food would spend more time hunting and/or travelling longer distances, increasing the number of times its flight path would intersect with a roadway. In addition, a weakened owl would be less agile in avoiding collisions.

Starvation deaths (characterized by extremely emaciated carcasses) accounted for 17%

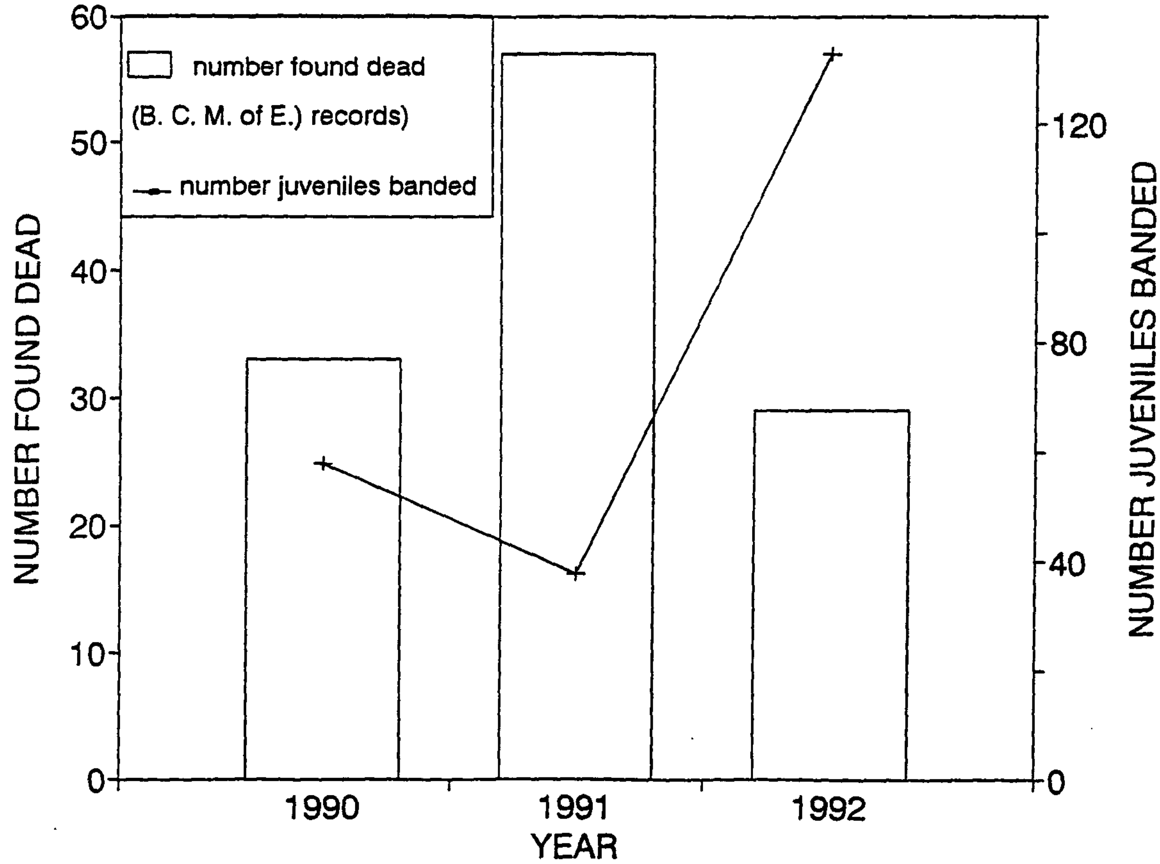



Figure 12. Barn Owl Production and Mortality.

TABLE 5. PERCENTAGE OF SUCCESSFUL BARN OWL NESTS

| YEAR | N | % SUCCESSFUL NESTS | % NESTLINGS FLEDGED |
|---|---|---|---|
| 1990 | 18 | 78% | 93% |
| 1991 | 17 | 86% | 89% |
| 1992 | 35 | 72% | 71% |
| **TOTAL** | 70 | 77% | 80% |

TABLE 6. CAUSES OF BARN OWL DEATHS

| CAUSE | NUMBER | PERCENT |
|---|---|---|
| Road Kill | 215 | 62.9 |
| Starvation | 57 | 16.7 |
| Unknown | 50 | 14.6 |
| Electrocuted | 7 | 2.0 |
| Window Strike | 2 | 0.6 |
| Caught in Fence | 2 | 0.6 |
| Trapped in Bldg. | 1 | 0.3 |
| Diseased | 1 | 0.3 |
| Broken Leg | 1 | 0.3 |
| Steamed | 1 | 0.3 |
| Caught Foot | 1 | 0.3 |
| Fell from Nest | 1 | 0.3 |
| Airplane Strike | 1 | 0.3 |
| Shot | 1 | 0.3 |

of the sample. Emaciation may result from many factors, including disease or non-apparent injuries, inexperience in hunting, scarcity of prey, or inaccessibility of prey due to weather conditions such as snowfall. It was not possible to assign a cause of death for 15% of the carcasses. A detailed post-mortem examination would probably have ascertained the cause of death of most of these cases, but the necessary funds were not available. The remainder of the deaths were due to causes that fall under the broad heading of accidents. None accounted for more than 3% of the total. It is encouraging to note that only one bird was found to have been shot. Although, of course, people illegally shooting barn owls are not likely to bring the carcass in for a taxidermy permit, it seems probable that at least a few gunshot-wounded or dying birds that had flown some distance would have been found by other members of the public.

### 4.3.2 Seasonal Mortality

Mortality in general was found to be greatest during the winter and lowest during the summer (Fig. 13). Starvation was responsible for significantly more deaths in the winter than in the other seasons ($\chi^2 = 76.27$, df = 3, $p < .05$, Bonferroni z test (Appendix III)), and there were more road-killed barn owls found in winter and spring than in summer and fall ($\chi^2 = 38.96$, df = 3, $p < .05$; Bonferroni z test (Appendix III)) (Fig. 14).

### 4.3.3 Longevity

The Canadian Wildlife Service in Ottawa provided records of 43 recoveries of nestling and adult barn owls either banded or recovered in British Columbia. The

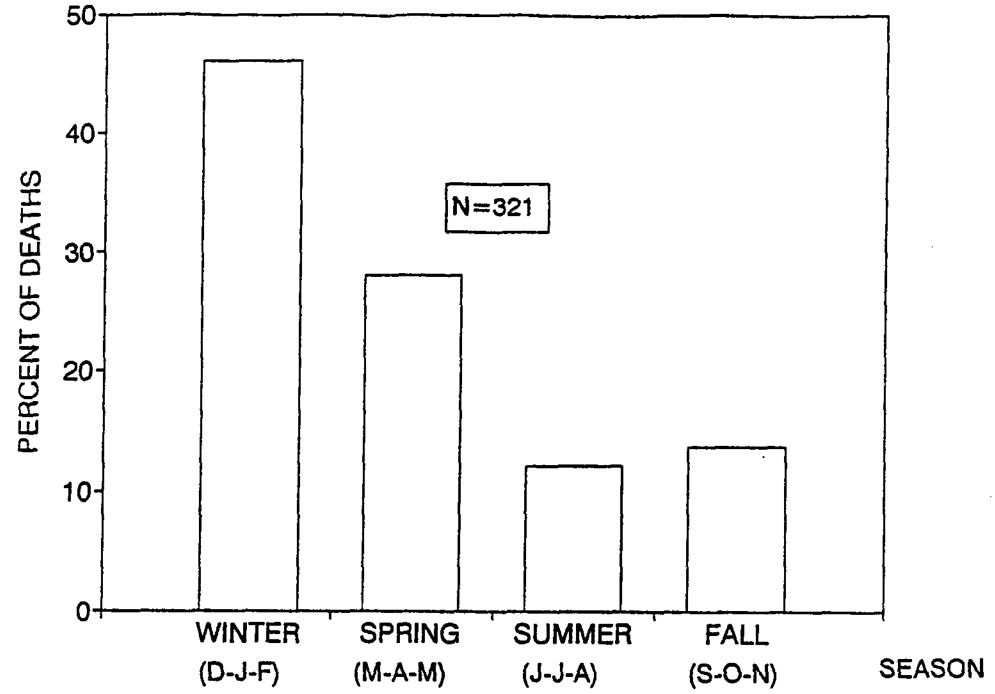



Figure 13. Seasonal Lower Mainland Barn Owl Mortality (B. C. Ministry of the Environment data).

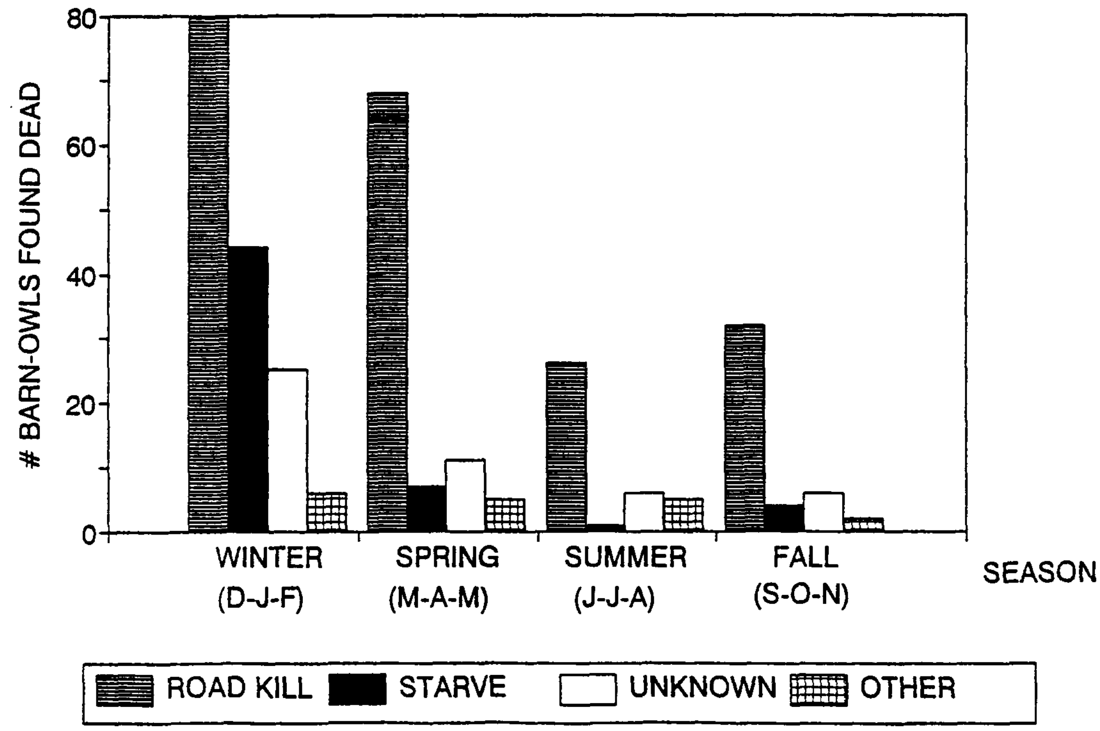



Figure 14. Seasonal Causes of Lower Mainland Barn Owl Deaths (B. C. Ministry of the Environment data).

average age at death was 28.1 months, with 51.2% of the individuals recovered dying before 12 months of age. The longest-lived individual was recovered 13.9 years after banding.

### 4.3.4 Dispersal and Migration

Most banded barn owls were recovered within 20 km of their banding location (Fig. 15). The longest distance travelled was 230 km. There was little relationship between the distance an individual travelled and time elapsed between banding and recovery (Fig. 16). Analysis of the flight path of the 28 individuals which had travelled between banding and recovery revealed a significant eastward trend in their movements ($\chi^2$ = 11.4, df = 1, $p < 0.01$) (Fig. 17).

### 4.3.5 Barn Owl Rehabilitation

Lower Mainland wildlife rehabilitators report that juvenile owls that had fallen from their nests account for the majority of their barn owl admissions (L. Short, pers. comm.; M. Tolksdorf, pers. comm.). Without human intervention these birds would die due to starvation or predation. Juveniles from nests in industrial sites have been admitted with feathers fouled with oil or other industrial debris. Adult owls are most often admitted with trauma due to vehicle collisions, but during especially cold or snowy weather many barn owls are reported suffering from starvation and hypothermia (L. Short, pers. comm.; M. Tolksdorf, pers. comm.) External parasites such as feather lice are relatively rare, but several cases of trichomoniasis or frounce (infection with the protozoan

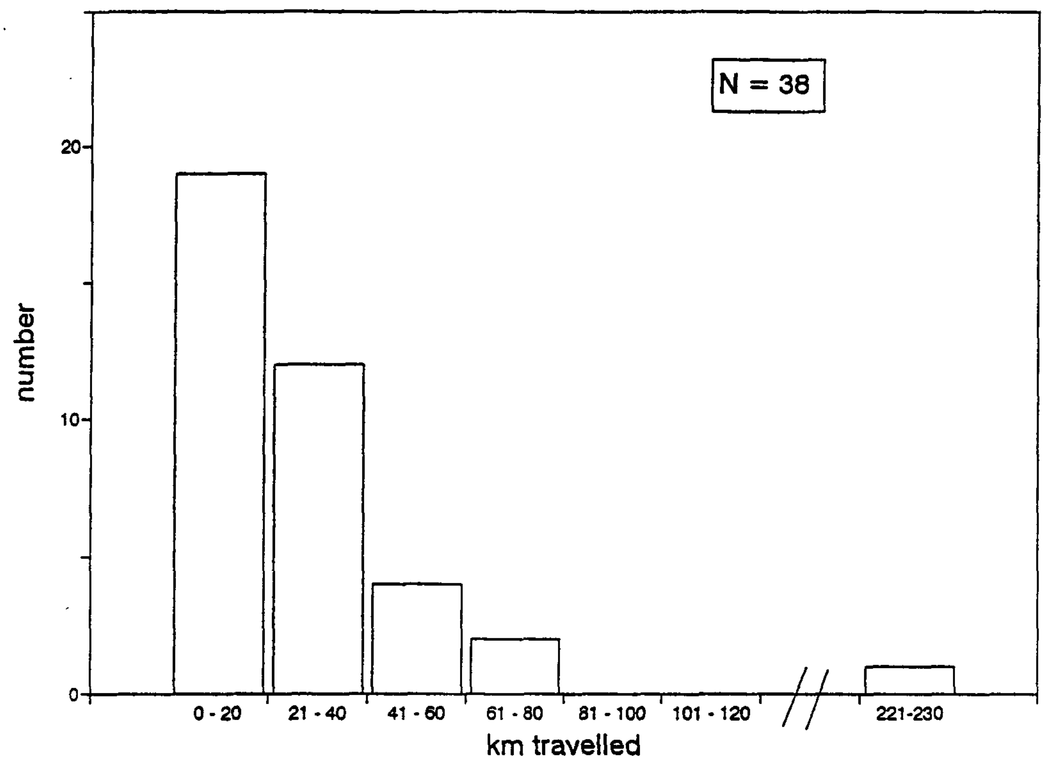



Figure 15. Distance Travelled by Banded Barn Owls (Canadian Wildlife Service Banding Office data).

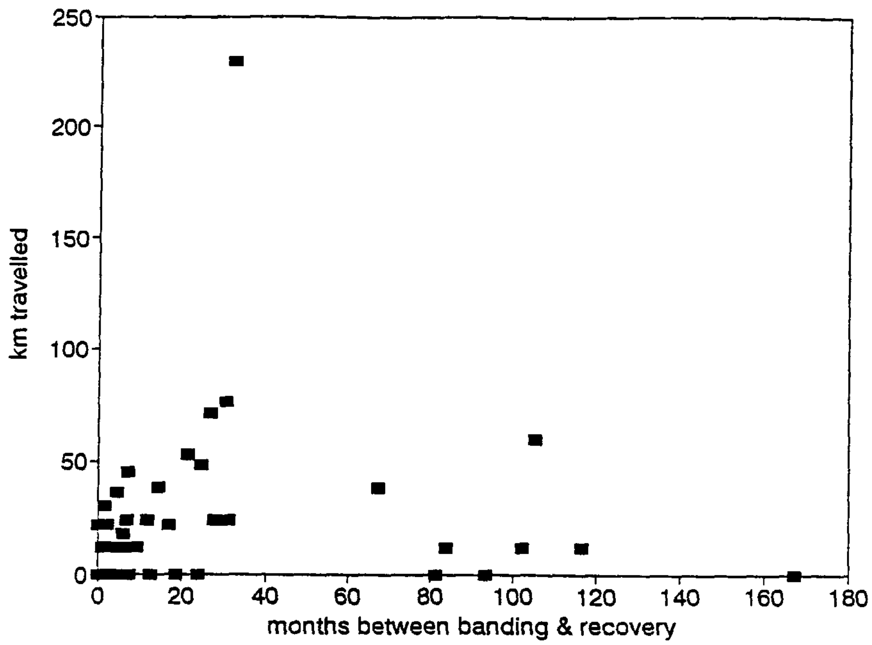



Figure 16. Months Between Banding & Recovery and Distance Travelled by Banded Barn Owls (Canadian Wildlife Service Banding Office data).

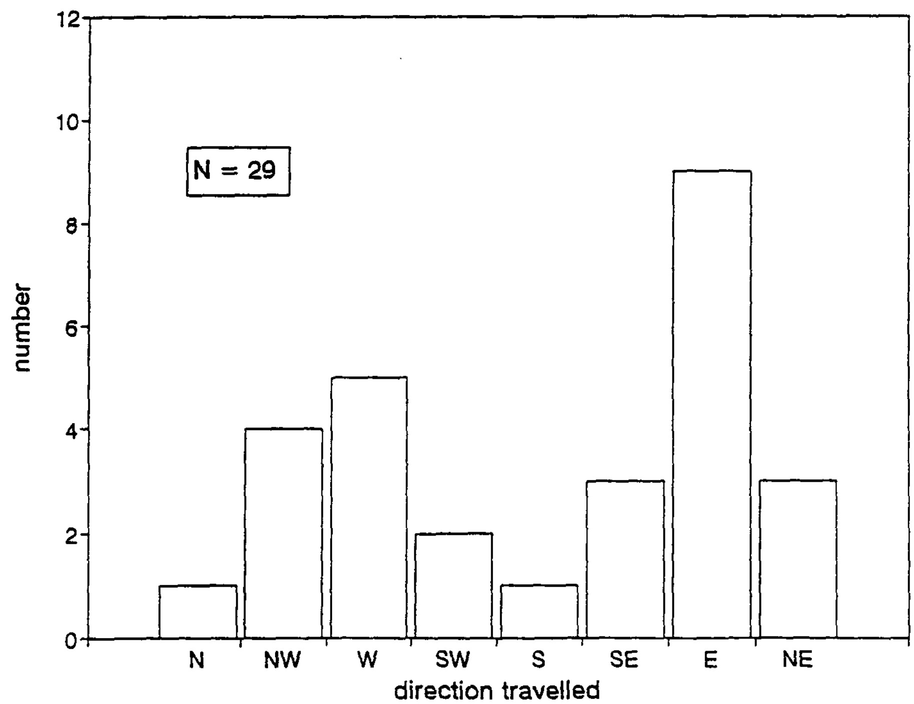



Figure 17. Direction Travelled by Banded Barn Owls (Canadian Wildlife Service Banding Office data).

*Trichomonas* sp.) have been recorded. This infection causes oral or intestinal lesions and is fatal unless treated. The consumption of feral pigeons is thought to be the source of the infection in barn owls.

## 4.4 Telemetry

Six adult barn owls were captured and fitted with transmitters. Contact with 1 owl was lost within 3 days, leaving 5 owls for which there are adequate data. The type of daytime roost chosen seemed to depend very much on the preferences of the individual bird (Table 7). One bird (S) tracked through the winter used exclusively natural sites and was never found within a building, while another (P) tracked in the summer was found roosting only at a single man-made site (a silo). The remaining 3 birds used both types of site to varying degrees. No correlation could be made between the type of site chosen and the weather at any particular time.

Each of the radio-tracked owls had a preferred roost site at which it was found from 72% to 100% of the time (Table 8). The individual using exclusively natural sites (S) was 1 of 2 birds which were trapped outside while hunting. If capture efforts had been restricted to owls inside buildings (which were certainly the easiest to capture), the conclusions drawn as to the owls' use of man-made roost sites would have been biased.

TABLE 7. ROOSTING HABITS OF INDIVIDUAL BARN OWLS

| OWL | S | W | R | B | P |
|---|---|---|---|---|---|
| # OF FIXES | 25 | 34 | 35 | 30 | 17 |
| # OF LOCATIONS | 3 | 5 | 2 | 2 | 1 |
| MAN-MADE | 0 | 3 | 1 | 2 | 1 |
| NATURAL | 3 | 2 | 1 | 0 | 0 |
| SEASON | winter | summer | summer | fall | spring |

TABLE 8. MAIN ROOST SITES OF INDIVIDUAL BARN OWLS

| OWL | S | W | R | B | P |
|---|---|---|---|---|---|
| SEX | F | ? | M | ? | M |
| MAIN SITE | NATURAL | MAN-MADE | NATURAL | MAN-MADE | MAN-MADE |
| # RELOCS. AT MAIN SITE | 72% | 74% | 91% | 87% | 100% |

## 4.5 Nestboxes

Of the 30 boxes placed in Delta by the B.C. Gas Consortium in 1992, 17 (57%) had been used for nesting by barn owls by the summer of 1993. One tree box was used by starlings, and another tree box had been usurped by honey bees and at the time of writing has not yet been cleared of comb and other debris. Delta has the densest population of barn owls in the Lower Mainland and it is expected that the boxes which are currently unoccupied will become inhabited within a year or so.

Nestboxes placed by the Stanley Park Zoological Society in an ongoing project were much more widely dispersed both in terms of geography and of habitat type. Three nest boxes were destroyed; 2 when the building upon which they were placed was demolished, and 1 when it was taken down and burned by a new property owner. A total of 19 nestboxes (31%) have been used for nesting by barn owls at the time of writing, including 2 of the tree boxes.

## 4.6 Barn Owls and Lower Mainland Agriculture

Data from Statistics Canada Censuses of Agriculture show that the Lower Mainland agricultural industry is changing slowly but steadily. The amount of farmland in pasture has declined steadily since 1956 (Fig. 18). Grain crops, which accounted for over 35,000 acres in 1941, are now planted on less than 5000 acres (Fig. 19). The area in unimproved pasture varies widely from census to census but has dropped from 66,000

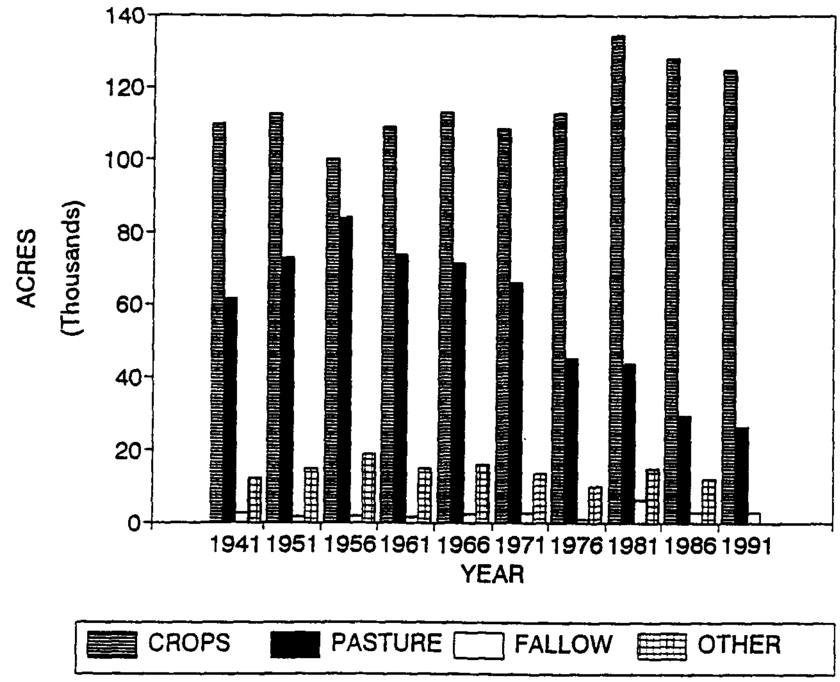



Figure 18. Uses of B. C. Lower Mainland Farmland (Statistics Canada Censuses of Agriculture data).

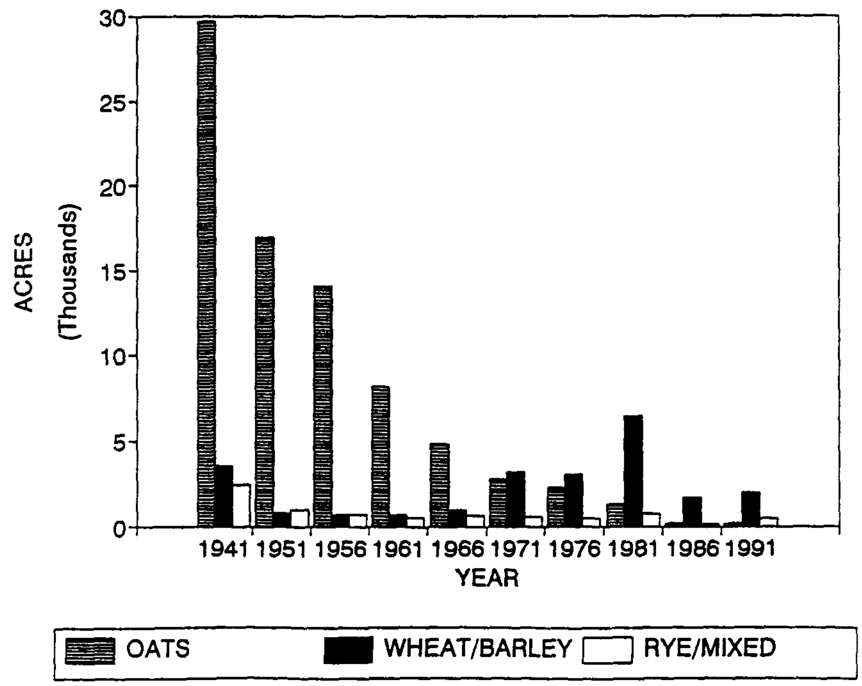



Figure 19. B. C. Lower Mainland Grain Crops (Statistics Canada Censuses of Agriculture data).

acres in 1941 to 35,000 acres in 1991 (Fig. 20). Unimproved pasture includes old fields which are prime habitat for the Townsend's vole (*Microtus townsendii*), the barn owl's primary prey species (Campbell 1983). Although the amount of pasture land has declined, the numbers of livestock (cattle, horses and sheep) in the Lower Mainland has increased over the years (Fig. 21). This reflects modern, more intensive methods of livestock raising, especially the trend towards feedlots for beef cattle. The Lower Mainland hay crop has remained relatively steady but shows a gradual increase from 51,000 acres in 1941 to 71,000 acres in 1991 (Fig. 22). Hay fields also provide good hunting habitat for barn owls. Over the past 50 years there has been a trend away from grain crops and towards cash crops such as berries and vegetables (Fig. 23). These 'bare soil' crops offer little habitat for small mammals.

# 5. DISCUSSION

## 5.1 Nest and Roost Site Choice

In the Lower Mainland barn owls appear to depend heavily on farm buildings, especially barns, for use as roosting and nesting habitat. Frequent use of man-made structures by barn owls is common throughout the world. In Holland 96% of barn owl nests were in man-made structures (Braaksma and de Bruijn 1976). Colvin (1984) found 26.4% of nests in man-made structures as well as a further 31% in nest boxes in or on buildings in New Jersey, and 37 out of 40 nests in New York were in man-made

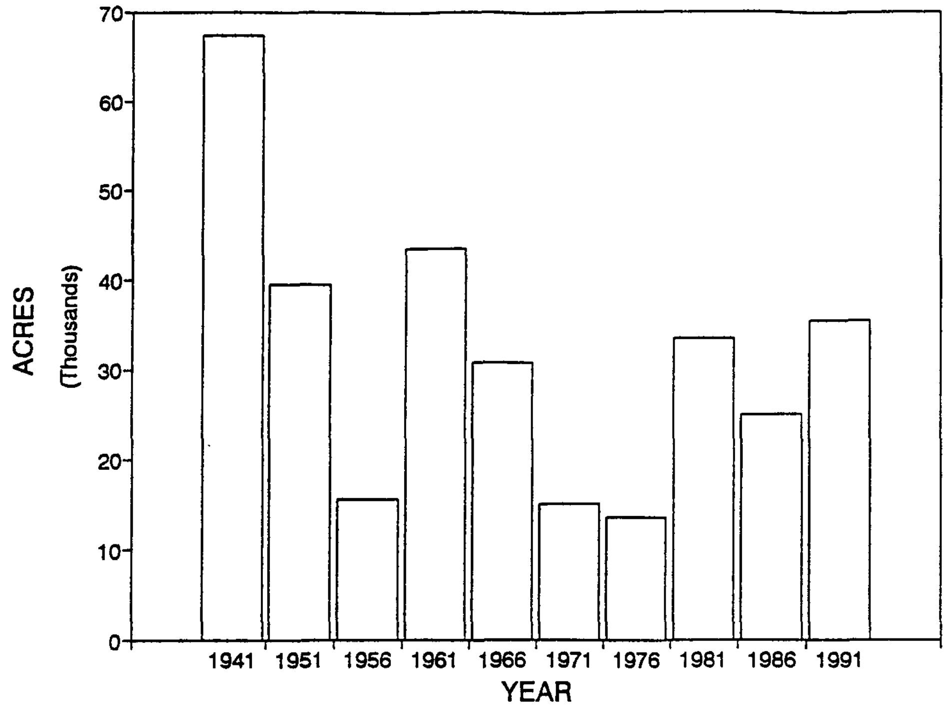



Figure 20. B. C. Lower Mainland Unimproved Pasture (Statistics Canada Censuses of Agriculture data).

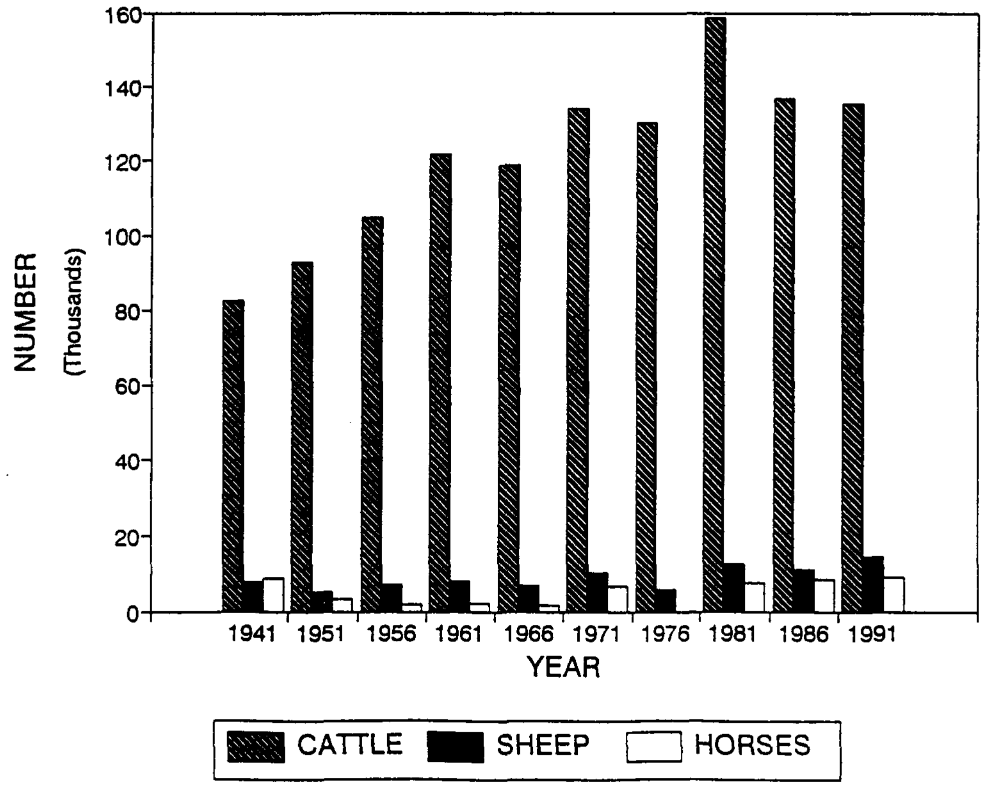



Figure 21. B. C. Lower Mainland Livestock (Statistics Canada Censuses of Agriculture data).

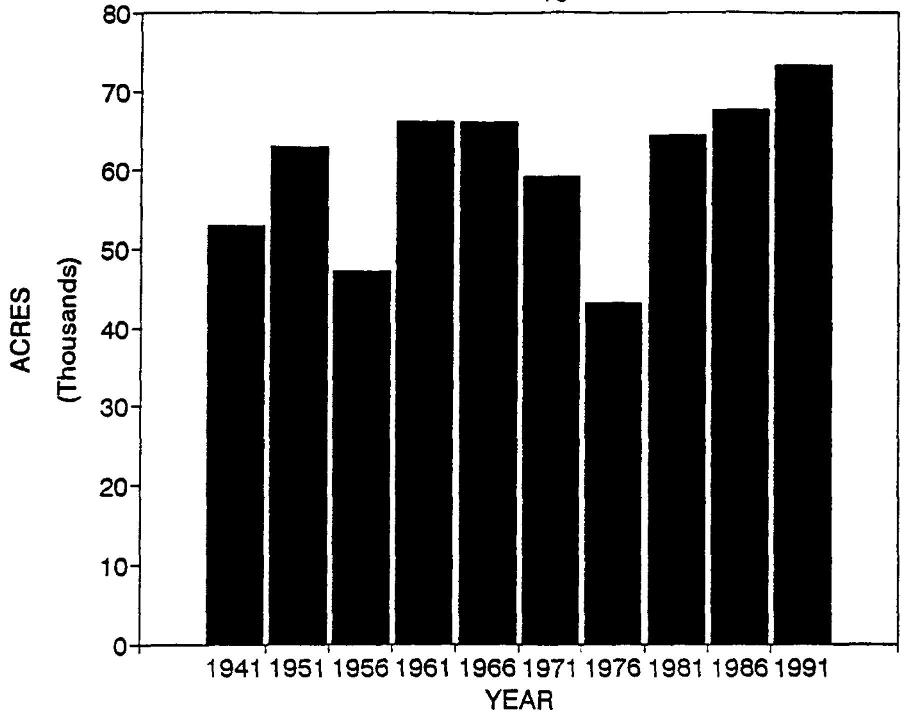



Figure 22. B. C. Lower Mainland Hay Crop (Statistics Canada Censuses of Agriculture data).

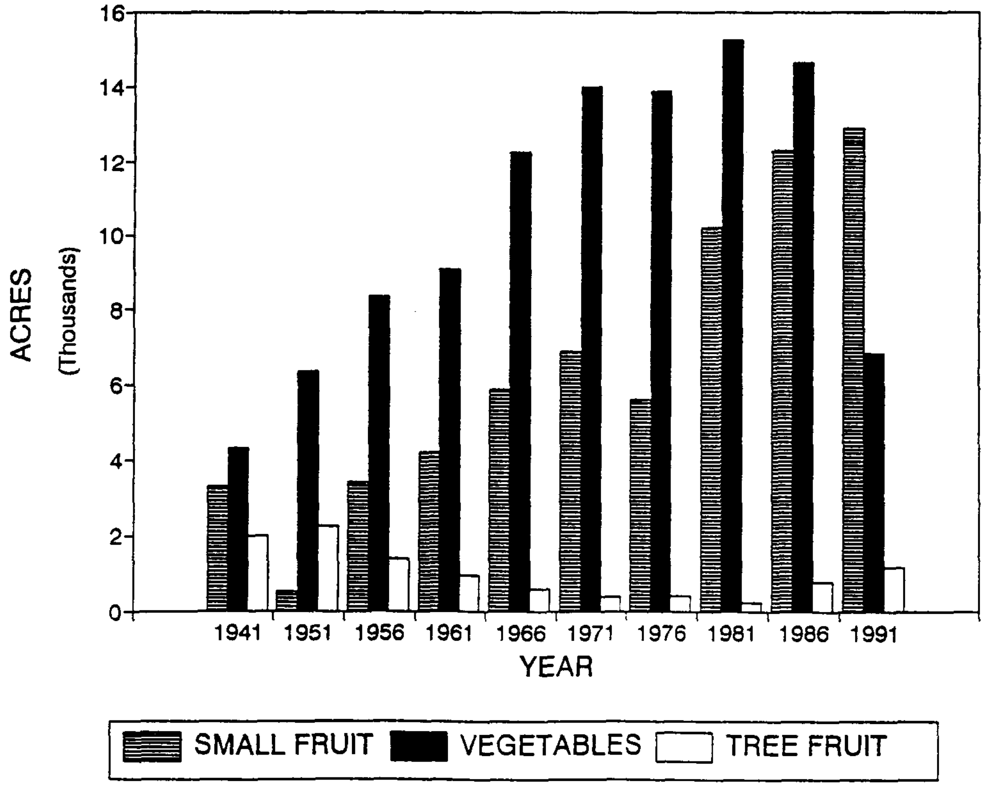



Figure 23. B. C. Lower Mainland Berry and Vegetable Crop (Statistics Canada Censuses of Agriculture data).

structures (Bull 1974). Nests in or on buildings accounted for 69% of known nest sites in Britain (Shawyer 1987). Ninety-three percent of 271 nests located in B.C. were in man-made structures, of which 82% were associated with farm buildings (Campbell and Campbell 1983).

Buildings provide a number of advantages over natural cavities. Firstly, they provide better protection against the elements. During the colder winter months a barn insulated with stored hay and straw and stocked with heat-generating farm animals would be much warmer than a natural site. Barn owls have little fat reserves and with a relatively low plumage insulative value (Johnson 1974) are sensitive to cold or snowy winter weather. Breeding barn owls in Leon, Spain were absent from temperature zones lower than the 8° C annual isotherm and below the 0° C isotherm in the coldest winter month (Alegre *et al.* 1989). Much research has been done on the microclimates of roost and nest sites and the effects of nest insulation ( Calder 1973; Bartholomew *et al.* 1976; Francis 1976; Tianen *et al.* 1983; Walsberg 1985, 1986; Millsap and Millsap 1987), and some studies have found relationships between microclimate and birds' energy budgets and/or reproductive success (Kendeigh 1961; White *et al.* 1975; Austin 1976; Kelty and Lustick 1977). Other researchers (Johnson 1974; Campbell and Campbell 1983) have suggested that the use of man-made structures is particularly important to barn owls inhabiting the northern limits of their range. A sheltered place to roost may enable an owl to conserve energy otherwise lost to thermogenesis, thus allowing it a wider margin for survival when temperatures are low and small mammals are scarce or unobtainable due to snow cover (Hayes and Gessaman 1980). During the course of this study farmers often reported seeing barn owls in their barns only during the winter months. In the warm climate of California barn owls were observed to nest in man-made sites only 28% of the time, apparently preferring natural sites 72% of the time (Campbell and Campbell 1983).

Barn owls in Britain tended to utilize tree cavities in portions of the country where rainfall is low and man-made structures where precipitation is higher (Shawyer 1987). Experimentally wetting the plumage of birds can cause decreases in thermal resistance of approximately 50% (Webb and King 1984). Young barn owls are slow to develop the capacity for temperature regulation (Howell 1964). A damp nest site would result in lowered nesting success at worst and increased brooding time at best. In a dry, sheltered nest site, parents may be able to decrease the amount of time spent brooding young and thus increase the time available for hunting. Shawyer (1987) also pointed out that buildings offer greater protection for young owls in the process of fledging. Fledglings can spend several days practising flying skills inside a barn without having to go outside to face predators and/or inclement weather.

Man-made structures also offer safety from most predators. Crows (*Corvus* sp.) mobbed any owl they detected roosting or flying outside in the daytime, but were never seen inside a barn. Several times during the course of this study an owl was flushed from a barn, was immediately set upon by crows, and was observed to dive back into the barn it had just left. Raccoons (*Procyon lotor*) enter barns only rarely, as do Great Horned Owls (*Bubo virginianus*). Rats and domestic cats are probably the major predators within buildings. Nest sites in stacked bales and young which have fallen from the nest are easy targets for rats and for domestic cats.

In utilizing barn platforms the barn owl has exploited a site for which there is very little competition. Large tree cavities, especially in the Lower Mainland, are scarce and are sought out by a number of species including raccoons, several other species of owl, several species of squirrel, opossums (*Didelphis virginiana*), porcupines (*Erethizon dorsatum*), and Wood Ducks (*Aix sponsa*) as well as honeybees and wasps. During the course of this study barn owl nestboxes placed in trees were observed to be occupied by raccoons, Douglas' Squirrel (*Tamiasciurus douglasi*) and a colony of honeybees. Raccoons and the larger owls could kill or seriously injure both adult and juvenile barn owls. It is difficult to predict the outcome of competition with the other species mentioned above. Choosing to nest within a building allows a pair of barn owls to get on with the business of reproduction without expending energy and time (and risking injury) defending their nest site from interspecific competitors.

Barn owls exhibit a high degree of nest fidelity (Bunn *et al.* 1982). Taylor (1989) reported that barn owls are "remarkably faithful" to their chosen nest sites and will remain at a site regardless of its quality even when an adjacent, better quality site becomes available. Strong fidelity to a breeding site may reflect historical scarcity of suitable, available nest sites and an advantage to remaining at a familiar one. Colvin (1984) observed that nests in trees were relatively short-lived, with 32% of the tree nests he had located being destroyed over 4 years of monitoring. A single storm in October 1987 destroyed 19% of the barn owl tree nests recorded in Britain and Ireland (Shawyer and Banks 1988). In the Lower Mainland in particular, one of the most common cavityforming trees is the Black Cottonwood (*Populus trichocarpa).* This tree is known for its relatively short life span and soft, low-strength wood (Hosie 1979), qualities which limit the useful life of cavities in its trunk. The Lower Mainland's wet climate also contributes to the swift rotting of wood, as do the excretions of the owls. During this study (4 years) 3 of the 8 natural nest sites found (38%) were lost. In contrast, only 7 of the 118 (6%) man-made nesting structures occupied by barn owls were demolished during the same period. However, this latter value does not include the loss of specific nest structures within the buildings (i.e. crevices between hay bales which are lost from year to year). Given that barn owls exhibit strong nest site fidelity (Bunn 1984; Taylor 1989) and that man-made nest sites are much more permanent than natural sites, the frequent use of man-made structures by barn owls can easily be explained.

Nestboxes built and placed especially for barn owls offer a high degree of nest security. Colvin (1984) found that significantly more young were fledged from nestboxes than from non-box sites, and attributed this to increased security from rain exposure, nest collapse and predators.

## 5.2 Reproduction

The mean clutch size found in this study is the second largest of several values reported from North America (Table 9), but the number fledged per nest was the second smallest. In Mali, most barn owl pre-fledging mortality occurred before Day 15 (Wilson *et al.* 1985). If this is also the case in the Lower Mainland, most nestling mortality

**TABLE 9 - COMPARISON OF BARN OWL REPRODUCTIVE DATA**

| SOURCE | AREA | CLUTCH SIZE | N | # FLEDGED/ NEST | N |
|---|---|---|---|---|---|
| this study | B. C. | 6.5 | 23 | 2.6 | 62 |
| Ault 1982 | Oklahoma | - | - | 2.81 | 55 |
| Millsap & Millsap 1987 | Colorado | 4.95 | 24 | - | - |
| Otteni *et al.* 1972 | southern Texas | 4.9 | 91 | 1.94 | 88 |
| Marti 1992b | Utah | 7.17 | 275 | 5.09 | 275 |
| Shawyer 1987 | Great Britain | 4.86 | 125 | 3.00 | 290 |
| Wilson *et al.* 1985 | central Mali | 6.05 | 140 | 1.85 | 136 |

would have occurred before the young were banded (counted), resulting in the small observed differences between the mean brood size and mean number fledged.

Productivity declined and mortality increased during 1991, a year notable for its cold winter and wet summer. These results were probably due to a combination of poor foraging weather during the nestling season and lower availability of small mammals due to snow cover during the pre-breeding season. Yet, the same year also had the greatest proportion of successful nests. This apparent contradiction may be due to young owls delaying the onset of reproduction under poor conditions. If older birds are initiating the majority of the nesting attempts under poor conditions, their parental experience may account for the large proportion of successful nests. Female Ural owls (*Strix uralensis*) have been ovserved to postpone their first breeding attempt when faced with poor environmental conditions (Pietiainen 1988).

The number of nesting attempts, the mean clutch size, and the mean number of young fledging from successful nests all declined the year following a severe winter in Utah (Marti and Wagner 1985). Braaksma and de Bruijn (1976) also reported barn owl population fluctuations with climate in Holland, and Henny (1969) found that annual rates of barn owl production were oscillatory. Colvin (1984) correlated barn owl breeding success with levels of rainfall. The barn owl's relatively large clutch size and its ability to raise more than 1 brood per year under good conditions allow populations to swiftly recover from a bad year. This reproductive potential is consistent with an r-selected life history strategy (Colvin 1984).

Although recovery following a bad year can be swift, a succession of poor years might decimate the small Lower Mainland population. The population would, however, probably be restocked by immigration from the south, but might take several years to recover its present level.

## 5.3 Adult Mortality, Longevity and Dispersal

The barn owl's habit of slow, low altitude flight and its frequent use of roadside edge as hunting habitat make it vulnerable to collisions with vehicles (Shawyer 1987). The owl's Lower Mainland range is criss-crossed with numerous, heavily-travelled roadways posted with high speed limits. Frequent heavy rainfall also makes visibility poor. Fifty-two percent of reported barn owl deaths in the British Isles were due to road kills (Shawyer 1987). Another British study of mortality in barn owls (Newton *et al.* 1991) also observed road kills (41.5% of deaths) and starvation (19.9% of deaths) to be the main causes of death. In addition, 8.8% of the deaths were due to organochlorine poisoning.

Many researchers (Stewart 1952b; Henny 1969; Glue and Nuttall 1971; Marti and Wagner 1985; Madge and Tyson 1987; Shawyer 1987; Taylor 1989) have commented on the barn owl's apparent intolerance of severe winter conditions in general and deep snow in particular. Freezing weather inhibits small mammal activity but increases the barn owl's thermoregulatory costs and energy intake requirements. Deep snow does not usually curtail small mammal activity, but the physical barrier of the drifts makes the barn owl's prey much less accessible. The barn owl is not known to be able to locate and capture prey under deep snow (Marti and Wagner 1985). During especially cold or unusually snowy periods in the Lower Mainland many barn owls are found dead (T. Plath, pers. comm.). Barn owls do not carry extensive fat reserves (Piechocki 1960), and their long, sparsely-feathered legs are not well-adapted to minimize heat loss. Barn owl plumage has relatively poor insulating properties and the barn owl's thermoneutral zone is narrower that of other owls (Johnson 1974). Piechocki (1960) concluded that a barn owl could starve after 8 days without food, and that starvation weight is approximately 21% below normal body weight. Marti (1992a) gives a mean body weight of 473.5 $\pm$ 32.3 g for male barn owls and 566.4 $\pm$ 57.0 g for females. Starvation weights would than be 374 $\pm$ 32.3 g and 447 $\pm$ 57.0 g, respectively. Eighty-three of the 341 carcasses examined during this study (25.6 %) weighed 375 g or less, and 174 (53.7 %) weighed 450 g or less. Water loss during freezing may have accounted for some of these light weights, but although other factors such as vehicle collisions may have been the immediate cause of death, it is likely that many of these birds would have eventually died of inanition. The increase in deaths due to starvation during the winter months may be explained by the relatively lower numbers of small mammals during this season. Initially, one might expect road deaths to occur at a fairly constant rate throughout the year. The high road mortality observed during the winter is probably due to a combination of hunger-stressed owls being more active along the roadside, poor weather conditions, and early sunsets resulting in owls leaving their roosts to hunt just as rush-hour commuter traffic begins.

The studies of Hardy *et al.* (1981) and Newton *et al.* (1991) in the British Isles provide an opportunity to compare the seasonal mortality results from this study with those of Britain (Fig. 24). Mortality in the British barn owl population appears to rise in autumn and drop again in winter, demonstrating a relatively higher autumn mortality and lower winter mortality than did the Lower Mainland population. This disparity may be due to an earlier onset of cooler weather in the British autumn which eliminates the vulnerable individuals earlier in the year.

Although nestlings hatched in the summer would be fledged in the fall, in the Lower Mainland fall mortality is only slightly higher than in summer. This pattern suggests that under good conditions young owls are able to become independent without high mortality. It is likely, however, that the mortality peak during the winter consists mostly of young birds in their first winter.

Hatching asynchrony in barn owls is thought to be an adaptation to unstable prey populations (Colvin 1984), with relatively large clutches being laid and brood reduction taking place after hatching. The younger nestlings in the brood are outcompeted by their older, more aggressive siblings and do not survive during poor years. During this study 5 bands were recovered from nestlings which failed to fledge. In all but 1 case these were the youngest individuals in the brood as determined by wing chord measurement.

The average lifespan of 28.1 months found for barn owls in British Columbia is similar to that reported in the literature. Keran (1981) reported a mean life span of 20.9 months, and Stewart (1952a) reported an average life span of nearly 27 months for southern birds (south of 35° N in North America) and 13 months for northern birds. Stewart suggested that the differences he found may have been due to severe winter conditions in the most northerly parts of the barn owl's North American range, although

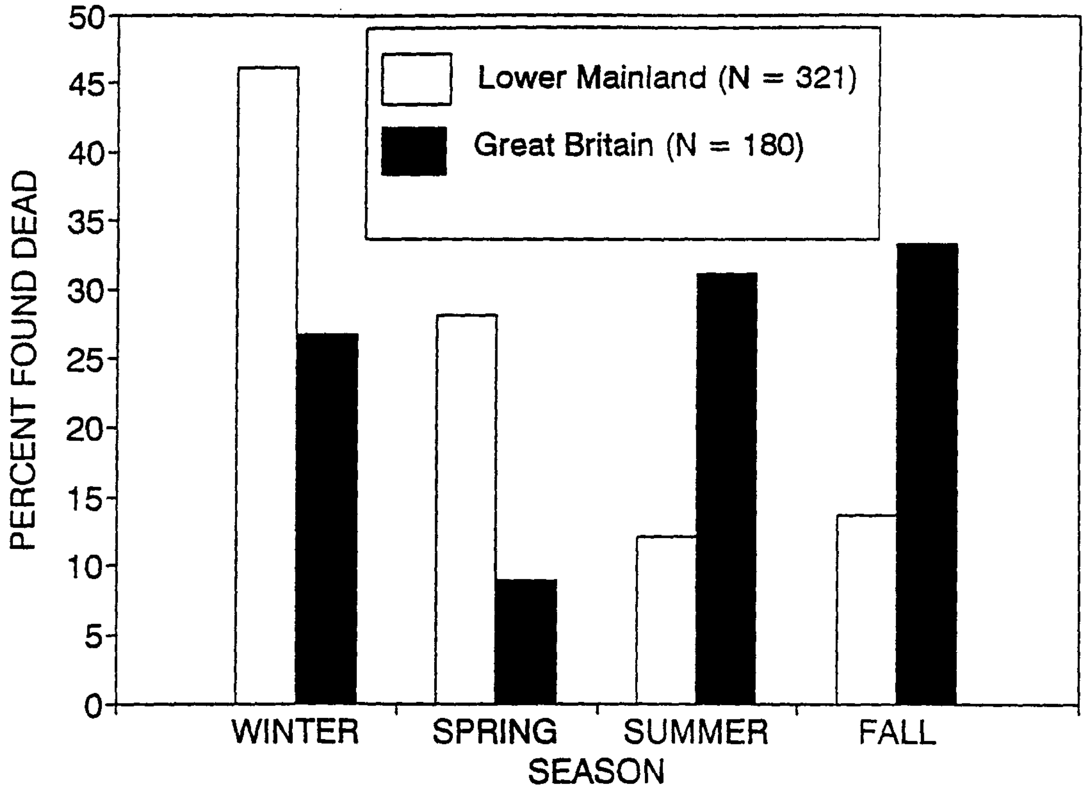



Figure 24. Comparison of British & B. C. Lower Mainland Barn Owl Mortality.

he could not find any significant clustering of deaths during the winter months.

In a widely-cited paper Stewart (1952a) concluded that "barn owls native to the northern part of their North American range were partly migratory", and Taylor (1989) stated that "in North America the most northerly populations perform regular southward migrations for distances up to 2000 km (1240 miles) to avoid harsh winters". We were unable to find any evidence to support these conclusions in British Columbia, the northwestern edge of the barn owl's North American range. On the contrary, a significant *eastward* trend to barn owl movements in the province was discovered. This may be due to individuals dispersing from the relatively dense barn owl populations in the southwest (Delta municipality) to less densely populated areas in the east, or it may simply be an artefact of the decreased probability of band recovery due to the Pacific Ocean in the west and the sparse human population north of the Lower Mainland. Unless evidence of migration appears from banding studies in the future, the British Columbia population of barn owls can be considered to be non-migratory.

### 5.3.1 Possible Biases of the Data

Taxidermy data provides the only large sample of barn owl mortality available in the Lower Mainland, and caution must therefore be used in interpreting the results. Carcasses unsuitable for mounting are not likely to be reported, resulting in an underestimation of deaths, for example, by drowning. This is probably significant, as Shawyer (1987) found drowning (possibly as a result of birds attempting to bathe in deep water) to be the second-highest known cause of mortality in the British Isles. His data were not obtained entirely from taxidermy records, but also by repeated public requests for farmers to turn in any barn owl carcasses found. No cases of drowning of adult birds were reported in the Lower Mainland.

Barn owls dying in highly-visible areas such as roadside are far more likely to be found than those killed by predators. Predation also would probably result in carcasses unsuitable for mounting. Only one case involving predation was reported in the taxidermy data: that of a starving, grounded owl captured by a dog. Barn owls are also known to be preyed upon by Great Horned Owls (*Bubo virginianus*) (R. Cannings, pers. comm.) and Red-tailed Hawks (*Buteo jamaicensis*) (M. Tolksdorf, pers. comm.).

Deaths due to poisoning also went unrecorded because of lack of funds for detailed autopsies. However, Lower Mainland wildlife rehabilitators report that barn owl poisoning is rare in this area (L. Short, pers. comm.; M. Tolksdorf, pers. comm.). Colvin (1984) concluded that the danger of secondary poisoning of barn owls due to pesticides is low, citing the owl's habit of foraging over open fields rather than close to farm buildings where poison is likely to be laid, and the owl's preference for herbivores such as voles which are unlikely to consume poison bait.

Finally, the accuracy of the information recorded depends almost totally on the honesty of the finder of the carcass. The location and date that the owl was found, as well as additional information affecting the final decision as to cause of death are subject to the memory and motivation of the public.

## 5.4 Telemetry

This study showed no correlation between the type of roost site selected by barn owls and the prevailing weather conditions. However, due to the difficulty of capturing free-flying adult owls outside of buildings, only 1 bird (S) was radio-tracked during the winter months. The data on the remaining 4 birds was gathered during the summer and fall. Therefore, a thorough test of the hypothesis that barn owls preferentially seek shelter in man-made structures during periods of thermal stress was not done. A true test can only be done when a reliable method of capturing free-flying barn owls is developed.

All of the owls tracked demonstrated a preference for a single roost site. This suggests that either a) high quality roost sites are scarce, or b) there is an advantage to using a familiar roost site, or both. High quality roost sites do not appear to be scarce. Usually only 1 or 2 owls are found within a single structure, although groups of individuals roosting within a single building or grove of trees have been observed ( Smith *et al.* 1974; Bunn *et al.* 1982). Re-using a familiar roost site may be an advantage for nocturnal birds which have to find their roosts in darkness. Bunn *et al.* (1982) observed a that barn owl had great difficulty in reaching its nest within a building when several obstacles which it normally had to negotiate were removed.

Other factors may also influence roost site choice, such as the amount of daytime disturbance occurring at the roost site or the presence of food, mates or predators nearby.

## 5.5 Nestboxes

The placement of nestboxes for barn owls is one method of enhancing their habitat in areas where nesting sites are scarce or declining (Marti *et al.* 1979; Bunn *et al.* 1982). Changes in agricultural building styles have meant a slow attrition of barns and silos allowing access to owls. In the interests of disease control and hygiene, new farm buildings are designed to prevent starlings and pigeons from entering. Buildings inaccessible to these birds are also inaccessible to barn owls. Old-style wooden barns are gradually being replaced with modern metal structures. Tower silos are also being replaced with bunker silos and plastic-bag methods of storing silage. In most instances farmers do not intentionally deny barn owls a place to nest or roost and they readily agree to the installation of nestboxes. If the nestbox is installed on the inside of the building with its entrance hole up flush against an opening in the building's wall, the building's interior remains inaccessible to birds. In this way nesting sites are provided for the owls with the farmer still having a "bird-tight" barn.

Properly constructed nest boxes also provide greater security for nestlings than do open platforms in buildings. Owlets fall from nestboxes much less frequently than from platform nests. One disadvantage of nestboxes as compared to platform nests is that the boxes require maintenance and must be cleaned out periodically to prevent pellet accumulation from rendering the box unusable. With platform nests any pellet build-up simply falls over the edge.

Providing a thorough distribution of nest boxes in an area removes the constraint of finding breeding sites from the local barn owl population and allows it to expand to the limit of the food supply or other limiting biological constraint. If the population is already at its maximum level as determined by carrying capacity, then the provision of nestboxes will not increase the density of breeding pairs but the increased number of young owls fledged because of the safer nest site will benefit neighbouring populations (Bunn *et al.* 1982; Seymour 1988).

Preliminary results from the 2 Lower Mainland nestbox programs are encouraging. Although several more years of evaluation are necessary, nestboxes appear to be a valuable component of barn owl conservation in the Lower Mainland.

## 5.6 Human Attitudes to Barn Owls

Barn owls were tolerated or encouraged at the majority of the man-made sites. Very few farmers professed dislike of the birds, which when expressed was usually due to problems with droppings or pellets fouling machinery, or to misconceptions as to the barn owl's propensity for attacking domestic animals. Most farmers expressed the belief that the owls discouraged feral pigeons (*Columba livia*) and Starlings (*Sturnus vulgaris*) from occupying farm buildings.

In the United States barn owls have become pests in some industrial areas (Martin 1986). Managers at industrial sites in the Lower Mainland occasionally complained about damage done to buildings or products by owl droppings, but usually seemed prepared to tolerate the birds. In only 1 case was the Ministry of the Environment asked to capture and remove the owls inhabiting a factory. Barn owls accidentally trapped in commercial buildings sometimes caused problems with motion-detection burglar alarms, necessitating the owls' removal.

## 5.7 Barn Owls and Lower Mainland Agriculture

One major problem in the evaluation of the impact of agricultural changes on the barn owl is the lack of any data on relative numbers of small mammals in various crop types. This data would be of great value when evaluating habitat for many of the Lower Mainland's raptor species. In the absence of such data one must rely upon anecdotal evidence provided by the farmers, who notice small mammals fleeing from the approach of farm machinery in the fields, and upon observations of large numbers of crows, gulls and hawks following the machinery when certain crops are harvested.

Current trends in Lower Mainland agriculture do not bode well for the barn owl's future here. The owl requires open grasslands with high populations of small mammals to nest successfully (Colvin 1985). In the Lower Mainland there has been a general decline in grasslands-associated agriculture and a trend towards more intensive farming. For example, in the municipalities of Pitt Meadows, East Richmond, and Abbotsford, the area in berry production increased by 58% from 1980 to 1987, mostly from land used previously for forage crop production or pasture (Moore 1990). The Lower Mainland is now the nation's largest producer of cranberries and raspberries (Moore 1990). Berry and vegetable fields support limited, if any, small mammal populations. Grain crops provide some small mammal habitat as rodents can be seen fleeing from the approach of the machinery as the field is harvested. Grassland is a favoured hunting habitat of the barn owl, and, except for hay meadows, the amount of this habitat is declining as farmers turn to intensive stock raising methods such as feedlots and silage feeding over pasture use. Colvin (1985) correlated the decline of the barn owl in Ohio with diminishing grassland availability as the dairy industry declined and farmers switched to row crops and intensive farming methods.

Agricultural land in the Fraser Valley is also being lost to urban development. The mild climate and natural beauty of the area attracts immigration from eastern Canada and from other countries, and high housing demand has forced land prices up. Between 1980 and 1987, 4,354 ha of rural land were urbanized, 26% of which had been previously used for pasture or forage crop production (Moore 1990). During this study farmers frequently spoke about how urbanization of agricultural land often causes drainage and vandalism problems for the remaining farmers. Faced with declining profits from farming and tempting offers from developers, one cannot blame farmers for selling out. Some large farms are broken up into 2-5 ha hobby farms. Although this keeps the "rural look" of the area, farms of this size tend to have heavily grazed pastures which do not support dense microtine populations.

Canada Land Inventory statistics reveal that agricultural land is second only to undisturbed land as a target for new urban activities (Moore 1990). The Agricultural Land Reserve (ALR) was established in 1974 as a means of restricting urban development on land with high agricultural productivity or potential. The creation of the ALR has slowed but not halted the conversion of farmlands to urban use, as withdrawals from the Reserve continue to occur at the rate of 620 ha/year (Moore 1990). The subject of golf courses on agricultural land has recently spawned much public debate. The acres of manicured lawn on a typical golf course do not provide suitable small mammal habitat to support foraging raptors. Recently golf courses were designated legitimate uses of ALR land, sparking an explosion of applications for course development. This designation was overturned after a change in government, leaving the future development of golf courses in ALR land mainly dependent on the political climate and speculators continuing to invest in farmland as holding properties.

The future of the barn owl in the Lower Mainland is inextricably linked to the area's agriculture. Conservation of grassland hunting habitat is vital to maintain viable owl populations. Grassland habitat is important for many wildlife species in the Fraser Valley, including Short-eared Owls, Red-tailed Hawks, Northern Harriers, Great Blue Herons and many species of shorebirds, waterfowl and songbirds (Butler 1992). Preserving grassland habitat will benefit all these species, including the barn owl.

## REFERENCES

Alegre, Joaquin, Angel Hernández, Francisco J. Purroy and Antonio J. Sánchez. 1989. Distribución altitudinal y patrones de afinidad trófica geográfica de la lechuza commun (*Tyto alba*) en Leon. **Ardeola** 36 (1):41-54.

Andrusiak, L. 1992. Progress Report on the Barn owl Nestbox Program. Unpubl. report to Stanley Park Zoological Society, Vancouver, B. C.

Ault, J. W. 1982. A quantitative estimate of barn-owl nesting habitat quality. M. Sc. Thesis, Oklahoma State University.

Austin, G. T. 1976. Behavioral adaptations of the Verdin to the desert. **Auk** 93:245-262.

Bartholomew, G. A., White, F. N., and Howell, T. R. 1976. The thermal significance of the nest of the Sociable Weaver, *Philetairus socius*: Summer observations. **Ibis** 118: 402-410.

Bent, A. C. 1961. "Barn owls", chap. *In* **Life Histories of North American Birds of Prey** (Part 2). Bulletin 170, U. S. National Museum.

Blood, D. A., and C. Dueck. 1992. Fraser Valley Gas Project - Barn owl Nest Box Program in Delta, 1992. Unpubl. report to Fraser Valley Gas Project, Vancouver, B. C.

Bloom, P. H. 1987. Capturing and handling raptors. *In* **Natl. Wildlife Fed. Sci. Tech. Ser.** No. 10, p. 99-103.

Braaksma, S., and De Bruijn, O. 1976. De kerkuilstand in Nederland. **Limosa** 49:135-187.

Bull, J. 1974. **Birds of New York State.** New York: Doubleday.

Bunn, D. S., A. B. Warburton, and R. E. S. Wilson. 1982. **The Barn-owl.** Staffordshire: T. & A. D. Poyser.

Butler, R. W. (ed.). 1992. **Abundance, Distribution and Conservation of Birds in the Vicinity of Boundary Bay, British Columbia**. Technical Report Series No. 155. Canadian Wildlife Service, Pacific and Yukon Region, British Columbia.

Calder, W. A. 1973. Microhabitat selection during nesting of hummingbirds in the Rocky Mountains. **Ecology** 54:127-134.

Campbell, E. C., and R. W. Campbell. 1983. **Status Report on the Common Barn-Owl (*Tyto alba*) in Canada - 1982.** Committee on the Status of Endangered Wildlife in Canada, B. C. Ministry of the Environment.

Campbell, R. W. 1983. "Feeding Ecology of the Common Barn owl in North America". M. Sc. Thesis, University of Washington.

Campbell, R. W., David A. Manuwal, and Alton S. Harestad. 1987. Food habits of the Common Barn-owl in British Columbia. **Can. J. Zool.** 65:578-586.

Campbell, R. W., N. K. Dawe, I. McTaggart-Cowan, J. M. Cooper, G. W. Kaiser, M. C. E. McNall. 1990. **The Birds of British Columbia.** Volume II, Non-passerines. Diurnal Birds of Prey Through Woodpeckers. Victoria: Royal British Columbia Museum.

Colvin, B. A. 1984. "Barn owl foraging behaviour and secondary poisoning hazard from rodenticide use on farms". Ph. D. Thesis, Bowling Green State University.

_____. 1985. Common barn-owl population decline in Ohio and the relationship to agricultural trends. **J. Field Ornithol.** 56:224-235.

Colvin, B. A., P. L. Hegdal, and W.B. Jackson. 1984. "A comprehensive approach to research and management of Common Barn owl populations", *in* **Proc. Workshop on Management of Nongame Species and Ecological Communities, June 11-12 1984,** edited by W. C. McComb, 99-123. University of Kentucky.

Colvin, B. A., and P. A. Hegdal. 1986. Techniques for capturing common barn owls. **J. Field Ornithol**. 57:200-207.

Cowan, I. McT. 1942. Food habits of the barn-owl in British Columbia. **Murrelet** 2:349-53.

Dawe, N. K., C. S. Runyan, and R. McKelvey. 1978. Seasonal food habits of the Barn-owl (*Tyto alba*) on the Alaksen National Wildlife Area, British Columbia. **Canadian Fld. Nat**. 92:151-155.

Dominion Bureau of Statistics. 1947. **8th Census of Canada (1941)**. Volume VIII. Agriculture. Part II. Ottawa: Queen's Printer.

_____. 1953. **1951 Census of Canada**. Agriculture. Volume VI. Part II. Ottawa: Queen's Printer.

_____. 1957. **1956 Census of Canada**. Agriculture. Bulletin 2 - 10. Ottawa: Queen's Printer.

_____. 1963. **1961 Census of Canada**. Agriculture. British Columbia. Bulletin 5.3 - 4. Ottawa: Queen's Printer.

_____. 1968. **1966 Census of Canada.** Agriculture. British Columbia. Ottawa: Queen's Printer.

Errington, Paul L. 1931. Winter-killing of barn owls in Wisconsin. **Wilson Bull.** 43(1):60-61.

Francis, W. J. 1976. Micrometeorology of a blackbird roost. **J. Wildl. Manage.** 40:132-136.

Glue, D. E., and J. Nuttall. 1971. Adverse climactic conditions affecting the diet of a barn-owl in Lancashire. **Bird Study** 18(1):33-34.

Hardy, A. R., Hirons, G. J. M., and P. I Stanley. 1981. The relationship of body weight, fat deposit and moult to the reproductive cycles in wild Tawny Owls and

Barn owls. *In* **Proc. International Symposium on Diseases of Birds of Prey held in London 1-3 July, 1980**, edited by J. E. Cooper and A. G. Greenwood. London: Chiron, Keighly.

Hayes, S. R., and James A. Gessaman. 1980. The combined effects of air temperature, wind and radiation on the resting metabolism of avian raptors. **J. Therm. Biol.** 5:119-125.

Henny, C. J. 1969. Geographical variation in mortality rates and production requirements of the barn owl (*Tyto alba ssp.*) **Bird-banding** 40:277-356.

Honer, M. R. 1963. Observations on the Barn owl (*Tyto alba guttata*) in the Netherlands in relation to its ecology and population fluctuations. **Ardea** 51:158-195.

Hosie, R. C. 1979. **Native Trees of Canada** (8th ed.). Ottawa: Minister of Supply and Services Canada.

Howell, T. R. 1964. Notes on incubation and nestling temperatures and behaviour of captive owls. **Wilson Bull.** 76: 28-36.

Johnson, W. D. 1974. "Bioenergetics of the Barn owl (*Tyto alba*)". M. Sc. Thesis, Calif. State University, Long Beach.

Kelty, M. P., and Lustick, S. I. 1977. Energetics of the starling (*Sturnus vulgaris*) in a pine woods. **Ecology** 58:1181-1185.

Kendeigh, S. Charles. 1961. Energy of birds conserved by resting in cavities. **Wilson Bull.** 73:140-147.

Kendeigh, S. Charles. 1969. Energy responses of birds to their thermal environments. **Wilson Bull**. 81:441-449.

Keran, D. 1981. The incidence of man-caused and natural mortalities to raptors. **Raptor Res.** 15:108-112.

Madge, G., and K. Tyson. 1987. Decline of the Barn owl in relation to mid-Devon weather records. **Devon Birds.** 40:84-87.

Marti, Carl D. 1988. A long-term study of food-niche dynamics in the common barn-owl: comparisons within and between populations. **Can. J. Zool.** 66:1803-1812.

_____. 1992a. **Barn Owl. The Birds of North America**. No. 1., edited by A. Poole, P. Stettenheim and F. Gill. American Ornithologists' Union, The Academy of Natural Sciences of Philadelphia.

_____. 1992b. Barn owl reproduction and its constraints near the limit of the species' distribution. **In Proceedings of the Raptor Research Foundation Inc. 1992 Annual Meeting, 11-15 November** in Bellevue, Washington, by the Raptor Research Foundation.

Marti, C. D., and P. W. Wagner. 1985. Winter mortality in common barn-owls and its effect on population density and reproduction. **Condor** 87:111-115.

Marti, C. D., P. W. Wagner and K. W. Denne. 1979. Nest boxes for the management of barn owls. **Wild. Soc. Bull**. 7:145-148.

Martin, Lee R. 1986. Barn owls and industry: problems and solutions. *In* **Proceedings of the Twelfth Vertebrate Pest Conference**, edited by T.P. Salmon, 281-285. Univ. of California.

Mayer, L., S. Lustick and B. Battersby. 1982. The importance of cavity roosting and hypothermia to the energy balance of the winter acclimatized Carolina Chickadee. **Int. Biometeor**. 26:231-238.

Millsap, B. A., and P. A. Millsap. 1987. Burrow nesting by common barn-owls in north central Colorado. **Condor** 89:668-670.

Moore, K. 1990. **Urbanization in the Lower Fraser Valley, 1980-1987.** Canadian Wildlife Service Technical Report Series No. 120. Ottawa: Canadian Wildlife Service.

Newton, I., I. Wyllie and A. Asher. 1991. Mortality causes in British Barn owls *Tyto alba*, with a discussion of aldrin-dieldrin poisoning. **Ibis** 133:162-169.

Otteni, Lee C., Eric G. Bolen, and Clarence Cottam. 1972. Predator-prey relationships and reproduction of the barn owl in southern Texas. **Wilson Bull.** 84:434-448.

Piechocki, R. 1960. Ueber die Winterverluste bei Schleiereulen (*Tyto alba*). **Vogelwarte** 20:274-280.

Pietiainen, H. 1988. Breeding season, quality, age, and the effect of experience on the reproductive success of the Ural owl (*Strix uralensis*). **Auk** 105:316-324.

Seymour, J. 1988. Nestbox studies of barn-owls. **B. T. O. News** No. 155.

Shawyer, C. 1987. **The Barn-owl in the British Isles - Its Past, Present and Future.** London: The Hawk Trust.

Shawyer, C., and P. Banks. 1988. An ill wind for Barn-owls? **B. T. O. News** No. 155:1.

Smith, D. G., C. R. Wilson and H. H. Frost. 1974. History and ecology of a colony of barn-owls in Utah. **Condor** 76:131-136.

Stager, J. K., and J. H. Wallis. 1968. The climatic factor - variations on a mean. *In* **Lower Fraser Valley - Evolution of a Cultural Landscape,** ed. A. H. Siemens, 89-100. B. C. Geographical Series No. 9, Tantalus Research Limited.

Statistics Canada. 1973. **1971 Census of Canada.** Agriculture. Catalogue 96-711, Vol. IV - Part 3. (Bulletin 4.3 - 4). Ottawa.

_____. 1978. **1976 Census of Canada.** Agriculture. Vol. 13 (British Columbia). Catalogue 96-810 (Bulletin 13 - 4). Ottawa.

_____. 1982. **1981 Census of Canada.** Agriculture. Catalogue 96-911. Ottawa.

_____. 1987. **1986 Census of Canada**. Agriculture. Catalogue 96-112. Ottawa.

_____. 1988. Census Metropolitan Areas and Census Agglomerations, Part 1. Catalogue No. 94-127. Ottawa.

______. 1992. **1991 Agricultural Profile of British Columbia.** Part I. Catalogue No. 95-393. Ottawa.

Stewart, Paul A. 1952a. Dispersal, breeding behaviour, and longevity of banded barn owls in North America. **Auk** 69:227-245.

______. 1952b. Winter mortality of barn owls in central Ohio. **Wilson Bull.** 64:164-166.

______. 1980. Population trends of barn-owls in North America. **Am. Birds** 34:698-700.

Taylor, I. R. 1989. **The Barn-owl.** Shire Natural History Series. 4:21-24. Shire Publications Ltd., Aylesbury, Bucks, England.

______. 1991. Effects of nest inspections and radio-tagging on Barn owl breeding success. **J. Wildl. Manage.** 55(2):312-315.

Tianen, J., I. K. Hanski and J. Mehtala. 1983. Insulation of nests and the northern limits of three Phylloscopus warblers in Finland. **Ornis Scand.** 14:149-153.

Walsberg, G. E. 1985. Physiological consequences of microhabitat selection. Chapter 13 (Pp.389-413) in **Habitat Selection in Birds**, edited by M. L. Cody. New York: Academic Press.

______. 1986. Thermal consequences of roost-site selection: the relative importance of three modes of heat conservation. **Auk** 103:1-7.

Webb, D. R., and J. R. King. 1984. Effects of wetting on insulation of bird and mammal coats. **J. Therm. Biol.** 9:189-191.

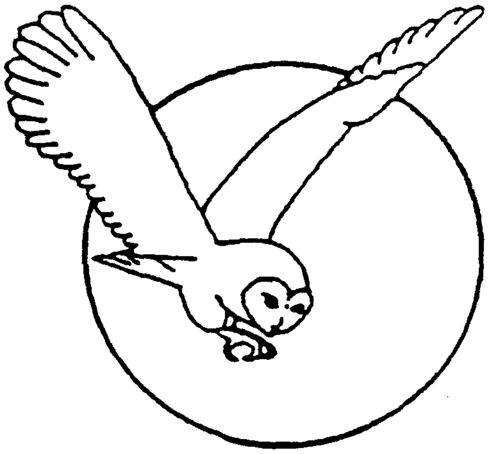
White, F. N., Bartholomew, G. A., and Howell, T. R. 1975. The thermal significance of the nest of the sociable weaver *Philetairus socius*: Winter observations. **Ibis** 117:171-179.

Wilson, R. T., M. P. Wilson, and J. W. Durkin. 1985. Breeding biology of the barn owl *Tyto alba* in central Mali. **Ibis** 128:81-90.

Winter, G. R. 1968. Agricultural development in the Lower Fraser Valley. *In* **Lower Fraser Valley - Evolution of a Cultural Landscape**, edited by G. Siemens, 101-116. B. C. Geographical Series No. 9, Tantalus Research Ltd.

APPENDIX I.

The poster used to publicize the study.



## Looking for Current Nesting Sites . . .

# Barn Owl Research

Your barn may be host to one of Canada's rarer birds — the barn owl.

Brown-speckled, with white heart-shaped faces, barn owls in Canada are found only in Southwestern British Columbia and some parts of Ontario.

These owls hunt primarily mice and seek out protected nesting sites, often in the rafters of barns and other covered wooden stuctures. Although regurgitated pellets on the floor are a common tell-tale sign of barn owls, these are quiet birds, so it is not unusual for people to be unaware of nearby nests.

There is still much we need to learn about the nesting and feeding habits of barn owls. A research project is underway through the University of British Columbia to catalogue nesting sites in the Lower Mainland, and to band birds.

This research will help enlighten biologists and conservationists, to ensure that the barn owl remains a vital part of our natural heritage.

If you, or someone you know, has a barn or other outbuilding that is a possible nesting site, please contact:

**Lorraine Andrusiak**
Department of Zoology
University of British Columbia
6270 University Boulevard
Vancouver, B.C.
V6T 2A9

Telephone:

Messages can be left at the above number, or at

Your assistance is greatly valued.□

## APPENDIX II.

Table A. Results of Bonferroni z test on barn owl mortalities 1990-1992.

| YEAR | # FOUND DEAD | OBSERVED PROPORTION OF TOTAL MORTALITY | EXPECTED PROPORTION OF TOTAL MORTALITY | CONFIDENCE INTERVAL OF OBSERVED PROPORTION |
|---|---|---|---|---|
| **1990** | 33 | 0.277 | 0.333 | $0.2406 < p < 0.3133$ |
| **1991** | 57 | 0.479 | 0.333 | $0.4383 < p < 0.5197$ |
| **1992** | 29 | 0.244 | 0.333 | $0.2085 < p < 0.2795$ |

Table B. Results of Bonferroni z test on number of juvenile barn owls banded 1990-1992.

| YEAR | # JUVENILES BANDED | OBSERVED PROPORTION OF TOTAL BANDED | EXPECTED PROPORTION OF TOTAL BANDED | CONFIDENCE INTERVAL OF OBSERVED PROPORTION |
|---|---|---|---|---|
| **1990** | 58 | 0.450 | 0.333 | $0.3718 < p < 0.5282$ |
| **1991** | 38 | 0.166 | 0.333 | $0.10770 < p < 0.2243$ |
| **1992** | 133 | 0.581 | 0.333 | $0.5034 < p < 0.6586$ |

## APPENDIX III.

Table A. Results of Bonferroni z test on road-killed barn owls by season.

| SEASON | # FOUND DEAD | OBSERVED PROPORTION OF TOTAL ROAD-KILLS | EXPECTED PROPORTION OF TOTAL ROAD-KILLS | CONFIDENCE INTERVAL OF OBSERVED PROPORTION |
|---|---|---|---|---|
| SPRING | 69 | 0.3382 | 0.25 | 0.2547 ‹ p ‹ 0.4217 |
| SUMMER | 26 | 0.1274 | 0.25 | 0.1255 ‹ p ‹ 0.1293 |
| FALL | 32 | 0.1568 | 0.25 | 0.0902 ‹ p ‹ 0.2234 |
| WINTER | 77 | 0.3774 | 0.25 | 0.2979 ‹ p ‹ 0.4569 |

Table B. Results of Bonferroni z test on starved barn owls by season.

| SEASON | # FOUND DEAD | OBSERVED PROPORTION OF TOTAL STARVED | EXPECTED PROPORTION OF TOTAL STARVED | CONFIDENCE INTERVAL OF OBSERVED PROPORTION |
|---|---|---|---|---|
| SPRING | 4 | 0.0909 | 0.25 | 0.0403 ‹ p ‹ 0.1415 |
| SUMMER | 2 | 0.0227 | 0.25 | 0.0 ‹ p ‹ 0.0489 |
| FALL | 3 | 0.0682 | 0.25 | 0.0238 ‹ p ‹ 0.1126 |
| WINTER | 36 | 0.8182 | 0.25 | 0.7503 ‹ p ‹ 0.8861 |

Table B. Results of Bonferroni z test on number of juvenile barn owls banded 1990-1992.