THE FORAGING STRATEGIES OF COMMON NIGHTHAWKS (*Chordeiles minor*) AND BIG BROWN BATS (*Eptesicus fuscus*)

By: Leah Schapansky
Wildland Recreation Technology
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SUMMARY

PURPOSE

"We will attempt to answer the following question: do the constraints of being a continuously flying nocturnal aerial insectivore cause broad overlap in the foraging behavior and the resources used by the common nighthawk (Chordeiles minor) and the big brown bat (Eptesicus fuscus)?"(Brigham, 1986)

To date, no qualitative comparison of the foraging behavior of sympatric species of bats and birds has been made.

ASSUMPTIONS

An aerial foraging strategy results in a broad overlap, but different aspects exist in feeding behaviors to allow a coexistance between species. It can be assumed that during certain periods through out the summer, that the flying insect population fluctuates, and as a result, the flying insect prey is a limited resource. From field observations, our team observed very low flying insect populations on cool and/or windy evenings.

METHOD

The period of the study is from May 10, 1986 to August 16, 1986. During this time, our team collected data on the diet, duration for foraging bouts, foraging range, habitat use, searching strategy and the effect of light levels on the foraging behavior of individual C. minor and E. fuscus to determine the overlap in foraging behaviors and resource use

between individuals and between the species.

CONTENT

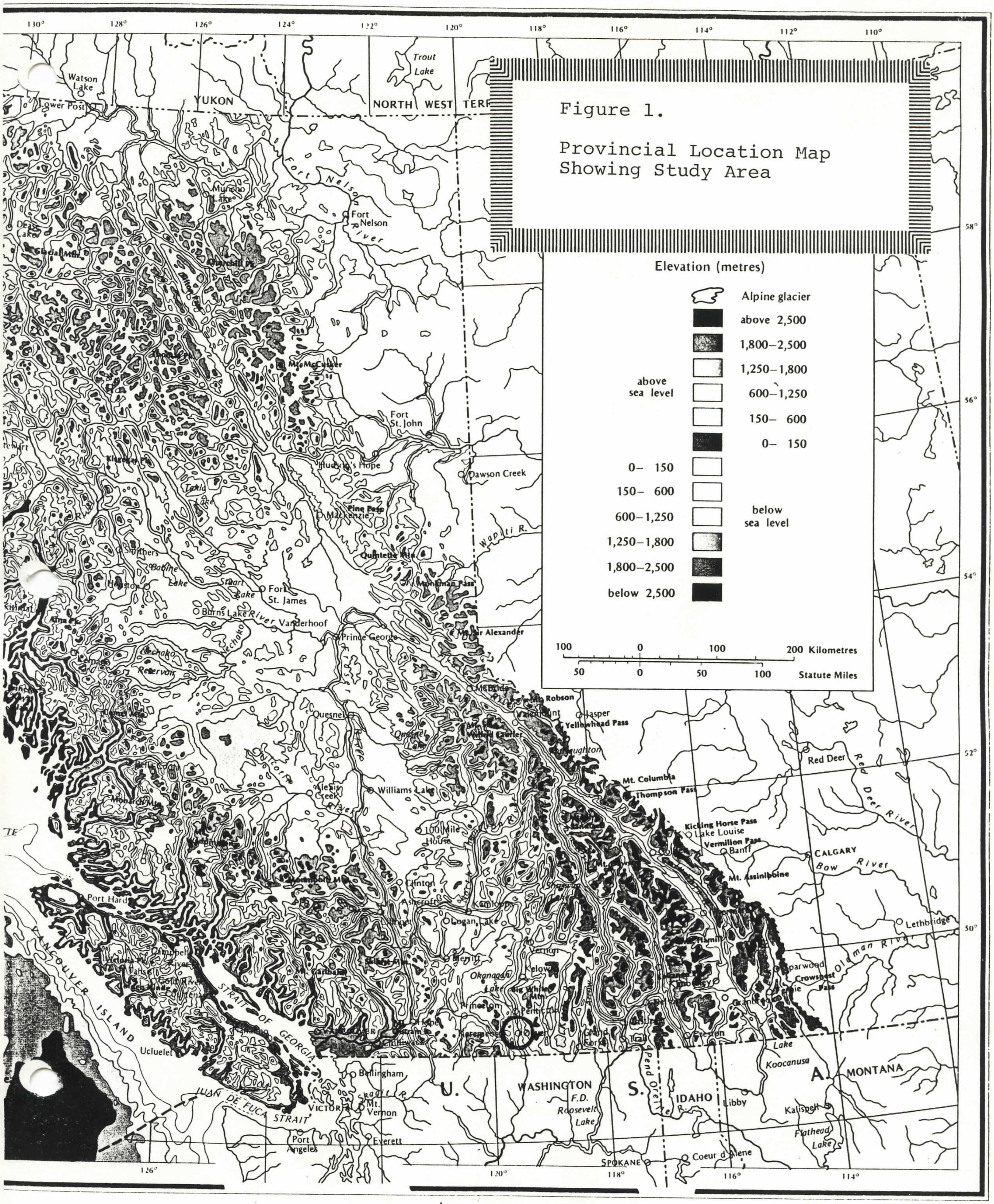
This report describes the methods that were used between May 10, 1986 and May 30, 1986. Since the study will not be completed until the end of August, I cannot analysis the data that has been collected up to date. But I have included a section on what general trends appear to be forming with the data that has been collected.

FINDINGS

Many conclusions were drawn by Mark Brigham on what results to expect from the data collected at present and from the data that will be collected throughout the summer. They are based on the trends that the data shows, and are by no means scientific fact as of yet. For a list of all the conclusions, see page 34.

Figure 1.

Provincial Location Map Showing Study Area



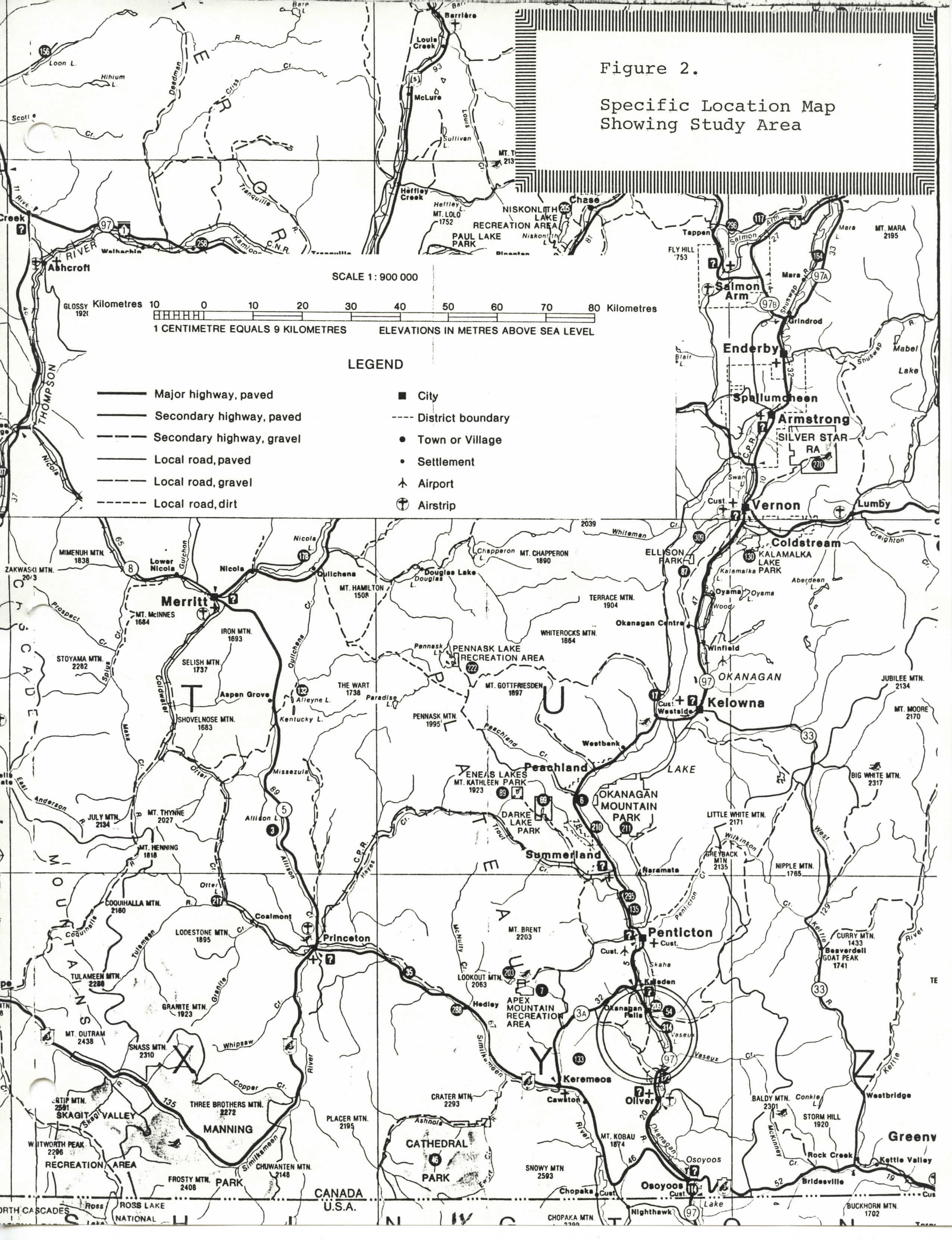


Figure 2.

Specific Location Map Showing Study Area

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THE FORAGING STRATEGIES OF COMMON NIGHTHAWKS (*Chordeiles minor*) AND THE BIG BROWN BATS (*Eptesicus fuscus*)

1.0 INTRODUCTION

Bats live almost everywhere in the world except the Artic and Antarctic. According to Fenton (1983) there are the second most diverse of all mammals. As the basic design of all these species is similar, all can be recognized easily. They are in the order Chiroptera which means "hand-wing". As shown in Figure 3, their wing structure is similar to that of the human hand.

Common nighthawks are found almost anywhere in Canada & the U.S. except in the far northern boundaries. They winter in South America. They become active before dark, flying above treetops and houses.

1.1 STUDY AREA

The study was conducted in the Okanagan valley near Okanagan Falls, B.C. whrre there are large resident populations of the big brown bat and the common nighthawk. There are 13 bat species known to be in the O.K. Falls area. During the summer of 1985, nine of these species, indicated by asterisk, were trapped (see Table 1).

1.2 STUDY ANIMALS

Eptesicus fuscus is a medium sized insectivorous bat

Table I: Known Bat Species of the O.K. Falls Area

SPECIES SCIENTIFIC NAME	SPECIES COMMON NAME
Antrozous pallidus	Pallid Bat
* Eptesicus fuscus	Big Brown Bat
Euderma maculatum	Spotted Bat
* Lasionycteris noctivagans	Silver haired Bat
Lasiurus borealis	Red Bat
Lasiurus cinereus	Hoary Bat
* Myotis californicus	Mouse eared Bat
* Myotis leibii	Small footed Bat
* Myotis lucifugus	Little Brown Bat
* Myotis septentrioalis	Northern Long eared Bat
* Myotis volans	Long legged Myotis
* Myotis yumanensis	Yuma Myotis
Plecotus townsendii	Plecotus townsendii

* Species trapped in 1985

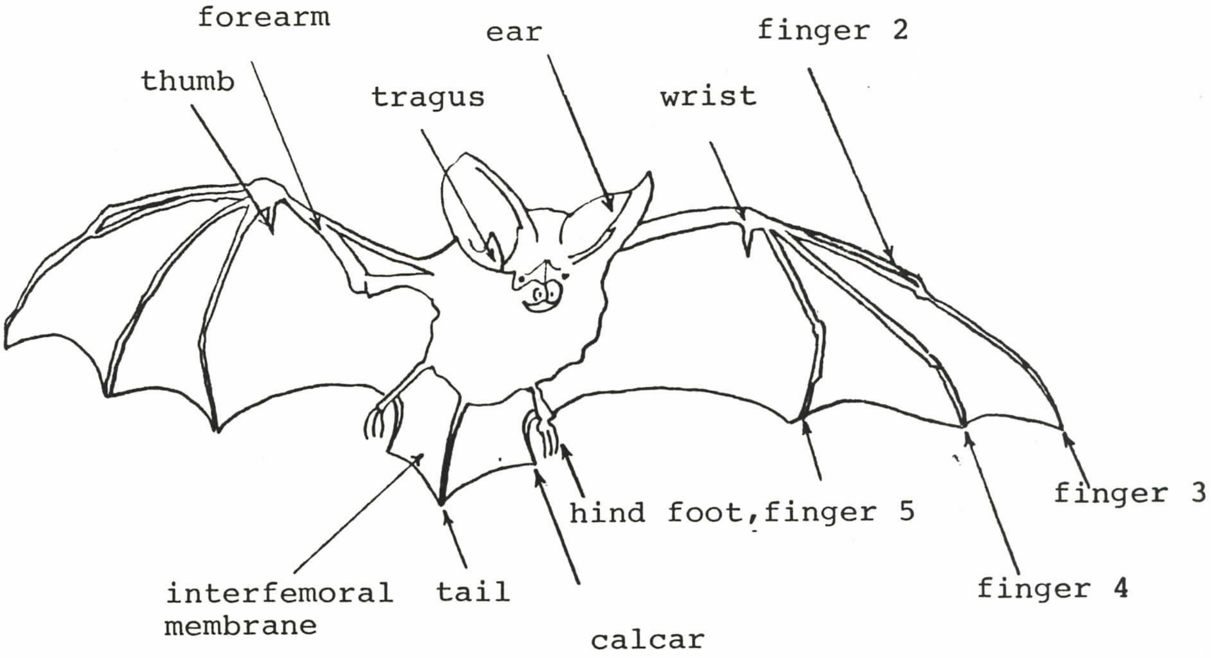


Figure 3

<u>External Bat Anatomy</u>

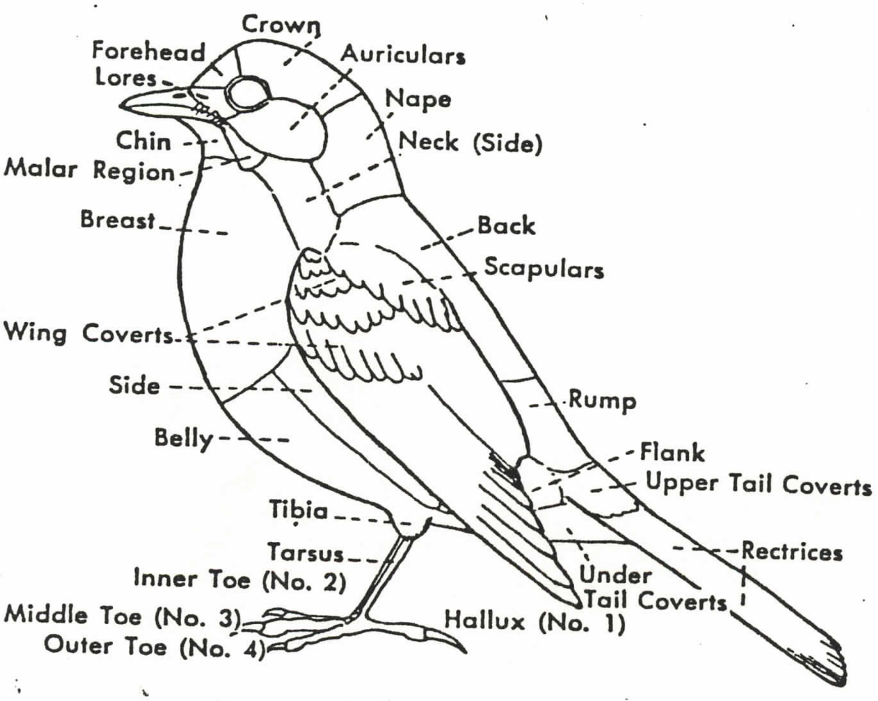


Figure 4

External Bird Anatomy

Figure 5: Common Nighthawk

Figure 6: <u>The Big Brown Bat</u>

(20.0g) which occurs from Alaska to northern South America including the Carribean (van Zyll de Jong 1985). Chordeiles minor (80.0g) is found throughout North and South America, with its breeding range restricted to North America (Gross 1964). There is no evidence suggesting that either species captures prey using other than a continuous flying strategy (Brigham and Fenton in press; Caccamise 1974). The major apparent difference in the foraging behavior of the two species is the prey detection system used. Eptesicus fuscus captures prey using echolocation (Simmons and Kick 1983). The echolocation call design is a broadband frequency modulated (FM) signal terminating with a shallow FM sweep which facilitates the accurate detection of a target's position (Simmons and Stein 1980). Barclay (1985a) interprets this call design as being adapted for short-range detection of prey. Kick (1982) reported that E. fuscus first reacts to prey at 1-2m, which supports the short-range interpretation. There is no evidence for echolocation by C. minor. Eptesicus fuscus forages at or above tree top level and aroung vegetation, rarely if ever going into the canopy (Phillips 1966; Caire et al. 1984; Brigham pers. obs.). Chordeiles minor appears to forage in the same zone (Caccamise 1974; Brigham pers. obs.) preferring to feed in swarms of insects (Caccamise 1974) suggesting that it is also a short-range species.

In a field study by Brigham in 1985, he measured body mass, wing span, wing area, wing loading and aspect ratio to asses the morphology of the two species in the study area (Table 2). Aldridge (1985) showed that morphology was correlated with manouverability and the use of foraging zones in British bats. There was no difference between the sexes for either species, although E. fuscus females are acknowledged to be slightly larger than males (van Zyll de`Jong 1985). Caccamise (1974) published morphological data for C. minor from New Mexico. Brigham found that wing loading was the same for Okanagan and New Mexican regions (21.1 vs 21.2 N/m^2), while the New Mexican nighthawks had smaller wing spans (59.4 vs. 54.0 cm) and aspect ratios (9.3 vs 8.3). The differences in wing loading and aspect ratios suggest that C. minor is a faster, but less manouverable flyer than E. fuscus. Wing loading and aspect ratio are probably the principle variables governing flight performance (Pennycuick 1975). A high aspect ratio, such as for C. minor, indicates a narrow wing that is more efficient at higher speed that a broader wing. Wings with high aspect ratios are usually correlated with high wing loading and are more efficient for prolonged flight in the open, where maneuverability is not important.

Table 2: The morphological measurements and standard deviations of adult <u>Eptesicus fuscus</u> and <u>Chordeiles minor</u>. (Brigham, 1986)

	Birds	Bats	
n	23	9	
mass (g)	81.48 ∓ 6.93	19.19 ∓ 1.96	
wing span (cm)	59.44 ∓ 1.20	33.62 ∓ 1.0	
wing area (m^2)	0.0380 ∓ .002	0.01619 ∓ .0012	
wing loading (N/m^2)	21.1 ∓ 2.22	11.43 ∓ 1.51	F=143, p<0.01
aspect ratio	9.31 ∓ 0.49	7.03 ∓ 0.73	F=104. p<0.01

2.0 FORAGING STRATEGY ELEMENTS

The following describes the methods used in this study.

2.1 DIET

The diet of the animals are assessed in terms of taxon, prey size, and prey flight speed (Hloroyd 1983) and hardness (Freeman 1981) by collecting and analysing feces from captured individuals of both speceis (Belwood and Fenton 1976; Kunz and Whittaker 1983) and by collaring young and removing food boli (Holroyd 1983) from nighthawk nestlings.

To test the hypothesis that teeth allow the bats to consume harder bodied insects, the diets of the two species were compared using the hardness index of Freeman (1981).

To assess whether prey is a limiting resource, leading to potential competition or to test the predictions of optimal foraging theory, a measure of insect availability and abundance is necessary. Brigham chose to use the whiriggig traps (Holroyd 1983) to attempt to gain some insight into insect abundance and availability (see Figure 7). The diets of the birds and bats will be compared with the trap samples. Also, a relative measure of

#1

#2

Figure 7: The Whirlygig Trap
(#1: trap is down; #2: trap is up)

any prey selection can be obtained. Any differences in diet between species should reflect differences in feeding adaptations.

2.2 DURATION OF FORAGING BOUTS

Radio tracking on a daily basis gave information which helped to determine the time each species spent feeding. Radio tracking also permitted an assessment of individual variability in foraging. Data from the Okanagan study conducted in 1985 showed no significant difference in the time of the first foraging flight, and confirmed that both species employ only a continuous flying strategy. No evidence was found of gleaning, or sallying from perches to capture prey. Data for subsequent foraging bouts of each species are required to determine if the duration of feeding bouts on a daily basis is the same.

To predict the duration of feeding bouts, data on the amount of food required, the size of food taken, the time between caputres and the time spent commuting between day roosts, night roosts, nests and feeding areas are needed.

2.3 FORAGING RANGE USED

Radio telemetry is used to gather more extensive data on the foraging range, than a previous study in 1985 (by Brigham) had gathered. Data from 1985 suggests that the two species have similar foraging range. Both forage primarily over the Okanagan River, and spend the day roosting/perching on the steep sides of the valley (2-5km from the river). A small sample size of bat telemetry data prevents a more complete comparison.

2.4 HABITAT USE

2.4.1. HABITAT AREA USED

By doing transects during both evening and dawn foraging bouts, the habitat use of both species can be assessed. To determine the habitat used by *C. minor*, the audible calls of males, and direct observations can be used while a bat detector enables the research team to monitor the echolocation calls and hance the habitat use of *E. fuscus* on the same transects (Fenton and Bell 1979; Geggie and Fenton 1985).

2.4.2. VERTICAL USE OF SPACE OVER THE RIVER

Using regular samples of estimated airspace volumes over the river at measured heights, Brigham determined where *E. fuscus* and *C. minor* spend the majority of their time feeding.

2.5 SEARCH STRATEGY

Using Morrison (1978)proposed model which explains the optimal searching strategy before the first prey encounter, Brigham will try to determine the prey detection radius of C. minor. It will depend on flight speed, visual acuity, light levels and prey size. Brighams observations suggests that the distance is similar to the bat. If Morrison's model is correct, Brigham predicts that the distance between turns should be greater than 5 meters for each species. From measurements taken on Eptesicus fuscus (Hayward and Davis 1964), it suggests a time interval of roughly one second or more between turns. Since C. minor is inferred from its morphology to fly faster, the time between turns should be shorter. The time between turns can be measureed visually and using telemetry data frr both species.

2.6 LIGHT LEVELS

Light levels will be determined by visual observations. From a literature review, Brigham suggests that Chordeiles minor should be influenced by moonlight, when more illumination could presumably make targets more visible in the evening or earlier in the morning.

Mills (1985) showed that activity, male calling and the feeding of young by C. vociferus was directly correlated with moonlight. Since E. fuscus uses only echolocation to detect prey, the bats should not extend foraging periods during moonlight nights and may be lunarphobic to reduce the risk of predation (Morrison 1978).

3.0 TECHNICAL ASPECTS OF METHODS USED IN STUDY

The following describes the more technical aspects of performing the methods previously described.

3.1 BAT TRAPPING

The best time to trap bats is during their feeding time. The best place is on or near a body of water that has a unobstructed surface area. The two types of live traps used were the Merlin Tuttle trap and the Japanese mist net.

3.1.1. MERLIN TUTTLE TRAP

3.1.1.1. THE SHAPE

The merlin tuttle trap is a free standing harp-like trap. This trap is light weight, compact when broken down and very durable. It consists of two aluminum frames strung with transparent fishing line about four feet by three feet with a canvas pouch underneath. The two frames are about four inches apart and may be set at any height above the ground (see Figure 8).

3.1.1.2. THE OPERATION

The bat flies into the fishing line and becomes trapped between the two frames. Here there is not enough room for the bat to take flight so it drops to the canvas pouch below. The canvas pouch is partially lined with plastic. When the bat climbs the bag, it becomes trapped between the layers of canvas and plastic. Insects also become trapped here so the bat is content to spend the night where it is warm and has plenty of food.

3.1.2. JAPANESE MIST NET

3.1.2.1. THE SHAPE

Japanese mist nets have a much larger

Figure 8: <u>The Merlin Tuttle Trap</u>

surface area than the Merlin Tuttle trap. The net measures 30 feet by 12 feet and it is spread between two towers. The net is attached to these towers by rope and is raised and lowered by pulleys on both towers. (see Figure 9 and 10).

3.1.2.2. THE OPERATION

The nets are set up in a area of suspected high bat populations and they require at least two people to operate. Since the nets are black and are made of extremely fine nylon they are not detectable by the bats echolocation. During feeding time, when the bats are most actively flying about, they become tangled in the netting. The two persons standing beside either tower pull the ropes which brings the net down and enables them to capture the bat or nighthawk.

3.1.3. TRAP EVALUATION

The Merlin Tuttle trap is the more effective and injury-free way of trapping bats. The

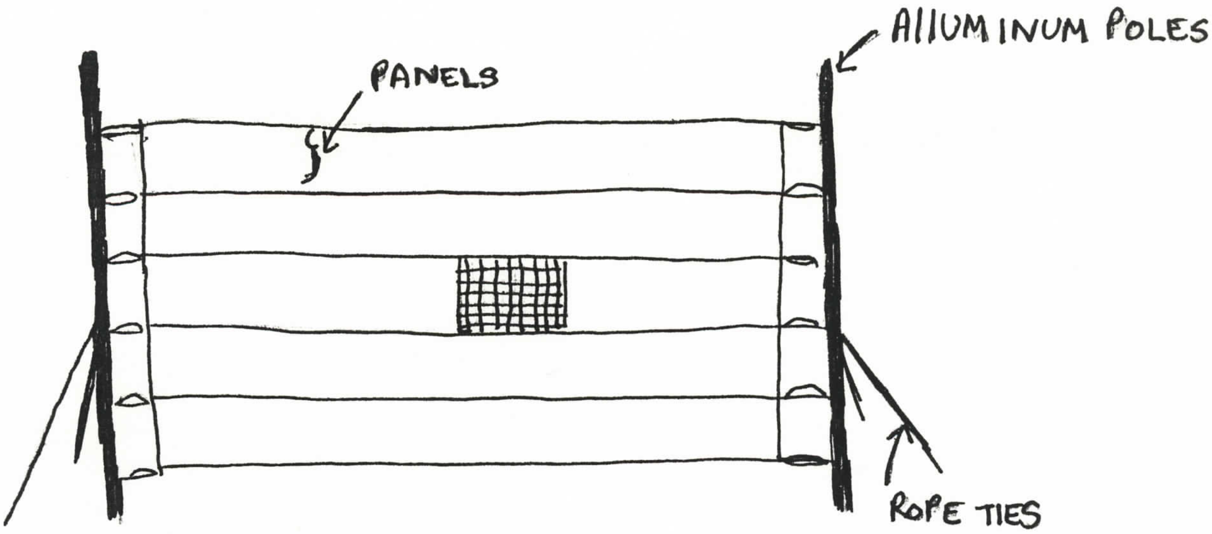


Figure 9: Japanese Mist Net

Figure 10: Pulley System Across River In Which The Mist Net Is Pulled Across

Japanese mist net is more time consuming in construction and processing each bat caught. However, the mist net, because of its large surface area, captures more big brown bats than does the Merlin Tuttle trap.

4.0 LABRORATORY WORK

Immediately after the bat was caught it was taken to the University of British Columbia, Geology Field School in Oliver, British Columbia. The field school served as a laboratory.

4.1 BANDING

At the lab, the bat was banded. The band identifies the species of bat, its sex and when and where it was caught. As shown in Figure 11, the bands are made of aluminum or plastic and were applied to the forearm of each bat.

4.1.1 DETERMINING AGE

Banding also helps age the bats since there is no other accurate way of determining age in bats. According to Brigham (1985) the only ageing that can be done is differentiating between juuvenile and adult bats by the appearance of finger joints in the wings. These finger joints are transparent in the first year juveniles.

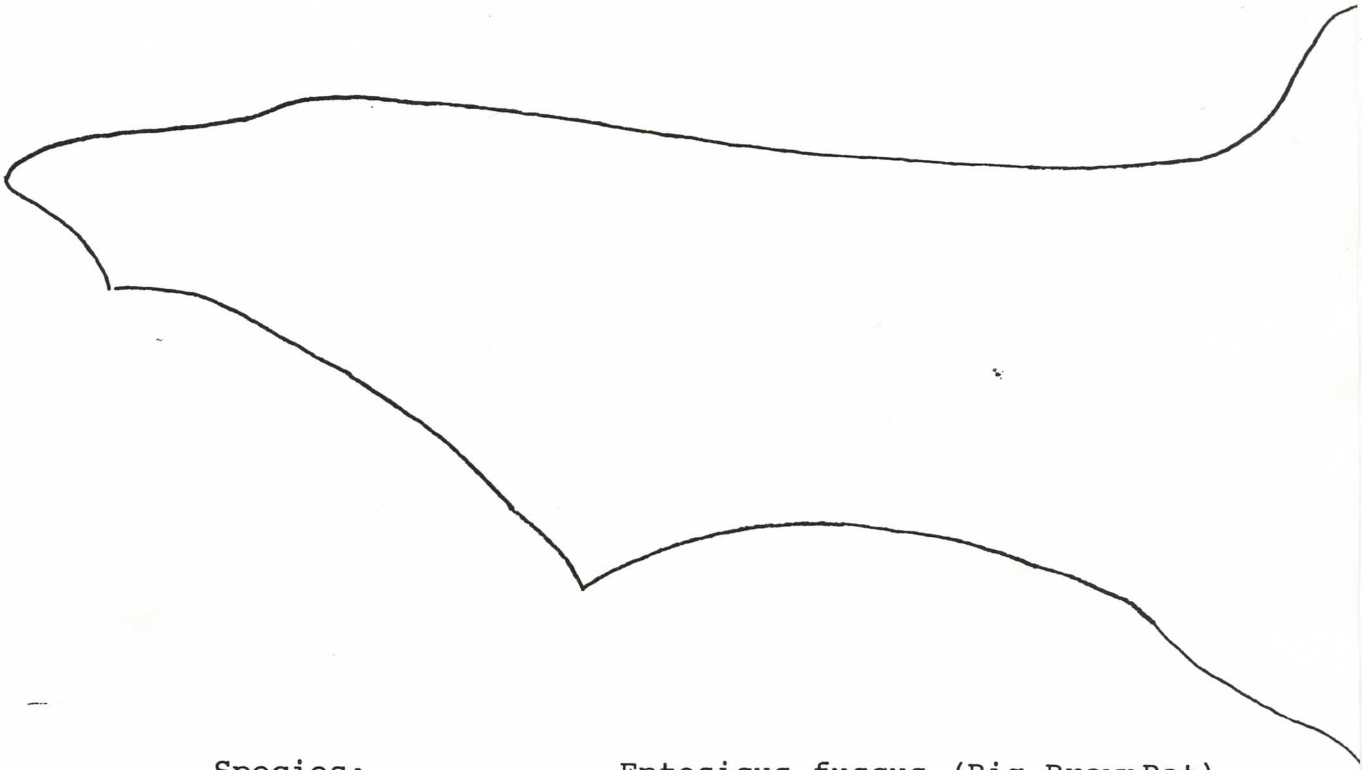
Figure 11: Banded Bats In Container

4.2 WING TRACING

At the laboratory the bat is also weighed, measured for wing span and a tracing is made of the wing (see Figure 12). This data is used to calculate the surface area of the wing for use in further tests on the bats flying and manoevering ability.

Figure 11

Wing Tracing Of Big Brown Bat



Species:	Eptesicus fuscus (Big BrownBat)
Mass:	14.7 grams
Wing Span	35.2 cm.
Forearm length	5.3 cm.
Band number	6-71283

4.3 RADIO TRANSMITTER

A radio transmitter was attached to some of the bats and nighthawks. The radio transmitter is a home made device. For the big brown bat, the device weights is under one gram. It consists of:

* a lithium watch battery = .3 grams
* a crystal = .3 grams
* a pulse generating circut = .3 grams
* 12 cm of .008 gauge wire attenna = .05 grams.

The transmitters life is approximately three weeks. It is applied to the back of the bat with skin bond cement and is placed in a position where it will not obstruct the bats flight in any way (see figure 13).

The radio transmitter attached to the common nighthawk was considerably larger than the big brown bats due to the size of the bird. It consists of the following:

* a lithium battery = 3½ grams
* a crystal = .3 grams
* a pulse generating circuit = .3 grams
* 12 cm of .008 gauge wire attena = .1 grams

The transmitters life is approximately four months. It is applied the same way as the bats (see figure 14).

Figure 13: Radio Transmitter Attached To Big Brown Bat

Figure 14: Radio Transmitter Attached To The Common Nighthawk

5.0 RELEASING

Approximately 24 hours after their initial capture the bats were released with identification bands and some also had radio transmitters. The time was roughly around 10:00 pm. The radio transmitter emits an electronic pulse every second. The pulse is in the form of a F.M. radio wave and can be heard on the radio tracking receiver.

For common nighthawks, they were released at early dawn 1½ days after capture. Nighthawks cannot be released in the middle of the night because they are unable to find their way back to their nest. The birds had identification bands and some had radio transmitters.

6.0 RADIO TRACKING

6.1 RADIO TRACKING RECEIVER

The radio tracking receiver is an electronic box approximately four inches by six inches by eight inches. It consists of a frequency setting button, squelch or R.F. gain button, volume button, and a speaker (see figure 15).

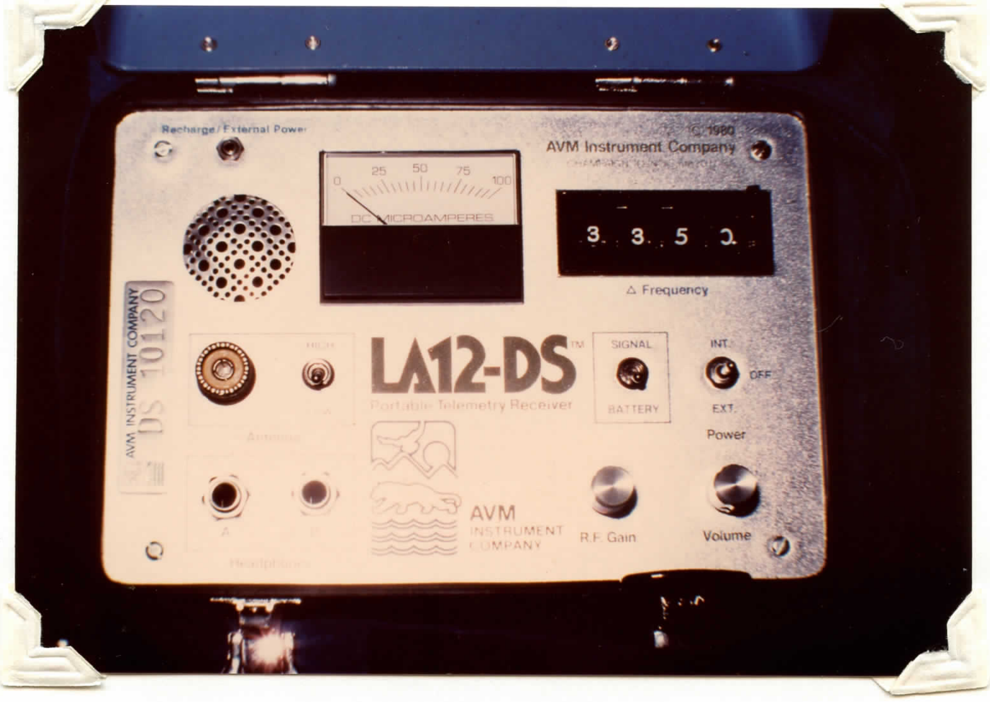


Figure 15: <u>Radio Tracking Receiver</u>

The radio tracking receiver can be adjusted to receive up to 12 different transmitted frequencies. These frequencies are the electronic pulses from each bats radio transmitter. The radio tracking receiver picks up the electronic pulse by way of an external antenna. This antenna is about four feet long and looks very similar to a house mounted T.V. antenna. It is spun slowly in a circle in an attempt to find the electronic pulse from the transmitter. When the pulse is received the antenna is rotated to find the direction of strongest signal. This is the direction the bat or nighthawk is flying in.

6.2 TRACKING

For the next few days tracking is done from the feeding area. Tracking starts approximately one half hour before the bats are known to be most active and it continues at ten minute intervals until the signal disappears. It is similar for nighthawks. Keeping accurate data on the direction of approach and retreat of each signal is very important. If a signal appears and disappears each night in the same direction then the bats or nighthawks nest or roost must also be somewhere in that direction. After receiving the same directional information for consecutive nights the observers would climb to the ridge where the signal disappeared behind and track from there. Here in the new position the observers again track the bats or nighthawks flight path and continue to move toward its roost. This manoeuvre would continue until the signal becomes so strong that it was difficult to determine any specific direction. This meant that the bats roost or nighthawks nest was in the immediate area. The roost or nest could not be located immediately because it was usually dark when the bat or bird retreated.

The following day the observer would hike to the area of the strong signal and search for suspect roosts or nests.

6.3 DAY TIME SEARCHING

When entering the area of suspect roost or nest it was necessary to pause every quarter mile and radio track, to get an exact direction to follow. When the signal direction became difficult to determine, a search of the area was made to locate the roost or nest. Bats typically roost in caves, houses, and old ponderosa pine snags. Common nighthawk nests were usually found in a hollow underneath an old ponderosa pine tree (see Figure 16 & 17).

7.0 MONITORING

Once a roost was found, an observer would sit by it (from dusk to about 11:00 pm) and count the bats that came out. The observer would also take note of the weather conditions. For every roost, Merlin Tuttle traps were placed over the entrance holes. Trapping occured on average, twice per week for each tree. The bats would fly out and be captured in the trap. Around 10:30 pm, the observers would take down the traps, check them for bats, place them in holding bags, collected the feces in the bag, and then go back to the laboratory.

#1

Figure 16: Old Ponderosa Pine Snag Bat Roosts
(#1: ropes positioned on tree to haul up traps)

Figure 17: Common Nighthawk Nest

8.0 THE WHIRLYGIG TRAP

The whirlygig trap is used to collect **flying** insects.

8.1 THE SHAPE

The machine is approximately 18 feet high by 10 feet wide. It consists of a generator (electric) mounted on a plywood base which is approximately four feet square. From the middle of the generator, an 15 foot alluminum pole protrudes. It is mounted by a pivot at the base. Two alluminum arms extend from the main pole at a 180° angle. These arms are supported by cross sections. Attached to the end of each arm is a mesh bag. At the bottom of the mesh bag, is a collecting bottle which is filled with alchohol. One arm is positioned so that the mesh bag sweeps low (approx. 2 feet off the ground), and the other arm sweeps high (approx. 18 feet off the ground). The alchohol is not an attractent, but is used as a preservative for the insects. See Figure 1 8 for a diagram.

8.2 THE OPERATION

The machine is run by electricity. Between 8:30 p m and 10:30 pm, the machine is running. It can be positioned either beside the Okanagan River or on the water surface (on top of a rock platform).

Figure 18: <u>The Whirlygig Trap</u>

When running, the machine turns in a counter-clockwise direction, at approximately 24 revolutions per minute. This sweeping motion collects the insects as they are flying.

9.0 CONCLUSIONS

The following are general conclusions made from the data collected. They are based on the trends that the data shows, and are by no means scientific fact as of yet.

1. Brigham predicts that C. minor should take prey items larger than those consumed by the bats.

2. Brigham predicts that the birds should take prey with a faster flight speed as well.

3. Brigham predicts that E. fuscus preys on relatively large insects, apparently preferring Coleoptera.

4. Brigham suggests that E. fuscus is opportunistic, feeding on a wide variety of insects including Coleoptera, Hymenoptera, Hemiptera, Diptera, Plecoptera and Lepidoptera.

5. Brigham suggests that C. minor's diet is composed of Hemiptera.

6. Brigham suggests that _C. minor_ normally forages in areas where there are high concentrations of insects, eg. swarms of flying ants, but when food becomes limiting, the birds become more general in diet.

7. Brigham suggests that from the available data, that _C. minor_ takes smaller insects than _E. fuscus_.

8. Brigham suggests that if the two species spend the same amount of time feeding over the entire 24 hour period, the ratio of food biomass consumed of 4:1 is correct, and the energy content of prey for the two species is similar, the energetic estimates predict that time between captures must be shorter for birds (based on similar prey size) and/or the time spent commuting must be shorter for the birds.

9. Brigham suggests that either _C. minor_ forages for a great duration during subsequent bouts than _E. fuscus_ or the bird does take larger prey, to make up the 4:1 ratio of food biomass.

10. Brigham suspects that foraging range is not a measure of anything biologically significant.

11. From preliminary observations, Brigham expects the two species will be found in the same area, with foraging concentrated over the river.

12. From personal observations, Brigham suggests that about 30 minutes before sunset (1 hour before dark), the first birds appear and forage very high (greater than 50m) over the river. As light levels decrease, the birds move lower until they are foraging 1m above the surface of the water. E. fuscus first appear at sunset and feed over the river in the region vacated by C. minor. Net captures suggest that E. fuscus rarely forage near the surface of the water.

13. Brigham suggests that the theory posed by Kick, 1982, on that E. fuscus probably detects prey at a maximum range of 5m is true. The prey detection radius of C. minor would depend on flight speed, visual acuity, light levels and prey size.

14. Brigham predicts that C. minor will use moonlight or artificial light sources to extend their foraging periods.

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APPENDIX: FIELD NOTES FROM NIGHTLY OBSERVATIONS ON THE BIG BROWN BAT AND THE COMMON NIGHTHAWK

MONDAY, MAY 19th.

17 to 9pm (8:43) - 500m from house with, at walk in point to tree C + D
- moon 60° SE sky, 70% illuminated moon face
- scattered clouds, chances of rain
- very little wind
- cumulous
- #2 present
- #3 no signal
- med to strong signal
- temp 22°C

8:53 - #2, 250° bearing, consistant strong signal
9:03 - signal becomes intermidant
9:05 - signal becomes noticeably loude
- same bearing
- bats definetly out, fly toward us
9:05½ - signal gets weaker
- med. to strong signal
- bearing same
- same intensity
- assume bat is flying around tree
- signal bearing now changed
- weak to med.
- heading toward river
- now signal becomes stronger
- very strong, 250°, towards roost
- bearing change was very little difference, couple of degrees toward the south
- signal fairly consistant towards roost
- 16° C temp
- signal still fairly constant, the bat may have gone in
- now signal fades out
- signal very weak, same bearing

9:11 - ~~lost~~ signal
- now back in range
- weaker
- same bearing
- fades in + out; suggesting still flying
- signal very weak
- moon gone behind cloud, virtually invisable
- still no wind
- cloud decreasing in sky
- heavy cloud, about 20% sky obscured
- ~~temp~~
- signal seems to be getting stronger
- definetly moved, towards the river
- 240°
- very strong signal
- lost signal
- still around the roost
- still fairly strong signal
- moon still obscured
- cumulo-stratus cloud ⇒ anval shape --> cumulo-nimbus
- intermintant

9:18
9:19 - intermintant + strong signal
9:20:25 - very weak signal
9:20:45 - strong signal
9:21:05 - moved 5° to south, appeared to get stronger
9:21:42 - moved, getting closer
- still intermidant
9:22:46 - its gone ~~over~~ over our heads
- In the orchard
- 70° F
9:24 - lost it
- out of range
9:26 - got it again

9:26:45 - its headings down the valley, 180°
9:27 - lost it

9:29:48 - nothing here at bottom of Kaledan turn of
-

9:34 - at ok. Falls park along the River
- no #2
- moon in full view
- 10% sky obscure
- very high clouds
9:36 - no #3 + #2
9:36:46 - few insects out over the water
- moon clear
9:37:27 - don't see anything over the River
9:38 - nothing here
9:38:13 - 2 big browns flying over campground
9:38:40 - still no sign
9:38:52 - no #3
9:39:15 - sign out

9:42:44 - .3 km from entrance to campground on our way up the hill
- Moon hazed over
- clear sky
9:48 - no #2
9:48:37 - no #3
- sign off

9:46:52 - back at original site
- more clouds present,
- cumulo-stratus
- Moon hazed over

9:47:38 no #2
9:47:52 no #3
sisning off

9:52:12 -Theurers orchard, walk-in entrance to tree A
9:52:31 -no #3
9:52:41 - cloud covered most of moon
-clouds high
9:53: - 4/10th of sky obscured
-moon visable
9:53:17 -no #2
-sign out

9:57:42 -Christie Memorial Park
-moon has haze over it
-very calm
-very little cloud cover
-no winds
9:58:10 -no #2
9:58:33 -no #3
-sign out

10:03:32 -gravel pit #2020, east side of Skaha lake, 1 km from Ok. Falls
-no three
10:04 -no #2

10:05:18 - 1 km from last stop toward Penticton
10:06:46 - 290°-300° #2 over towards the rock-throwing place
-weak to medium signal
10:07:25 - weak intermidant signal
-slight breeze
10:08:23 - #2 at 320°
-medium intermendant

10:10:46 - still in same place
- weaker signal
- moon still hazy
- lots of high cloud
10:12:49 - very faint signal
10:13:09 - still constant
10:13:47 - no# 3
- temp 20°C
- appears to be constant toward rock throwing area (#2)

10:21:38 - Kaledan Road, 1 Km from highway
10:22:13 - #2 is here
- light breeze
- strong signal
10:22:40 - strong signal, 0°
- intermidant
- clouds high, scattered, cumulos

10:27 - still along Kaleeden Road, 1/2 km from previous stop
10:28 - no signal

10:34 - 1 km past rock throwing place toward highway
10:36:36 - #2 is at 0°
- med signal, intermidant
10:36:59
10:37:37 - signal getting stronger, same bearing
10:38:25 - moon obsured
- I think the bat is flying at base of cliff
10:39:18 - moon coming out from clouds
10:40 - moon goes behind cloud
10:40:18 - weaker

10:40:56 – weak + intrmidant
– calm wind
10: 41:10 – signal getting stronger
10: 41:56 – signal same
10: 42:49 – moon is half obsured behind clouds
10:43:05 – still weak
– same bearing
10:44:22 – signal detenatly getting weak
10:45:08 – moon obscured behind clouds
10:47:58 – 0° degrees
– lost it

10:51:47 – walk in place
– full view (moon)
– clear skies
10:52 – moon goes behind clouds
– wind 6 km/h
10:52:24 – no #2

10:55:36 – soft sand area on kaladan rout
– moon still obscured behind clouds
10:56 – no #2

end of tape

Tues, May 20th

6:45pm - #2 is back in tree

9:18: - first 2 bats have left tree

9:30 - no bat beeps picked up
- #3 no sign
- moon obscured
- fairly windy

9:31:37 - few bats flying around
- Cloud cover 1/10
- temp 12°C

9:35 - moon obscured by haze
- wind 8km from North
- sky relatively clear - cumulus; low
- no #3

9:41 - 18 left tree
- #2 not left
- no signs of anything
-

9:44 - still no sign of #3
- #2 not left yet
- approx 30 bats left tree
- coming out of new hole
- no signs of night hawks
- very cool
- very windy

9:53 - no #3
- wind brisk, 12 Km.
- moon illuminated
- cooling off rapidly - 12°C
- starless night
- hazy sky

9:55 - 15 still in roost
- bats starting to return

10:00 - fysanoitis let go
- pack upped stuff

10:26 - #2 still in tree

WEDNESDAY, MAY 22

8:32 pm - at walk-in entrance to the C
- overcast skies
- 8 Km wind
- temp. 11°C
- clouds high
- no moon out - it should be up

8:53 - 10°C
- no #2
- weather same

9:01 - 10° c
- more overcast skies
- no moon
- wind died down - calm 4 Km/hr
- #2 there

9:12 - #2 present
- 10° c
- moon faint glow, 40° on horizon due East

9:27 - 9°C
- #2 present

9:57 - #2 still there
- 9°C
- packed up

FRI, MAY 23

9:10 pm
- Temp 13°C
- calm
- haze sky's
- clouds cumulus
- sky obscurred 90%
- no stars
- no moon
- at tree C/D
- no bats out
- #2 in tree
- not much light visible

9:21
- 3 tuttle traps in tree D
- #2 still there

9:35
- 1 bat just left

9:39
- #2 gone
- intermidant
- roughly up Skaha Lk toward Penticton (N)

9:40
- 3rd ~~one~~ bat out
- weak intimindant to North

9:46
- 13°C
- no moon up
- #4 bat left

9:58
- no #2

10:05
-

10:16
- wrapping up
- no #2

10:45
- #2 still has not returned

- clouds forming bands: cumulo-stratus
- moon high in sky 60°

9:50 - he can no longer make out the tree
- stars are out

10:10 - #2 is still there

SAT, MAY 29

8 pm — lost #2 from tree D
— ~~???~~ overcast sky
— no find #2 or #3 in major

8:45 — tree B
— sky overcast
— some light on east ridge
— threat of showers
— no sign #2 or #3
— 15°C
— no wind
— no sign of moon

— tree A (Martin + Christa)
— no #2 or #3

— Leah at Wirly-gig on Dike

9:08 — first bat left tree

9:13 — 7 bats leave

— # bats left tree A before tree B (15 min before)

9:18 — heading towards valley (tree B)
— one just came back
— starting rain (light)
—

9:28 — 4 bats appear, starts to entr by circling tree, one misses

9:40 — 14°C

- 61 out, everyone came out same hole except 1 – 2nd one came out from hole on opposite side with crack in it
- overcast
- no moon
- sky still quite light

- 28 min after first in
- 1 comes out 10 sec later

~~K0:28~~
9:35 – final talley 69
- 3 from back hole
- 66 " front hole
- weather hasn't changed
- temp 13°C

10:45 – wirly gig stopped at 10:30 (8:30 – 10:30)
- 20 rpm
- still no moon