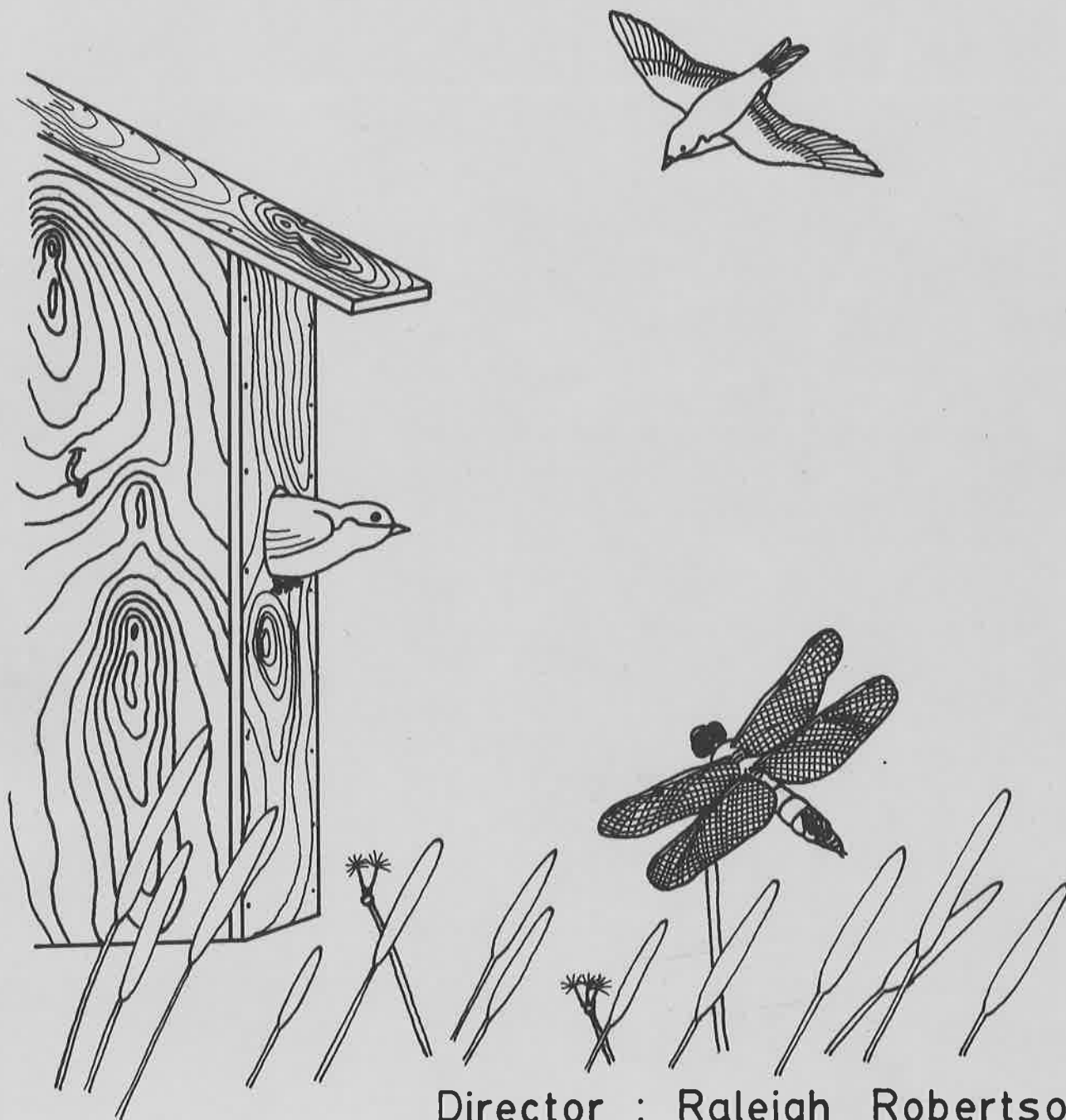


Queen's University Biological Station Annual Report & Newsletter 1979



Director : Raleigh Robertson

Manager : Frank Phelan

INTRODUCTION

Nineteen seventy-nine was our busiest summer yet. Increased interest in field research saw the season begin with nearly 30 researchers at the station. This number caused some initial problems, but these were overcome and the field season turned out to be most productive. The unfortunate accident involving Ted Tozer and Lesley Cameron in July kept late summer spirits low, but happily, Lesley was able to return to class in September under her own power and Ted was discharged from hospital as of Christmas.

On average, 26 researchers were in residence from May through August. With this number of regulars, station residency swelled to capacity during field modules. There were 9 field modules in all offered at the station under the auspices of the Ontario Universities Program in Field Biology. These are described in Tables 1, 2 and 3 of this report. In addition, a naturalist's workshop was offered by staff of Queen's Biology. A wide variety of groups visited the station during 1979. These are outlined in Table 5. To keep use of the station's facilities at a high rate, we encourage the use of the station by groups planning educational/recreational outings.

The entire year 1979 was spent in further projects aimed at undoing the damage inflicted by the windstorm of 1978. The new manager's house was completed in February and was landscaped in late summer. At the same time, the leach field was groomed and seeded. The interior of the Trilab was partially renovated to provide each wing with teaching and research capability. The addition of a fourth entrance, located in the second wing, solved some of the traffic problems of past years. The remnants of cabin #8 were removed and a new cabin has been erected on the site. As of this writing, the exterior of the cabin is finished. The interior will be finished before next field season. Except for the derelict which was the old "bat lab", there now is virtually no sign of the fury of the storm. Hopefully, in 1980, the old "bat lab" will be repaired.

This year, we added a new dimension to activities at the field station. For the first time, the station offered a course of its own. The Naturalist's Workshop, a one-week review of the identification and ecology of plants and animals, was a success. Aimed at park naturalists, the workshop was coordinated by Dr. Crowder (Queen's Biology) with a large number of other contributors. The response to the workshop by its 17 participants was so favourable that it will be repeated in 1980. Also planned are two additional 3-day workshops on special topics, a more intensive study of distinct groups or habitats. We look forward with anticipation to the continued success of these programs which greatly expand the scope of station activities.

Dr. Robertson returned in late August from a year's sabbatical in Australia, where he studied some communally breeding birds. Since his return, he has resumed duties as Director of the station. Many thanks go

to Dr. S.R. Brown who served as Interim Director during Raleigh's leave. Dr. Brown's intense interest and concern helped the station's cause greatly, especially during the rebuilding after the windstorm of 1978.

The sauna project was a success because of a cooperative effort on the part of all regulars. The old sauna, a serious fire hazard and an unsightly mess to boot, was torn down and ceremoniously incinerated. Regulars are to be commended for their initiative in raising the funds and in providing the labour to erect the new sauna. This project serves to illustrate what can be accomplished in a spirit of cooperation - the fundamental spirit of the station as a whole.

The research projects conducted at the station in 1979 are described in abstracts on the following pages of this report. Research use is summarized in Table 4. We are currently attempting to compile a complete reference list based on research at QUBS. We would like to receive complete citations and, if possible, a copy for file at the station of any publication or thesis based on research carried out at the field station as they become available.

The seminar series of 1979 continued to be a valuable exchange of ideas, comments and criticisms. We thank all those participating in the seminars. For those of us with photographic tendencies, the visit of Dr. Aubrey Crich was a highlight of the year. His presentations and excellent slides, particularly macrophotographs of insect subjects, were well received. A special thanks goes to Richard Norman who organized the seminar schedule. Speakers and titles of their presentations are listed in Table 6.

It is said that an army travels on its stomach. In the same way, the station is fired by the visits to the table. Our cooks this year, Ethel Dickerson and Linda Simmons, kept the internal fires burning, providing most excellent meals. Hand in hand with the cooks' jobs comes the job of surrogate mother, which the girls filled most ably.

The fee schedule has changed again for 1980. In the face of rising costs for everything, and because of massive budget cuts, we are forced to increase the rates once again. We will try every means possible to keep costs down, but it is increasingly difficult to do so. The new fee schedule is outlined in Table 7.

ABSTRACTS OF RESEARCH CONDUCTED AT QUBS 1979

I. RESEARCH BY QUEEN'S UNIVERSITY STUDENTS AND STAFF

DR. PATRICK COLGAN"Studies on Sunfish Behaviour"

This year Joe Brown began his Ph.D. thesis research with the objective of describing and quantifying the behavioural ontogeny and comparing the social organization (outside the breeding season) of the rock bass and pumpkinseed. Procedures for the successful rearing, feeding, identification, and observation of groups of young-of-year fish were established. A method for the identification of young-of-year pumpkinseed and bluegill in the field, a stumbling block in previous studies, resulted from this work and with the aid of the photographic talents of Frank Phelan a note will be published on this method in 1980.

Late in the year, Patrick Colgan finally got around to writing up the three years of pumpkinseed nest defense data (which had been the basis of the B.Sc. theses of Bill Nowell (1977) and Nigel Stokes (1978)) as an examination of applied catastrophe theory, and Susan Clarke defended her M.Sc. thesis.

Joseph Brown - "Behavioural Development and Comparative Social Systems in Three Centrarchid Species". Ph.D. Thesis.

From May to September extensive data on behavioural ontogeny and social organization in rock bass and pumpkinseed young-of-year were collected. Observations on aquaria-held fish were matched with field observations in the lake. Results indicate that selective feeding is evident on day 1 (figured from start of free swimming). Social responses (aggression) appear in rock bass at about 40 days and in pumpkinseeds at about 70 days resulting in territorial and hierarchical behaviour respectively. Interestingly, predator-avoidance (to conspecific or pike) changes with age: predator-avoidance is evident on day 2 but by 30 days yearling conspecifics begin to be approached while large conspecifics are still avoided. An underlying mechanism involving relative sizes seems likely. Preference experiments in which yearling fish were permitted to choose between conspecifics and heterospecifics, and experiments dealing with the ability of these species to recognize individuals, were performed but the data have not yet been analyzed fully.

Research in these areas will be continued in 1980, with the addition of largemouth bass young-of-year. Other areas to be examined include: the effect of early social environment on later social preferences in these species, swarm fidelity and identity in largemouth fry, and swarm defence by male largemouth bass during the care-taking period.

Publications and Theses:

- Clarke, S.E. 1979. Comparison of courtship sequences in parental and hybrid sunfish (Lepomis spp.): Evidence for a behavioural isolating mechanism. M.Sc. thesis. 128 + x pp.
- Colgan, P.W., W.A. Nowell, M.R. Gross, and J.W.A. Grant. 1979. Aggressive habituation and rim circling in the social organization of bluegill sunfish (Lepomis macrochirus). Env. Biol. Fishes 4: 29-36.

DR. ADELE CROWDER AND DR. R. HARMSSEN

"Successional Sequences and Community Structure"

The succession project is continuing, now into its fifth year. The nine insect control plots were sprayed twice with a strong insecticide, which seemed to be highly effective in controlling the phytophagous insects. The rodent control plots were not actively worked on, since the rodent populations in the area are still at low densities. All plots were sampled every two weeks for insect population measurements and twice in the summer for vegetation analysis.

Some major shifts in vegetation composition are becoming obvious and experimental and control plots are starting to show significant differences.

DR. R. HARMSSEN

"Insect Predation and Parasitism"

Past interest in insect population processes sparked interest in the behaviour of a predatory wasp and parasitism in the fall webworm. Fall webworm tents were collected in two areas (one with a low population density: Chaffey's Locks; the other with a high population density: Glenburnie). Tents were collected on six different host plants: Ulmus, Prunus, Betula, Fraxinus, Carya, Malus. The caterpillars were raised in cages and are now wintering in the pupal stage. Levels of parasitism will be calculated in spring 1980.

Assistant: Karin Lindinger.

Marjan Thesingh - "Behaviour of Amophila procera".

A quantitative study was initiated, looking into the behavioural variability in hunting, digging and reproductive behaviour of a Sphecid wasp, Amophila procera. Preliminary data were collected and study techniques were developed. Research will continue in 1980.

DR. J. A. KEAST

"Seasonal Song Sequencing in a Passerine Bird Community,
Lake Opinicon"

In accordance with arrival dates, nest initiation dates, and the phases of the breeding cycle, there is much seasonal variation in the time of peak song. Once young hatch, many species cease singing, to start again prior to the second brood. Other species sing virtually throughout the season irrespective of the phase of the breeding cycle. Wood thrushes have a brief period of intense song; robins sing over many months. Baltimore Orioles sing intensely early in the season, then largely cease, but start up briefly again in July. By contrast, the vireos have a very protracted song period. Analysis shows that not all species are singing at the same time. There is a partial sequencing of the various species.

This study was initiated to get this into a proper quantitative framework. At weekly intervals surveys were carried out of the time, intensity, and duration of singing in the different species. Every 10 minutes from dawn to 10 a.m., and hourly after that until 5 p.m., then at 10 minute intervals after that through to dusk, the amount of song of territorial individuals of each species was recorded over a two-minute time span. The measure was the percentage of the time when territorial individuals were singing. A formula had to be derived to equate continuous singers like the robin with intermittent singers like the Chickadee and Red-eyed Vireo. In the case of some species high breeding densities permitted analysis of 2-3 males simultaneously, in others single birds only.

Results, that are still being analysed, show marked seasonality in singing, considerable differences between species in song strategies, and close link between intensity of singing and phase of the reproductive cycle.

"Insect Seasonality and the Link Between Abundances and
Breeding Times of Bird Migrants"

This work, initiated on an exploratory basis, entailed counts of caterpillar numbers on basswood (this being chosen as a 'typical' tree) at weekly intervals, and determining time of appearance of commoner caterpillar species. It was accompanied by malaise trap studies and counts of butterflies and dragonflies on transects through a variety of habitats.

Assistants: Cathy Backman, Nichole Bruinsma.

"Effects of the Introduced Aquatic Weed, Myriophyllum
spicatum, on Fish Communities, Lake Opinicon"

Little work has been done on the effects of habitat change on fish communities. Establishment, in recent years, of the Eurasian Milfoil, Myriophyllum spicatum, in the Rideau Lakes and, especially

in Lake Opinicon, where comprehensive fish community studies have been carried out, invited a study of the ensuing effects. In Lake Opinicon M. spicatum is now a major problem to resort operators and fishermen, blocking channels and clogging propellers. It forms dense banks in water 1.5-3.5 m deep.

Studies entailed gill netting within, and adjacent to the beds, taking of benthic invertebrate samples, determining insect emergences by means of emergence traps, and determining water temperatures and oxygen levels.

The major effects on the fish community in the area of the beds are: (a) Bluegills no longer breed in those parts of the 2-3 m depth zone where there are weeds; there is not much breeding in shallow waters where (in some cases) the colonies are more susceptible to wave action; (b) The larger Bluegills have been largely displaced from the 2-3 m zone and now tend to be in deeper water; (c) There has been a large increase in populations of Alewife and Golden Shiner, both of whom favour weedbeds in deeper water; (d) The Myriophyllum beds, in slowing water movements, have led to increased silting in of a couple of the sandy inshore bays, resulting in increased growth of Potamogeton sp., Valisneria, Najas, Ceratophyllum and other shallow-water weeds. This has created favourable habitat for first and second year Bluegill, Pumpkinseed, and Yellow Perch. These have good populations in these bays where formerly there were none; (e) There is no evidence of Myriophyllum either favouring or being deleterious to the large game fish, i.e. Largemouth Bass and Pike. Further study in this area is planned.

In effect, apart from the 'environmental' and economic aspects of this change, an opportunity has been presented to develop an analysis of a progressive habitat change on fish communities and to get this into an appropriate quantitative framework.

Assistant: Anne MacMillan.

Publications:

- Keast, A. 1978. Trophic and Spatial Interrelationships in the Fish Species of an Ontario Temperate Lake. *Env. Biol. Fish* 3: 7-31.
- Keast, A. 1978. Feeding Interrelationships Between Age-groups of Pumpkinseed (Lepomis gibbosus) and Comparisons with Bluegill (L. macrochirus). *J. Fish Res. Bd. Canada* 35: 12-27.
- Keast, A. 1979. The Beginning of Exogenous Feeding, Foods and Feeding Relationships of Young Fish in the First Weeks of Life, Open Water Community, Lake Opinicon, Ontario. *Env. Biol. Fish* (in press).
- Keast, A. and J. Harker. 1978. Fish Distribution and Benthic Invertebrate Biomass Relative to Depth in an Ontario Lake. *Env. Biol. Fish* 3: 235-240.

Keast, A., J. Harker and D. Turnbull. 1978. Nearshore Fish Habitat Utilization and Species Associations in Lake Opinicon (Ontario, Canada). Env. Biol. Fish 3: 173-184.

Jim Complak - "A Comparative Analysis of Three Aquatic Systems Based on the Fish Communities and their Utilization of the Resource Base". M.Sc. Thesis.

In April of 1979, I began working on the above thesis at the Queen's Biology Station. Using the station as a base camp, I undertook a detailed study of three distinct aquatic environments located within a seventy mile radius of the station. These study sites vary in trophic state:

- 1) Oligotrophic - Little Round Lake located at the junction of Hwy's #509 & 7, just west of Sharbot Lake, Ontario
- 2) Eutrophic - The Cataraqui River, about 3 miles north of the LaSalle Causeway, Kingston, Ontario
- 3) Dystrophic - Atkin's Lake which is about 12 miles northwest of Brockville, Ontario.

Field work consisted of concentrated sampling, twice at each site, during May, July and September. These times correspond to initial, mid- and termination of the growth cycle of temperate fishes respectively. Sampling involved the collecting of fish (using seine and gill nets) and the resource base, i.e. benthic and water column invertebrates. In this way one can note differences between these communities in terms of fish diversity and how they divide up and compete for the associated resources. At this date the benthic samples have all been analyzed leaving only the zooplankton and fish diet to be completed.

In 1980, work will continue and include: (1) completion of data processing on 1979 collections; (2) a spring analysis of high waters at Little Round Lake, i.e. connections and fish dispersal from Twin Lakes; (3) a July effort in locating the Blacknose Shiners of Atkin's Lake which disappear in this month; (4) completion of any further sampling deemed necessary.

Assistants: Anne MacMillan, Cathy Backman, Nicole Bruinsma.

DR. R. J. ROBERTSON

"Selective Forces and the Evolution of Breeding Strategies in Birds"

This past year I enjoyed a year-long field season in Australia, studying cooperative breeding in the Bell Miner, an Australian Honeyeater. While away, ongoing projects at Opinicon were continued,

including work on Kingbirds and Tree Swallows. Pete Blancher, although doing his Ph.D. on Kingbirds in Arizona, helped organize field work for the Kingbird project which was done by Marilyn Snell. Ted Tozer and Lisle Gibbs worked on Tree Swallows for their M.Sc. and B.Sc. theses respectively.

Pete Blancher - "Eastern Kingbird Nesting Distribution".

This study centres on the factors influencing the nesting distribution of Eastern Kingbirds in the Lake Opinicon area. A high density of Kingbirds nest along the shores of Lake Opinicon where the time and energy needed for foraging are lower than in nearby upland areas. However, Kingbird densities are not uniform along the lakeshore. This summer's research was concerned with the influences of food supply and predation on the nest site distribution around the lake.

Reproductive success of breeding pairs and growth rates of nestlings were calculated for all accessible nests. These data will be used to see if close neighbours experience similar predation levels and growth rates of young (used as an indirect measure of food supply). Data will be compared between years to see if the most favourable sites remain the same each year and to see how nesting density correlates with these factors. Nest site distribution is known to have changed little in the last three years but this may be due to nest site tenacity of breeding adults. Nestlings were therefore colour-banded so that the nest site selection of any returning young can be distinguished from the site tenacity of older birds.

Assistant: Marilyn Snell

H. Lisle Gibbs - "Determinants of the Dispersion Pattern in Nesting Tree Swallows (Iridoprocne bicolor)". B.Sc. Thesis.

The summer of 1979 was the last season of a three-year project carried out to investigate the dispersion pattern of nesting tree swallows and to quantify its ecological determinants.

Swallows avoid nesting near each other at distances up to 18 metres between nestboxes, while at greater distances, the settling pattern appears to be random although sample sizes are too small to test significance of these results.

Nesting birds may avoid each other to: (i) prevent overlap in core foraging areas centered on the nestbox - overlap here could result in decreased food availability for feeding young; (ii) decrease the risk of cuckoldry; (iii) increase feather capture success rate; (iv) decrease risk of predation. This latter reason can be discounted because Ricklefs (1969) has shown that hole-nesting birds suffer low rates of predation.

There was no relationship between size of foraging area and nest density. Foraging areas did not increase when neighbours were removed. There was no relationship between copulatory response to a female in an invitation to copulate display and nest density. There was no increase in guarding behaviour by males with increase in nest density. Feather capture success was diminished when nest density increased (feathers increase the insulative value of the nest by 11-21%).

These results suggest no ecological advantage in avoiding conspecifics during nesting except to possibly increase feather capture success. The dispersion pattern shown is therefore interpreted as a result of early season territorial defense of a nestbox by nesting pairs.

Ted Tozer - "Behavioural Ecology of Tree Swallows". M.Sc. Thesis.

Observations continued on the nestbox populations of Tree Swallows on the New Land. The nestbox grid crosses two habitats, beaver marsh and old field. Marsh sites appear to be preferred due to decreased losses to predators, a richer food supply and a more amenable thermal environment. Data collected using a behavioural scoring scheme are being used to test the hypothesis that marsh sites are more expensive (in terms of time and energy) to procure than field sites during the site selection phase of the breeding cycle. Time/energy budgets were detailed during the incubation-nestling phase of the breeding cycle to further elucidate differences between pairs residing in different habitats.

Publications:

Clark, K.L. and R.J. Robertson. 1979. Spatial and temporal multi-species nesting aggregations in birds as anti-parasite and anti-predator defenses. *Behavioural Ecology and Sociobiology* 5: 359-371.

Clark, K.L. and R.J. Robertson. 1980. Cowbird parasitism and the evolution of anti-parasite strategies in the Yellow Warbler. *Wilson Bulletin* (in press).

Robertson, R.J. and G.C. Biermann. 1979. Parental investment strategies determined by expected benefits. *Zeitschrift für Tierpsychologie* 50: 124-128.

Robertson, R.J. and N.J. Flood. 1980. Effects of recreational use of shorelines on breeding bird populations. *Canadian Field Naturalist* (in press).

Weatherhead, P.J. and R.J. Robertson. 1979. Offspring quality and the polygyny threshold: "The sexy son hypothesis". *American Naturalist* 113: 201-208.

II. RESEARCH BY NON-QUEEN'S STUDENTS AND STAFF

DR. D. W. BARR - Department of Entomology, Royal Ontario Museum.

"Locomotory Behaviour and Community Structure in Aquatic Mites"

Aquatic mites achieve a high degree of sympatry (25 genera, 90+ [est.] species) in Lake Opinicon. Previous studies of the maintenance of sympatry in this group have stressed larval ecology, but research at the R.O.M. suggested that differing locomotory capabilities of adult mites might be correlated with microhabitat and food specialization. In 1979 many mite species were photographed at QUBS at 100 fps in dorsal and lateral views, and maximum swimming speeds at a variety of water temperatures were determined experimentally. Observations on microhabitat selection, phototactic responses and feeding behaviour of common species were also recorded.

At the same time, the mite fauna in Deadlock Bay was sampled at two week intervals to provide seasonal data on community dynamics. Widespread sampling in surrounding lakes was designed to test the degree of consistency of mite community make-up in similar habitats. Preliminary analysis of the summer's data suggests that common co-existing adult mites tend to be relatively dissimilar in size and locomotory ability. Thus it may be that adult ecology too contributes to the maintenance of sympatry in these organisms.

Assistants: Kathy Ferrier, Norma Barr, Jacqui Shykoff.

DR. E. L. CHARNOV - Department of Biology, University of Utah.

Mart R. Gross - Department of Biology, University of Utah.

"Sexual Selection and Reproductive Strategies in Sunfishes (Lepomis: Centrarchidae)". Ph.D. Thesis.

This season (1979) terminated research towards my thesis and maintained continuity with several continuing long-term projects. The mating system of sunfishes is dominated by solitary male parental care. Within this context exists a complex series of reproductive adaptations. Some results are: (1) A polymorphic mating strategy has been discovered in males - about 85% of reproductively active male bluegill (Lepomis macrochirus) in Lake Opinicon do not provide care but instead reproduce through the parasitization and cuckoldry of males which build nests and provide brood care (15% of males). The sunfish system is the first example known of a truly parasitically dependent mating strategy in animals. (2) Despite extensive male investment into nest construction, brood care, etc., sexual selection in sunfishes continues to operate on the male sex because male reproductive variance is greater than female variance (I strongly believe that Trivers (1972) widely used arguments of relative P.I.

(parental investment) determining sexual selection are misleading and incorrect). (3) Sexual selection in pumpkinseed (L. gibbosus) operates primarily through female choice. Females visit 2-7 males and body size and courtship sequences are cues used in discrimination between males. Large size and aggressive courtship is tightly correlated to future male investment into brood defense. (4) Sexual selection in bluegill operates primarily through male-male competition. Females choose central nest sites in bluegill colonies independent of male characters. This explains the delayed maturation in males (bluegill parental males first mature at ages 7 or 8 while most bluegill females are dead before then; pumpkinseed males and females breed concurrently) and lack of a courtship display (contrast this to the vivid display of pumpkinseed). (5) The evolution of patterns of breeding dispersion in sunfishes can largely be attributed to morphological and behavioral feeding adaptations. A major predator on sunfish brood is the snail, Viviparus georgianus. Pumpkinseed are mollusc feeders and are capable of grasping and removing snails from their nests. Bluegill brood suffer heavy predation by snails because males are adapted for suctorial feeding in the water column and are not morphologically and behaviorally suited to deal with this predator. I predict female choice will be greatest in non-colonial Lepomis species. When males nest closely, they must share females. This represents a cost to social breeding. Since pumpkinseed derive little benefit in terms of predator defense, natural selection has not favored the evolution of colonial breeding. This also explains male-male competition and female territory choice in bluegill-central colony positions which suffer little predation by snails, and not male quality per se, are the resources of prime value to females.

These results from pumpkinseed and bluegill which represent extreme differences in social breeding can now be tested against the 9 remaining members of the genus. The sunfish system holds promise for major contributions to ecological-evolutionary theory.

Assistant: Nancy Gerrish.

DR. M. B. FENTON - Department of Biology, Carleton University.

"Behaviour and Vocalizations in Bats"

During the summer of 1979 work continued on a variety of bat projects centered around basic questions about ecological and behavioural problems. These included studies of mother-young interactions, night roosting behaviour, the defensive behaviour of moths which can hear bats, and considerations of feeding behaviour and echolocation.

Robert Barclay - Department of Biology, Carleton University.

"The Costs and Benefits of Communal Night Roosting to the Little Brown Bat, Myotis lucifugus." Ph.D. Thesis.

This study involves observations and experimentation on the behaviour of little brown bats using several night roosts located in buildings on the station property. By using infra-red TV equipment and monitoring the amount of activity at these sites through the spring and summer, predictions associated with several hypothesized benefits accrued by communal night roosting are being tested. Trapping and colour banding is being used to follow known individuals from day roosts to night roosts and determine the consistency of roost usage.

The data gathered during 1979 strongly suggests that the night roosts serve a thermoregulatory purpose for pregnant females who must maintain a high body temperature in the face of cool ambient temperatures present in the spring. The energy conserved by roosting communally in the warm roosts must compensate for the increased commuting time and decreased foraging time brought about by this behaviour. Observations also suggest that the roosts may be used as information centres with respect to feeding area suitability. These and other hypotheses will be examined further during the forthcoming field season in an attempt to weigh the costs and benefits of communal night roosting to this species.

Assistant: Peter Stys.

Publications:

Barclay, R.M.R. and D.W. Thomas. 1979. Copulation call of Myotis lucifugus: A discrete, situation-specific communication signal. J. Mammal. 60: 632-4.

Barclay, R.M.R., M.B. Fenton and D.W. Thomas. 1979. Social behaviour of the little brown bat, Myotis lucifugus. II. Vocal communication. Behav. Ecol. Sociobiol. In press.

Thomas, D.W., M.B. Fenton and R.M.R. Barclay. 1979. Social behaviour of the little brown bat, Myotis lucifugus. I. Mating behaviour. Behav. Ecol. Sociobiol. In press.

Thesis:

Barclay, R.M.R. 1978. Vocal communication and social behaviour of the little brown bat, Myotis lucifugus (Chiroptera:Vespertilionidae). Unpubl. M.Sc. thesis, Carleton University, 64 pp.

Christine Thomson - Department of Biology, Carleton University.

"Mother-infant communication in Myotis lucifugus: Individual Recognition." M.Sc. Thesis.

The role of vocalizations in individual recognition between mother and infant little brown bats was investigated in a large nursery colony near Westport, Ontario. As females of this species selectively nurse their own young, they must locate them each night

upon returning to the nursery roost from foraging. Observations of the retrieval of marked infants at this time suggest that close range inspection (perhaps including olfactory cues) is necessary for final recognition and acceptance for nursing. Infant vocalizations (isolation calls and double note calls) seem to serve as distant cues providing a coarser basis of discrimination. Closely synchronized calling between the mother and her infant adds a temporal component for further discrimination. Tapes of infant vocalizations and retrieval sequences are presently being analyzed with respect to frequency and temporal patterning, and energy content at various component frequencies.

Playbacks of infant isolation calls and juvenile echolocation calls inside the colony while females returned from foraging failed to elicit any obvious consistent responses. Unfortunately, due to technical difficulties, these playbacks were not appropriately timed (mid-late July) or of sufficient intensity. These experiments will be modified and repeated in June and early July of 1980 to evaluate the females' ability to recognize their own infants on the basis of calls alone.

Based on some evidence obtained in 1979, the possibility that females are feeding insects directly to their infants during some stage of the weaning process will also be investigated in 1980.

Assistant: Peter Stys.

Tracey Werner - Department of Biology, Carleton University.

"Behavioural Responses of Non-Flying Moths to Bat Calls."
M.Sc. Thesis.

I examined whether or not moths which have ears that are tuned to the frequencies used in echolocation by bats use these ears to detect approaching bats when the moths are resting on surfaces. All studies of bat-moth interactions to date have focussed on flying moths. The results of this study indicated discrete behavioural responses by the moths to the echolocation calls of bats, suggesting a defensive system directed towards gleaning bats.

Gary Bell - Department of Biology, Carleton University.

"The Endangered Bat Myotis sodalis and High-Speed Photography of Bat Flight."

Projects included a preliminary investigation of summer habitat use by the endangered bat Myotis sodalis near Watertown, New York, carried out in association with the New York State government, and the development of techniques of high-speed stroboscopic photography of flying bats. The photographic techniques, which allow detailed analysis of flight speed, mechanics and orientation, were used in October during field work in Africa, and will be used for Ph.D. studies of feeding behaviour of bats in Arizona in 1980.

Assistant: Shelagh Hurley.

DR. J. FULLARD - Department of Biology, Erindale College.

"Neuroethology of arctiid moths."

This spring and summer I was interested in determining if there was any evidence that the time of emergence of adult arctiid moths throughout the season affected their auditory characteristics. Since levels of bat predation, and more specifically, tendencies to feed more heavily on moths, increase towards the middle of summer, corresponding increases in auditory sensitivity should appear. Tympanic nerve responses were electrophysiologically monitored and resultant auditory sensitivity curves (audiograms) analyzed with reference to various characteristics such as high-frequency sensitivity, best frequency, etc. The study, this year, was greatly facilitated by the relocation of the nerve recording equipment to the more solid foundation beneath the library. I hope to extend these investigations to look at the in-field responses of arctiids to free-flying bats and the neurological control of the sound-producing organs in arctiid moths.

In addition to these studies, a serious attempt was initiated this summer to rear the Dogbane Tiger moth (Cycnia tenera) from field-collected fertile females. This species promises to be a valuable one for the understanding of neurological pathways governing defensive behaviours such as evasive flight and sound production. This summer 80 pupae were successfully raised and are presently awaiting experimentation at the university. Considering the oligophagous nature of the beast, in-lab colony rearing still seems unlikely and future populations of this arctiid will need to be reared at QUBS.

DR. D. KRAMER - Department of Biology, McGill University.

Roberto Cavalcanti - Department of Biology, McGill University.

"Nest Desertion: An Adaptive Behaviour Pattern in Birds."
Ph.D. Thesis.

The study tested predictions based on the hypothesis that nest desertion is an adaptation to maximize lifetime reproductive output in birds. Clutch size manipulations were performed on nests of Song Sparrows (Melospiza melodia), Chipping Sparrows (Spizella passerina), Field Sparrows (Spizella pusilla), and Red-winged Blackbirds (Agelaius phoeniceus), from 1977 to 1979. The following predictions were supported:

- 1) Nest desertion is more likely with a reduced clutch than with a full clutch.

- 2) Nest desertion is more likely earlier than later in a nesting attempt.
- 3) Nest desertion is more likely in a multi-brooded than in a single-brooded species.
- 4) Nest desertion is more likely earlier than later in a breeding season.

Assistant: Jeffrey Yachnin.

Roberto Cavalcanti and Jeffrey Yachnin - Department of Biology,
McGill University.

"Do Song Sparrows Recognize Cowbird Eggs?"

Song Sparrows (Melospiza melodia) are heavily parasitized by Brown-Headed Cowbirds (Molothrus ater) but, unlike some species, do not remove the foreign eggs from their nests (Rothstein, S.I. 1975, Condor 77: 250-271). One potential alternative to egg ejection is desertion of parasitized nests.

Clutch manipulation experiments showed that Song Sparrows deserted nests containing only one Song Sparrow egg, but remained incubating clutches in which all but one of the host eggs were removed and replaced by an equivalent number of either Cowbird eggs or Cowbird eggs artificially coloured blue.

The results indicate that Song Sparrows at Lake Opinicon do not discriminate against Cowbird eggs, and that mimicry in egg coloration does not explain the presence of Cowbirds in Song Sparrow nests.

DR. R. LEMON - Department of Biology, McGill University.

Howard Kramer - Department of Biology, McGill University.

"Vocal Strategies Among Neighbouring Song Sparrows, Melospiza melodia." Ph.D. Thesis.

Individual Song Sparrows sing 6-9 song types in the Lake Opinicon area; they repeat a given song type a variable number of times before switching to a new type of song. My research investigates the advantages accrued by Song Sparrows singing repertoires of songs. Preliminary research suggested that neighboring birds signal which individual they are directing their songs at by switching to new song types in synchrony with that neighbor. Song Sparrows may also signal variations in their level of aggression by switching more rapidly in highly motivated contexts, such as territorial fights.

To test the motivational hypothesis I performed playback experiments which compared the subjects' overall response to recordings

with different song switching rates, done 20 m. inside or outside the territory, and at different phases of the nesting cycle. Trial and post-trial comparisons were also made. The playback results support the idea that Song Sparrows switch more rapidly when they are highly motivated.

The Beau Geste hypothesis claims that territory holders use song repertoires to fool floaters into thinking the area is more densely populated than it really is. We began to test this idea by removing males from their territories and observing who reoccupies the vacated areas. In two preliminary experiments the immediate neighbors either expanded their territories or shifted over completely, suggesting that in the Opinicon area the Beau Geste hypothesis is invalid because the threat to territorial ownership comes from established neighbors, not floaters.

Assistant: Cindy Sinclair.

Richard Norman - Department of Biology, McGill University.

"Interspecific Communication Between Chipping Sparrows and Pine Warblers."

Recent efforts to understand animal behavior in terms of game theory models, yield non-trivial predictions about patterns of fighting, and postures in agonistic displays; and these have been corroborated in experimental studies (see Maynard Smith, 1978; Sci. Amer., 239: 176). Applications have not been made to behaviors such as bird song for which sound communication is a major feature. In this study evolutionary game models are applied to song communication within and between species, especially to questions on agonistic function of song repertoires and interspecific convergence-mimicry of song patterns. This study compares the behavioral ecology of Chipping Sparrows and Pine Warblers whose rather similar and simple songs display unexplained patterns of even greater similarity in situations of microsympatry (such as on the islands of Lake Opinicon and the pine-juniper barrens around Hart Lake).

Last summer's work consisted of recording natural song behavior of both sparrows and warblers, especially countersong duels. Pine Warblers have 3 song types, not only one as described in the literature. Observations were also made on interspecific aggression. In the summer season of 1980, field experiments on leader-follower roles will be used to test hypotheses about the evolution of vocal duelling.

Assistant: Carolyn Rymes.

DR. J. TOOHEY - Department of Medicine, University of California, Los Angeles.

"Fungus Rings in Soil."

This project is a continuing study of fungi which grow in ring-shaped patterns in soil and produce visible effects either as fungal products or as alteration of the herbaceous vegetation. Annual measurements are made on approximately 150 rings near Lake Opinicon to characterize each fungal species with respect to rate of expansion, mushroom production, and effects on plants. Measurements are made each Fall during the season of mushroom production for many of the species. In 1979, observations were made during the first three weeks of October. 1979 was an average year with respect to expansion of rings and a relatively good year with respect to mushroom production but it was by no means comparable to the record year of 1977. Eight species produced mushrooms just before or during the observation period and seven new rings were found, one of which is a new species.

DR. S. Vander KLOET - Department of Biology, Acadia University.

Long-term interests include the demography of Pinus rigida and Pellaea glabella and the pollination and reproductive strategies of Vaccinium angustifolium and V. corymbosum.

Short-term interests: Recently I have shown (Vander Kloet, 1976) that seed dispersal and seedling establishment of Vaccinium angustifolium markedly differs in Nova Scotia and Eastern Ontario. According to the evolutionary model based on the guessing game theory, Blueberry populations from these two localities should have different reproductive strategies. In Eastern Ontario where very few seedlings have established themselves in the last 40 years, the few survivors should allocate more of the energy for non-sexual modes of reproduction. Nova Scotia populations, which reproduce readily by seed, should put more of the available energy into seed production.

To test this hypothesis, I have established trial plots at Lake Opinicon and Pictou County, N.S. Plants begun from seed in the greenhouse from both localities and headlands of Newfoundland have been transplanted in 12 replicated triplets to each locality and will be left in place for 3 years, during which time, rhizome growth and seed production will be monitored, and in this way, bring hard evidence for or against this evolutionary model.

Assistant: Richard Norman.

NATURALIST WORKSHOP

JUNE 2-9, 1979

In June 1979, a workshop in Field Taxonomy and Identification was held, with the aim of providing guidance through the mazes of taxonomic literature and practice in field identification with access to expert assistance. Seventeen participants came for the week, from backgrounds including the Ministry of Natural Resources, Parks Canada, Durham Education Board and Cataraqui Region Conservation Authority. A leaven of amateur naturalists provided welcome experience and enthusiasm.

The organisms studied included plants, insects, fish, reptiles, amphibians, birds and mammals in habitats ranging from old field to forest to sand dune to lake and stream.

Teaching was done by many members of Queen's staff; Drs. Crowder, Roff, Bristow, Downe, Good and Keast, Ms. Young and Messrs. Connor and Phelan. Helen Quilliam offered her vast experience in the section dealing with birds.

Those completing the workshop received a certificate from Queen's Department of Extension.

Dr. Crowder, workshop coordinator, has commenced arrangements for summer 1980. The workshop will be held May 31-June 7. Also planned are two weekend workshops, one on bog ecology, the other on Lepidoptera.

TABLE 1: Summary of course credits in the Ontario Universities Program in Field Biology earned at Queen's University Biological Station - Lake Opinicon in 1979.

MODULE TOPIC	PROFESSOR & AFFILIATION	DATES	CREDIT PER STUDENT	QUEEN'S	CARLETON	YORK	BROCK	WATERLOO	WESTERN	OTHER	TOTAL STUDENTS PER MODULE	TOTAL HALF- COURSE CREDITS
Winter Ecology	Crowder and Phelan (Queen's)	Feb. 18-24	¼	6	-	4	1	-	-	-	11	5.5
Spring Flora	Roff (Queen's)	May 13-19	¼	5	2	3	-	-	-	-	10	5
Fish Ecology	Keast (Queen's)	May 13-19	¼	9	1	4	-	1	1	-	16	8
Insect Ecology I	Howden (Carleton)	Aug. 26- Sept. 1	¼	4	2	1	1	-	-	-	8	4
Aquatic Macrophytes	Bristow (Queen's)	Aug. 26- Sept. 1	¼	4	2	1	-	2	-	-	9	4.5
Lakes & Streams	Dickman (Brock)	Aug. 26- Sept. 1	¼	4	2	2	2	1	1	-	12	6
Insect Ecology II	Carmody (Carleton)	Sept. 2-8	¼	5	-	2	1	1	1	-	10	5
Caves & Bats	Fenton (Carleton)	Sept. 2-8	¼	3	1	2	2	-	-	-	8	4
Plant Succession	Crowder (Queen's)	Sept. 2-8	¼	4	2	2	-	-	-	-	8	4
Total Number of Student Weeks	-	-	-	44	12	21	7	5	3	0	92	-
Half-Course Credit Equivalent	-	-	-	22	6	10	3.5	2.5	1.5	0	-	46

TABLE 2: Summary of course credit in the Ontario Universities Program in Field Biology earned at locations other than QUBS in 1979.

MODULE TOPIC	PROFESSOR & AFFILIATION	DATES	LOCATION	CREDIT PER STUDENT		QUEEN'S	CARLETON	YORK	BROCK	WATERLOO	WESTERN	OTHER	TOTAL STUDENTS PER MODULE	TOTAL HALF-COURSE CREDITS
Tropical Ecology	Keast and Connor (Queen's)	Feb. 18-26	Belize	1/4	10	-	-	-	-	-	-	-	10	5
Bird Migration	Cooke (Queen's)	May 20-26	Prince Edward Island	1/4	6	1	2	1	1	1	1	-	12	6
High Arctic Tundra	Lewis (York)	July 23-Aug. 14	Iqloolik	1/4	-	1	4	1	-	-	6	-	12	12
Animal Behaviour	Miller (York)	Aug. 19-25	(Algonquin Park)	1/4	2	-	2	1	-	-	1	-	6	3
Marine Ecology I	Owen (Western)	Aug. 25-Sept. 8	Huntsman Marine Laboratory	1/2	-	1	3	1	-	-	*	-	5	5
Natural History	Licht (York)	Aug. 26-Sept. 1	Algonquin Park	1/4	4	2	4	-	-	1	1	-	12	6
Marine Ecology II	Gross (Queen's)	Sept. 1-15	Huntsman Marine Laboratory	1/2	9	-	-	1	-	-	-	-	10	10
Small Mammals	Morris (Brock)	Sept. 2-8	Frost Field Station (Dorset)	1/4	5	2	2	-	-	1	1	-	11	5.5
Water Management	Day (Waterloo)	Sept. 2-8	Univ. of Waterloo	1/4	4	1	1	-	-	2	-	-	8	4
Conservation & Resources	Sutfling (Waterloo)	Sept. 2-8	Univ. of Waterloo	1/4	5	1	2	2	2	2	-	-	12	6
Freshwater Ecology	McQueen (York)	Sept. 4-9	Manitoulin Island	1/4	1	1	4	-	-	-	1	-	7	3.5
Total Number of Student Weeks	-	-	-	-	55	12	31	10	7	17	0	0	132	-
Half-Course Credit Equivalent	-	-	-	-	27.5	6	15.5	5	3.5	8.5	0	-	-	66

(Footnote) * - Not part of OUPFB Program

TABLE 3: Overall summary of the Ontario Universities Program in Field Biology for 1979.

	QUEEN'S	CARLETON	YORK	BROCK	WATERLOO	WESTERN	OTHER	TOTAL STUDENTS PER MODULE	TOTAL TOTAL HALF- COURSE CREDITS
TOTAL STUDENT WEEKS NOT AT QUBS	55	12	31	10	7	17	0	132	66
TOTAL STUDENT WEEKS AT QUBS	44	12	21	7	5	3	0	92	46
TOTAL STUDENT WEEKS IN FIELD MODULES	99	24	52	17	12	20	0	224	-
TOTAL HALF- COURSE EQUIVA- LENT IN FIELD MODULES	49.5	12	26	8.5	6	10	0	-	112

TABLE 4: Summary of research use of Queen's University Biological Station
- Lake Opinicon, 1979.

PROJECT SUPERVISOR	PROJECT TITLE	STUDENTS (QUEEN'S UNLESS STATED)	RESIDENCY
Dr. P. Colgan	Sunfish, Behaviour		Occasional
	Behavioural Development in Three Centrarchids	Joe Brown	May 6 - Sept. 8
Dr. A. Crowder	Succession Studies		Occasional
Dr. R. Harmsen	Succession Studies		Occasional
	Insect Predation and Parasitism	Karin Lindinger	July 30 - Sept. 3
	Behaviour of <u>Amophila</u> <u>procera</u>	Marjan Thesingh (Univ. of Wagen- ingen, Holland)	June 24 - Sept. 15, Oct. 5-12
Dr. J.A. Keast	Aquatic Studies (Fish and <u>Myriophyllum</u>) and Bird Song Sequencing		May 7-25, June 3-28, July 18- Sept. 17
	<u>Myriophyllum</u> and Fish Communities	Anne MacMillan	May 10 - Aug. 11, Aug. 22,23
	Comparative Analysis of Fish Communities	Jim Complak	May 6 - Sept. 16
	Bird Predators and Insect Prey	Nicole Bruinsma	May 5 - Sept. 16
	Insect-Plant Associations	Cathy Backman	May 9 - Aug. 29
	Fish Communities	John Eadie	May 7-22, Occasional
	Fish Communities	Paul Payson	May 11-19, Occasional
Dr. R.J. Robertson	Aspects of Bird Ecology and Behaviour		Aug. 14-25
	Eastern Kingbird Nesting Distribution	Pete Blancher Marilyn Snell	Occasional May 11 - July 25

PROJECT SUPERVISOR	PROJECT TITLE	STUDENTS (QUEEN'S UNLESS STATED)	RESIDENCY
Dr. R.J. Robertson (continued)	Nesting Dispersion in Tree Swallows	H. Lisle Gibbs	May 4 - July 14
	Behavioural Ecology of Tree Swallows	Ted Tozer	Apr. 13 - July 19
Dr. W. Newcomb	Manuscript Preparation		Occasional, Aug. 7-15
Dr. D. Barr (Royal Ontario Museum)	Aquatic Mite Studies		May 10 - July 28
	Locomotory Behaviour and Mite Communities	Norma Barr	May 10 - July 28
		Kathy Ferrier (U. of Toronto)	May 23 - Aug. 2, Aug. 15-27
		Jacqui Shykoff (U. of Toronto)	June 12 - Aug. 27
Dr. E.L. Charnov (Univ. of Utah)	Sexual Selection in <u>Lepomis</u>	Mart Gross (U. of Utah)	June 2-30
		Nancy Gerrish (U. of Toronto)	June 2-30
Dr. M.B. Fenton (Carleton U.)	Communal Roosting in Bats	Robert Barclay (Carleton Univ.)	May 1 - June 7, June 19 - July 5, July 17 - Aug. 20
		Peter Stys (Carleton Univ.)	May 7 - Aug. 17
	Mother-Young Communication in Bats	Christine Thomson (Carleton Univ.)	May 1 - Aug. 3, Occasional
	Responses of Moths to Bat Cries	Tracey Werner (Carleton Univ.)	May 6 - Aug. 25
	Bat Flight and Capture Sequence Photography; <u>Myotis sodalis</u> Study	Gary Bell (Carleton Univ.)	May 11 - June 9, June 26 - Sept. 18
	Bat Control	Shelagh Hurley	Occasional

PROJECT SUPERVISOR	PROJECT TITLE	STUDENTS (QUEEN'S UNLESS STATED)	RESIDENCY
Dr. D. Kramer (McGill Univ.)	Song Sparrow Nesting Studies	Roberto Cavalcanti (McGill Univ.)	Apr. 20 - July 30
		Jeffrey Yachnin (McGill Univ.)	May 5 - July 30
Dr. R. Lemon (McGill Univ.)	Song Sparrow Song Studies	Howard Kramer (McGill Univ.)	Apr. 24 - July 30, Aug. 4-16
		Cindy Sinclair (McGill Univ.)	May 5 - July 30
	Bird Communities	Carolyn Rymes (McGill Univ.)	May 10 - Aug. 8
Dr. J. Toohey (U.C.L.A.)	Fungus Rings		May 4-14, Oct. 1-21
Dr. S. Van der Kloet (Acadia Univ.)	Blueberries and Pitch Pine		Occasional
Dr. G. Morris (Erindale College)	Measurement of Underwater Sound Transmission Through Natural Environments	Ron Aiken	July 31 - Aug. 2, Sept. 10- 12
	Neuroethology of Arctiid Moths	Jim Fullard	May 1-31, July 9 - Aug. 16

TABLE 5: Summary of conference, meeting and field trip use of Queen's University Biological Station - Lake Opinicon in 1979.

ORGANIZER	FUNCTION	NUMBER OF PARTICIPANTS	DURATION
Kathy Young	Italian Language Immersion Weekend	11	Jan. 12-14
Floyd Connor Queen's Biology	Biology 202 (Ecology) Volunteer Winter Field Trip	16	Jan. 19-21
Dr. W. Reeve Queen's German	German Language Immersion Weekend	16	Jan. 26-28
Dr. R. Harmsen Queen's Biology	Biology 439 (Population Ecology) Weekend	20	Feb. 9-11
Doug Campbell	Brockville Militia Officer's Weekend	16	Feb. 16-18
Mike Harrison Science Consultant Ottawa Board of Education	Glebe Outing Club Weekend	6	Feb. 23-25
Dr. R. Harmsen Queen's Biology	Biology 439 (Population Ecology) Weekend	21	Mar. 2-4
Dr. M.B. Fenton Carleton University	Mammalogy Weekend	7	Mar. 9-10
Dr. W. Reeve Queen's German	German Language Immersion Field Camp	16	Apr. 29 - May 5
Mrs. Rogers, Mrs. Wynne-Edwards Queen's English	English Immersion Weekend	24	July 28-29
Roger Taylor	Ottawa Field Naturalists Picnic	50	Aug. 11
Dr. McQueen York Biology	Limnology Field Trip	19	Sept. 14-16
Dr. McQueen York Biology	Limnology Field Trip	18	Sept. 21-23
Dr. Brown Queen's Biology	Limnology Field Trip	35	Sept. 22-23
Dr. Brown Queen's Biology	Limnology Field Trip	35	Sept. 29-30

ORGANIZER	FUNCTION	NUMBER OF PARTICIPANTS	DURATION
Dr. Bastianautti Queen's Italian	Italian Club Outing	16	Oct. 20
Dr. R.J. Robertson Queen's Biology	Discussions with Dr. J. Brown (S.U.N.Y.)	11	Nov. 14-15
Floyd Connor Queen's Biology	Biology 202 (Ecology) Volunteer Weekend	7	Nov. 16-18

TABLE 6: Seminars at QUBS 1980.

Speaker (affiliation)	Topic
Jeff Yachnin, McGill Univ.	Oxygen concentrations and predation rates in tropical fish
Roberto Cavalcanti, McGill Univ.	Nest desertion as an adaptive behaviour in song sparrows
Howard Kramer, McGill Univ.	Song sparrows and the Beau Geste hypothesis
Richard Norman, McGill Univ.	Relevance of the sexual handicap principle (Zahavi)
Anne MacMillan, Queen's Univ.	Advantages of colonial nesting in sunfish
Robert Barclay, Carleton Univ.	Mother-young interactions in <u>Myotis</u>
Dr. W.A. Crich	Aquatic invertebrates
Dr. W.A. Crich	Techniques of macrophotography
Richard Norman, McGill Univ.	Parulid warbler assemblages in Eastern Ontario
Dr. J.M. Winterbottom, Univ. of Capetown, South Africa	Evolution of African fauna
Joe Brown, Queen's Univ.	Ontogeny and experience in Centrarchids
Dr. R. Bigalke, Univ. of Stellenbosch, South Africa	Scent marking and communication in antelope
Mart Gross, Univ. of Utah	Sunfish mating systems
Dr. A. Forsyth, Univ. of Arizona	Sex ratio in colonial insects

TABLE 7: Fee schedule for 1980.

I. ACCOMMODATION (ROOM AND BOARD)

\$140/month	- involves obligation for dishwashing or other chores on a rotating schedule
\$180/month	- no obligation for chores
\$ 60/week	- including weekend, e.g. Field Camp - no chores (also includes a lab fee)
\$ 45/week	- single week - involves chore obligation
\$ 8/day	- 24 hours room and board
\$ 1.50	- breakfast or lunch only
\$ 3.00	- dinner only
\$ 2/person	- overnight accommodation - academic purposes - no food
\$ 3/person	- overnight accommodation - non-academic purposes - no food

II. BOATS

Fee for extensive boat use with guaranteed availability
- includes maintenance and upkeep:

\$350/summer; \$95/month; \$40/week

Fee for frequent boat use - availability not guaranteed
- includes maintenance and upkeep (frequent use >2x/week):

\$200/summer; \$50/month; \$20/week

No charge for occasional and non-exclusive use of boats and motors (<2x/week). Purely recreational use should be limited to canoes.

III. BENCH FEES

\$50/month; \$2/day - Non-Queen's staff or major researcher.*

\$25/month; \$1/day - Queen's staff or major researcher.*

Bench fees may be waived or reduced if sufficient research funds are not available upon written application to the Station Director, Dr. R.J. Robertson.

* M.Sc. or Ph.D. candidate, project coordinator or Post-Doctoral fellow.