Queen's University Biological Station

Annual Report and Newsletter

1989

Director - Dr. R.J. Robertson
Manager - Frank Phelan
INTRODUCTION

Nineteen eighty-nine was the busiest year yet at QUBS! Use both for teaching and research purposes increased substantially from 1988 to 1989. Overall, the number of user-days was up 19% over 1988 levels. Increase in levels of use has occurred each year. Since we started recording use as user-days in 1965, there has been a 45% increase in total user-days.

On average, 43 researchers (professors, graduate students, honours students and assistants) were in residence throughout the summer (up from 37 in 1988). Abstracts of research projects and personnel involved are contained in the following pages.

In teaching activities, QUBS hosted ten modules in the Ontario Universities Program in Field Biology. Titles and enrolments for modules held at QUBS and for the OUFPB program in general are found in Tables 1-3. In addition to these, Dr. M. Brock Fenton (York University) brought his course on bats, Dr. Ed Kott (Wilfrid Laurier University) his course for senior undergraduates and Dr. Bob Montgomerie (Queen's) his course for graduate students, to QUBS in 1989. The eleventh edition of the Naturalist's Workshop program was held in May (more on this later).

The Biological Station continues to be an important facility for a variety of field trips, especially those associated with fall and winter term university courses. In many cases, this exposure to field work is a key element in stimulating interest in field biology. A tabular summary of conference, meeting and field trip use of QUBS in 1989 appears later in this report.

The largest single event of 1989 was the acquisition of the Wright property. Just before Christmas, we took possession of this beautiful and extensive property. Details are contained in the section of this report titled "On the Wright Tract".

During 1989, we made a great number of changes to QUBS facilities. In no particular order, they were: (1) Cabin #14 was built. This cabin, one of our new, improved, larger basic cabins is to be used by senior researchers. (2) The electrical supply line to the top row of cabins was disconnected from the lodge and split into two lines fed from the library. Cabins #1, 2, 12 and 14 are now on one line, while cabins #3, 4, 5 and 13 are on another. (3) Curran Cottage's renovation was nearly completed. We completely renovated the two bathrooms, resurfaced the halls, carpeted the living room, installed a new kitchen, improved the entrances and exits and replaced windows in the bedrooms facing the lake. (4) In fall, we renovated the main bedroom in Earl Cottage. We panelled and insulated, replaced windows and put in a new ceiling. (5) The rotting deck of the barge was removed, replaced and resurfaced in mid-summer. (6) In the rear hallway of the lodge, we removed the old sinks, covered and painted the walls, installed a new counter, deep sinks and a laundry tub. The new installation enables dishwashing to be removed from the kitchen. (7) The bathrooms in the rear of the lodge were spruced up with paint. In the women's bathrooms we installed folding privacy doors. In the men's bathroom we installed a urinal. (8) In fall, we installed drain tiles and gravel around the Trilab to carry away spring runoff. Hopefully, this will keep the floors and sills of the labs dry in spring. (9) Bruce Cameron is fabricating a new barge
with the help of QUBS. The new thirty-foot pontoon boat will be used both at QUBS and Bay of Quinte. As this is being written, the final touches are being applied - maiden voyage come spring. (10) Renovations were done to the lower level of the Boathouse to allow more efficient use by skin and SCUBA divers. The storage space in the old shop was improved. Also improved were facilities for hanging, drying and storing dive gear. (11) A large, moveable net winder was built for the storage of seine nets. This winder will greatly extend the life of nets and reduces dockside clutter enormously. (12) The influx of extra research personnel necessitated changes to the library. In spring, we built new study tables and added privacy screens to create five individual workspaces. (13) Along the hydro line to Curran Cottage, a new service was installed to provide power to the pool facility of Mart Gross' crew. This 250MCM service runs back from the meter pole at Sumac Cottage to the pool site at the North-east side of the leach field. (14) A new culvert was installed in the entrance road. Situated at the bottom of the big hill and next to the Curtis entrance, this should handle spring runoff. (15) Two new johnboats were purchased in early summer. These new workboats proved very useful during the summer research season. (16) We removed the deck from boat #3 and are rebuilding it as an open runabout. It should be much more versatile when finished. (17) We purchased a brushcutter to enable clearing of roadsides and trails. (18) We decided to purchase rather than continue leasing the kitchen stove, a top of the line Garland propane stove. We will pay for this purchase over three years. (19) The old doors to the storage room at the rear of the lodge were replaced. The new installation should keep out the weather and mice, yet improve access to the dryer and storage room. (20) The purchase of a grader blade and landscape rake combination for the tractor makes it possible for us to maintain roadways ourselves. (21) A modem for the station computer was purchased and installed. A second phone line was also installed to enable the use of the modem and allow business calls. Considerable use of this arrangement has been made already in transmitting data files from the weather station to various users. (22) The PCP/CBA lab windows were installed along with an aluminum entrance door. These changes will allow a greater scope of use of this building.

Thanks to Parks Canada - Rideau Canal, we were provided with a free season's lock pass for the barge. Our 'floating classroom' was used on many occasions for interlake comparisons. It would seem that QUBS is getting some recognition from government agencies.

The annual Open House was held on Sunday, July 9. Station regulars hosted over 215 visitors who toured the displays of research projects and species. In June, the ninth edition of our Community Newsletter was delivered to over 600 households and cottages in the area. These two public relations efforts are important in maintaining contact with the neighbouring community. Many thanks to the regulars for making these efforts so successful. Our position in the community has greatly improved over time as a result of such effort.

This year, the Biology Department Picnic was not held on the heels of the Open House. Rather, the picnic was scheduled for the 19th of August. Attendance was only 35 members of the Department, their families and friends. We hope to make the timing and schedule of events more interesting in the future to encourage more to attend.

The seminar series was once again organized by Dr. Raleigh Robertson in 1989. These presentations are a most interesting facet of life at QUBS and
provide a forum for exchange of ideas concerning an array of biological topics. The list of speakers and topics appears in tabular form later in this report.

The new fee schedule for 1990 appears on the last page of this report. Increases attempt to keep pace with inflation. It will be noted that room and board costs will be separated. This will allow us to more easily apportion income into food recovery and maintenance of accommodations. An in-depth financial analysis indicated that we were not recovering enough of our costs of accommodation. Hence, there will be a phase-in of increases in this category aimed at correcting this shortfall.

We are attempting to keep a current list if theses and publications emanating from field work done at QUBS. Please forward copies of theses (we will have them bound) and articles (or at least the citation of same) as they become available.

Our kitchen staff was extensive this year - Barbara Sly, Elaine Larson, Cheryl MacDonald, Marg Phelan, Odette McCarthy, Robin Coombes, Morgan Grady-Smith, Jodie Knapp and Christine Knapp. Fortunately, these were not all on at once! The large numbers of users this year strained our staff and food service space. In the light of the difficulties faced, we owe a vote of thanks for the efforts of our staff.

Dave Fleming was a welcome addition to our staff as Assistant to the Manager. He was at QUBS from April through October. With his capable help, we were able to cope with user numbers and complete a great many maintenance projects. Thanks, Dave, for a job well done!

With our ever-expanding group of alumni and friends, our list of significant events-in-the-life is growing. During 1989, we experienced a mini baby boom: to Kevin Dufour and Jennifer Magwood, their first-born, a son, Patrick Lawrence on 15 April; to Bob Montgomerie and Cathy Redsell, a second son, Dylan Redsell, on 5 November; to Laurene Ratcliffe and Peter Boag, a baby girl, Angela, on 20 July; to Tim and Kathy Ehlinger, a daughter, Sarah Quinette, on 21 July; to Marty Leonard and Andy Horn, a girl, Claire, on 24 January, 1990; to Susan Lempriere and Franz Menges, a boy, Isaac, on 27 January, 1990; to Jim and Mary Anne Complak, a son, their first-born, Andrew John, on 17 January, 1990; to Dave and Liz Fleming, a girl, on February 4, 1990. Best wishes to all new parents.

There was a wedding between two long-time station regulars in 1989. Dr. Bruce Smith married Katherine (Kit) Muma on 19 August in London, Ontario. Congratulations!

Thanks to Karyn Boak for the sketch which graces the front cover of this report.
Map showing present landholdings of QUBS and relationships between the four tracts.
Adapted from Westport topographic map.
Scale 1:50,000
On the Wright Tract

In December 1989, a 315 hectare parcel of land was purchased from Opinicon Properties Ltd. This tract, boasting some 11+ km. of shoreline, will greatly expand the types of projects that can be conducted at QUBS, enhance the quality of studies, and ensure the security of both research and teaching programs at QUBS, especially those concerned with watersheds and lake margins, for the long term future.

Beginning in 1985, after being approached by Henry Wright, president of Opinicon Properties Ltd., Queen's and Opinicon Properties explored the possibility of a gifting of the land to Queen's. However, an unfavourable tax ruling from Revenue Canada precluded an agreement on this basis. Thus, in November 1988 we began to negotiate a straight sale and purchase of the property. The property was valued at $533,000, but was offered to Queen's for $300,000. Time limitations dictated that the purchase could not be incorporated within the university's projects schedule, so outside sources of funds were sought.

Raleigh and Frank mounted an aggressive campaign to apply to as many potential sources of funds as possible and to marshal support for such an acquisition. Letters of support came in from all quarters: researchers from a wide variety of institutions, field naturalist groups, Ministry of Natural Resources, Parks Canada, teachers, local resource-user groups, Ducks Unlimited, Chaffey's Locks Improvement Committee, Conservation Authorities, Property Owners Associations, sportsmen's associations, and many individuals having interest in the area. This overwhelming display of support for the acquisition was a key factor in the procurement of funds.

Mr. Charles Sauriol, who had helped raise money for the purchase of the Bonwill Tract, was a tremendous source of inspiration, advice, and support in our efforts to raise money for this project. His willingness to share his many years of experience in funding efforts for conservation proved extremely valuable in raising the funds for the acquisition of the Wright property.

Financial support was received from a variety of sources: a very generous donation ($100,000.) from Brigadier General John M. Cape was critical in helping to convince various agencies this project would succeed. A second very generous donation ($50,000.) from Mrs. John M. Pangman, arranged through Charles Sauriol, and a contribution of $50,000 from Canadian National Sportsmen's Shows helped to convince Queen's to proceed with the purchase. Finally, a contribution of $50,000 from the Ontario Heritage Foundation's Challenge Program put us well within reach of the goal. By late fall of 1989, $250,000 had been raised for the purchase. Outstanding applications, plus the continued efforts of Charles Sauriol, are quite certain to result in full funding for the project in the very near future.

On the basis of funding that was available by mid-summer, Queen's proceeded with the legal aspects of the purchase. Since the University was buying a company, subsequently folding up the company and transferring its assets (the land) to the University, it was a very complex procedure. However, in spite of many delays and complex legal matters, the purchase was finalized on 11 December 1989!
We would like to wholeheartedly thank everyone who has supported this acquisition and who worked for its realization. Many people were involved, including those people and organizations who wrote letters on our behalf, the staff at the various funding agencies with whom we developed proposals, Charles Sauriol who helped in many ways, David Dennis who as head of department was fully supportive from the beginning of negotiations, Ken Brodie who helped with the early negotiations, Vice-Principals Rod Fraser and Bill McLatchie who have been strong advocates of the station's program, Dee Wilson in the Vice-Principal's Office who handled many complicated issues, Director of Development John Heney who recognized the significance of this acquisition to the environmental programs at QUBS, and Principal David Smith who gave the University's support to this project.

We especially thank those individuals and agencies mentioned above for their financial contributions which made this acquisition possible. Henry and Sherwood Wright, as well as the other shareholders of Opinicon Properties, are also recognized for their patience in these negotiations, and their willingness to sell this property for education and research purposes for a price much lower than they could have obtained through developing the area.

This new tract (locator map follows) will play many roles. It increases the capacity of the field station for teaching and research in areas dealing with conservation and environmental awareness. It establishes an important conservation presence in the rapidly-developing and heavily-used Rideau Lakes area. It provides exceptional long-term opportunities for research, especially on watersheds, ecosystems and lakeshore environments. It provides a counterpoint to developed areas. With rapidly growing interest in environmental education and the recognition of the importance of wetland and shoreline areas for local fish and wildlife, the preservation of this area will greatly enhance its value for education, research, conservation and management purposes.
The Naturalist Workshop program was established to fulfill four main roles: (1) to provide a unique educational experience that improves awareness and understanding of the natural history of Southeastern Ontario (2) to provide a forum for naturalists, both amateur and professional, to share skills and information concerning natural history, ecology, conservation and education (3) to provide training for professional naturalists (especially staff from Ontario Ministry of Natural Resources, Parks Canada and Conservation Authorities, teachers, etc.) to enable them to better convey an appreciation of natural history to the public and (4) to increase the contacts between a range of organizations, agencies and interested individuals whose common interest is in natural history. Of course, we are very interested in increasing contacts between this group and the staff of the Biology Department at Queen's, especially those using the Biological Station for research and teaching purposes.

The eleventh annual Naturalist's Workshop was held May 20-27, 1989. This year, because of space constraints, enrolment was limited to eighteen participants (applications far exceeded this upper limit). A good cross-section of backgrounds and interests were represented in our participants: a teacher, two from Conservation organizations, four from the Ontario Ministry of Natural Resources, one from Parks Canada, one undergraduate university student, one professional naturalist and consultant and eight amateur naturalists. This mixed group worked well together - the only difficult aspect was keeping their collective enthusiasm under some sort of control.

This year’s team of instructors was spearheaded by Dr. Adele Crowder and Dr. Jim Pringle (Queen’s - Biology and Royal Botanical Gardens, respectively). These two are largely responsible for the great success of the program. The workshop is effective because of the devotion of time and effort of all our instructors. A heartfelt thanks to all: Floyd Connor (QUBS), Dr. Francis Cook (National Museum of Natural Sciences), Terence Dickinson, Charles Francis (Queen’s - Biology), Jennifer Harker (M.M. Dillon Consultants), Dr. Allen Keast (Queen’s - Biology), Dr. John Kingston (Queen’s - Biology), Dr. Sandra McBride (Queen’s - Geological Sciences), Frank Phelan (QUBS), Dr. David Philipp (Illinois Natural History Survey), Dr. Laurene Ratcliffe (Queen’s - Biology), Dr. Raleigh Robertson (Queen’s - Biology), Kevin Seymour (Royal Ontario Museum), Dr. Bruce Smith (Univ. of New Brunswick), Dr. John Smol (Queen’s - Biology) and Dr. Ian Walker (Queen’s - Biology).

This year, two day-long sessions, one a field trip to observe spring bird migration at close range and another on interlake limnological comparisons, were featured. During the former, we were allowed close inspection of birds netted, weighed and measured by Charles Francis and the members of Dr. Fred Cooke's (Queen's - Biology) Ontario Universities Program in Field Biology field course on bird migration at Prince Edward Point. Dr. Allen Keast also assisted with observations on free-flying subjects. Dr. John Smol and members of his lake study group led us on sampling trips of Lake Opinicon (a shallow, polymictic lake) and Clear Lake (a deep, dimictic lake). Comparisons of the algal communities of each lake showed marked differences dependant on the physical and biological constraints of the two contrasting systems.

In 1989, the Kingston Field Naturalists again offered a full scholarship
for one workshop participant. In addition, the generosity of Shannon McCorquodale provided a scholarship for one student to attend the workshop. It seems clear that there are some real believers in the program! Thank you for your support of our efforts.

Plans for the 1990 version of the workshop are nearing completion. We will again venture to Prince Edward Point to observe migrating birds. We will also address concerns about human development in watersheds by considering risks and impacts of development at sites in the Napanee watershed. This more applied exercise will combine the skills of natural history, biological surveys, conservation, environmental assessment, risk management, hydrogeology, site planning etc. - an interesting challenge, indeed!
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Table: Course Credits in the Undergraduate Program in Field Biology, United States University, Biological Station.
Table 2: Summary of course credits in the Ontario Universities Program in Field Biology earned at locations other than UOVS in 1988.

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Total Number of Student-weeks  

| Total Number of Student-weeks | 34 | 16 | 22 | 14 | 34 | 82 | 40 | 16 | 10 | 268 | -- |

Half-course Equivalents  

| Half-course Equivalents | 17 | 8  | 11 | 7  | 17 | 41 | 20 | 8  | 5  | --- | 134 |

* 2 students from University of Manitoba
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* QUBS: Queen's University Board of Studies

Table 1: Summary of the Ontario Universities Program in Field Botany for 1988.
ABSTRACTS OF RESEARCH CONDUCTED AT QUBS in 1989

I. RESEARCH BY QUEEN'S UNIVERSITY STUDENTS AND STAFF

DR. P.W. COLGAN

"Field Ethology of Fish"

In 1989, Lake Opinicon was the source of bluegill sunfish for laboratory studies on feeding behaviour by Janice Frame (research assistant) and Jim Kieffer (M.Sc. student), observational learning by Heather Groten (M.Sc.), and growth studies in the presence of pentachlorophenol by Andrew Samis (M.Sc.)

Publications:


DR. TIMOTHY J. EHLINGER - (Queen's University and University of Toronto)

"The Ecology of Trophic Diversification and the Evolution of Behavioural/Morphological Variation in Bluegill Sunfish" - Post-Doctoral Research

My research at QUBS is asking to what extent morphological-behavioral variation in Bluegill reflects selection on trophic form (i.e. growth/survival) versus sexual form (i.e. reproductive success) and studies conducted in the summer of 1989 provided some valuable data.

I've continued to explore how differences in morphology affect individual feeding rates, growth, and survival, and how these relationships differ within and between lakes of various niche structure. Bluegill from Mosquito Lake and Clear Lake (adjacent to Lake Opinicon) exhibit large amounts of morphological divergence. Bluegill from Mosquito Lake (a shallow-weedy lake) possess a body plan that is better for maneuvering and feeding in vegetation (e.g. longer fins and deeper bodies) whereas bluegill from Clear Lake (a deep-openwater lake) have shorter fins and fusiform bodies that are better suited for cruising and feeding in the open water.

A second dimension of the research (collaborating with Mart Gross and Isabelle Cote from U. of T.) is examining the reproductive consequences of variation in bluegill morphology. We are asking how the patterns of morphological variation between the sexes are functionally related to performance of reproductive tasks (e.g. nest site acquisition by males, sneaking success by cuckolders etc.) and how this might relate to trophic divergence (as above). For example we have found that females change morphologically between lakes to
a great degree whereas the body plan of nesting males is conserved. Experiments in the new pool structure last summer showed that the cuckolder males incur greater mortality from bass predation compared to immature males and females of the same size. All-in-all, it is becoming very apparent that males, females and cuckolder males are integrating their foraging and reproductive strategies in different ways.

Publications:


DR. ADRIAN FORSYTH

"Behavioural Ecology of Insects"
Assistant: David Bell

DR. H. LISLE GIBBS

"Parentage Analysis of Red-winged Blackbirds using DNA Probes"

Co-Investigators: Dr. Peter Boag, Dr. Bradley White and Lisa Tabak (all Department of Biology, Queen's University)

In collaboration with Dr. Pat Weatherhead (Carleton University), we have been conducting parentage analyses on populations of Red-winged Blackbirds (Agelaius phoeniceus) breeding in marshes around the field station. To estimate the frequency of extra-pair fertilizations (EPFs) in these birds, we have used a hypervariable single locus DNA genetic marker derived from a mouse major histocompatibility locus. Preliminary results for samples collected in 1986 indicate that 40% (7 of 18) of all males had at least one chick in a nest on their territory which was fathered by another male and that 21% (18 of 87) of all chicks resulted from an EPF. These results confirm earlier behavioural observations which implied a high frequency of EPFs in this species and demonstrate the value of using this new class of single locus genetic markers in evolutionary studies of animal mating systems.

Assistant: Erin Yosinda

DR. R. HARMSEN and DR. A. CROWDER

"Plant-Insect Interactions"

"Effects of Grazing on Succession in an Old-Field Community"

This is a continuation of a long-term project initiated in 1975. In two old hayfields, 27 100m² research plots were permanently established in 1975.
Every year, insect, rodent and plant populations are quantitatively sampled in all 27 plots, of which nine are screened with rodent-proof fencing and trapped empty once a year and nine others are treated with insecticides in order to avoid insect grazing damage to vegetation.

In 1989, we continue to monitor closely the population of *Triphabda* spp. (Goldenrod beetles). In this, the 15th year of the project, it was decided to scale the project down by eliminating the insect collections in those plots where shrub and tree growth has advanced to a point where the community is no longer an old field. It is expected that the project will continue on a smaller scale for a further ten years.

Assistant: Sarah Newbery

Ann Schindel - "Host Plant Specificity in *Triphabda* Beetles" - B.Sc Thesis

Populations of larvae were collected on two species of goldenrod and one of aster, and reared (in nylon mesh enclosures in the field) on three species of goldenrod and one aster in all possible combinations of origin plant and food plant. Just prior to pupation, the larvae were brought into the lab to pupate in captivity. The resulting adults were maintained on the same host plant they were raised on, until death. Growth rates, weights and survival were recorded, and eggs laid for each group are overwintering for follow-up experiments in 1990. We hope to be able to use the larvae that will emerge from overwintering eggs to record rates of adaptive change in various fitness components related to host plant.

Mary Stockdale - "Life Strategy Comparisons between Two Species of *Lygus*" - B.Sc. Thesis

In 1988, *Lygus lineolaris* and *L. vanduzeei* were collected, alive, in August and host plant preference experiments were conducted. The generalist *lineolaris* was indeed much less specific in its host plant requirements, but the reputed goldenrod specialist was surprisingly broad in its host selection. Longer-term experiments testing for survival on different host plants also indicated that both species survived well on a broad spectrum of plant species.

In 1989, some of the above experiments were repeated and earlier trends were confirmed. The data from the long-term study on old-field succession are interpreted within the paradigm of the two different strategies.

Thesis:


DR. ALLEN KEAST

"Seasonal Ecology of Forest Bird Communities"

Work continued on the Lake Opinicon forest bird community with special reference to sequencing of the major events of the annual cycle and how this
related to season and the prey resource base. Times of arrival/departure on the breeding ground and were recorded. Are these times correlated with prey insect buildup in April-May and drop-off in late June-August? What is the relationship of the nestling period to insect abundance? We recorded data on foods fed to young, prey abundance and the temporal relationships of various species of birds and insects. The project is being developed in a comparative framework.

Assistant: Sari Saunders

Michael Fox and Dr. Allen Keast

"Ecology of Fish in Beaver Ponds"

Studies continued on growth and trophic ecology of fish in small beaver ponds adjacent to Lake Opinicon. The ponds, shallow and subject to winter kill support only small-bodied fish with the largest species, the Pumpkinseed Sunfish, showing a skewed population composition.

Michael Fox - "Factors Governing Growth Rate of Juvenile Fishes in Culture Ponds" - Ph. D. Thesis

Work continued on factors governing growth rate of juvenile Walleye in artificial culture ponds as part of a broader study on the effects of diet and crowding on the development of young fish.

Sari Saunders - "Ecomorphology of Bird Species in a Forest Bird Community" - Research Assistant

Sets of 10-15 skeletons of the twenty commonest adaptive types of birds were a part of the study of how structure adapted the major components of the Lake Opinicon bird community (i.e. warblers, flycatchers, thrushes, woodpeckers, etc.) for specific ecological roles. Simultaneously, Keast and Saunders have quantified and analysed how the body structures were used, especially relative to locomotory feeding movements.

Publications:


Keast, A. Distribution and origins of forest birds. Monographae Biologicae, in press.

Keast, A. Biogeography of the North American broad-leaved deciduous forest avifauna. Monographae Biologicae, in press.

DR. ROBERT MONTGOMERIE and DR. HENRIK SMITH

"Parental Care in American Robins"

In 1989 we continued working on aspects of parent-offspring interactions in robins by conducting experiments designed to test some recent ideas about factors influencing the evolution of loud begging behaviour in birds. To do this, we deprived some nestlings of food for short periods, then looked at their response and the responses of their siblings and parents when they were returned to the nest. Nests were watched by video cameras so that the behaviour of both parents and nestlings could be studied in detail back in the lab. We found that the intensity of begging is influenced by both the nestling's own physiological need for food and by the begging of siblings thus suggesting that competition among siblings has been an important factor in the evolution of this begging behaviour.

Assistants: Susie Everding, Karen Holder, Tarmo Poldmaa, Tammy Fessenden, Peter Hurd

"Sexual Selection and Parental Care in Barn Swallows"

We did this study largely to compare with the results of a recently published study on this species from Denmark. Since male barn swallows contribute to incubation in North America but not in Europe, we expected some differences in the intensity of sexual selection between these populations and we tried to account for the difference in male incubation behaviour. Our studies indicate that male incubation in North America may be driven by colder nest environments than those in Europe or possibly by a difference in food availability. As in Europe, however, North American female swallows seem to prefer males with longer tails so this cannot account for the shorter tails of North American males. Our results suggest that tail length in North American males may be limited by the costs of feather damage during incubation.

Assistants: Susie Everding, Karen Holder, Tarmo Poldmaa, Tammy Fessenden, Amanda Johnson

DR. ROBERT MONTGOMERIE

"Song and Sexual Selection in American Robins"

This year we completed studies begun in 1986, looking at various aspects of the singing behaviour of robins in relation to mating and territoriality. We have so far determined that neighbours share significantly more syllables than non-neighbours and that there is (probably as a result) some geographical variation in song structure that looks like local dialects. Robins at QUBS and Curtis' field, for example sound slightly different from those in Chaffey's Lock and Skycroft. We also completed our measurements of male characteristics
(reproductive effort, parasite load, plumage colour, size, mating success, etc.) so that we can look for correlations between these traits and song structure as a test of the idea that songs are used to advertise quality.

Assistants: Tarmo Poldmaa, Ian Jones, Susie Everding, Karen Holder


During late August and September, I did a field study to test for positive assortative mating with respect to elytra length in the soldier beetle, Chauliognathus pennsylvanicus because elytra length is strongly correlated with weight and can be used as an indicator of overall size. My study began with samples of various fields in and around QUBS which yielded 536 mating pairs and a very significant but weak correlation between the male and female elytra length. This was followed by experiments in the lab using one-litre jars and biased sex ratios, either towards females or males, to see if there was any mate choice preference which would cause the correlation found in the field samples. Experiments were also done to identify a density-dependent effect. Similar field sampling was done in Georgia by D.L. Mcclain in the early 1980's resulting in his claims that Chauliognathus pennsylvanicus mates assortatively for elytra spot length. I measured this and found no significant correlation in mating pairs.

Assistant: Susie Everding

Thesis:

Poldmaa, Tarmo. 1989. Song repertoires and syllable sharing in the American Robin (Turdus migratorius). B.Sc. Honours Thesis, Department of Biology, Queen's University

DR. LAURENE RATCLIFFE

"Vocal Behaviour of Chickadees"

As part of a larger study on pitch production and perception in songbirds, we continued recording and song playback experiments on 40 male chickadees around QUBS in 1989.

Assistants: Lesley James, Ingrid Johnsruide, Rachel Scudamore

Drs. Andy Horn and Marty Leonard - "Variability in the Whistled Song of Black-capped Chickadees" - Post-Doctoral Research

The songs of most passerine birds consist of a repertoire of discrete, stereotyped song types whose functions are obscure. The song of the black-capped chickadee was thought to be an unusually simple exception, consisting of just one highly stereotyped two-note whistle. However, by recording 35 males at the field station in 1989, we discovered that each male can whistle at up to six different frequencies. This is the first documented case of a song repertoire whose song types vary primarily in one dimension (frequency). This
simple structure provides an excellent opportunity for testing hypotheses about the function of song repertoires. We tested some of these hypotheses by observations of song use, by song playback experiments and by monitoring song development in young males.

Collaborators: Drs. L. Ratcliffe and R. Weisman (Queen's - Psychology)

Dr. Marty Leonard - "Parent-offspring Interactions in Chickadees" - Post-Doctoral Research

Parent-offspring theory suggests that parents and their young may come into conflict about the timing of independence of the young. Relatively little work has been done on parent-offspring interactions in altricial birds, especially after the chicks have left the nest. The purpose of this study was to examine these interactions in black-capped chickadees during the fledgling period. The main interest was in the relationship between independence and parental feeding of the chicks, parental aggression toward chicks and sibling aggression.

Collaborators: Drs. Andy Horn and Laurene Ratcliffe

Susan Lempriere - "Call Convergence in Natural and Captive Flocks of Black-capped Chickadees" - M.Sc. Thesis

The "chick-a-dee" call varies in structure among winter flocks and may act as a unique flock "signature". In 1989, I completed a study of song convergence, which involved recording known, free-ranging birds over the winter, as well as conducting aviary experiments with reassembled flocks. In captivity, call convergence occurs quickly (2 days - 2 weeks, depending on the call characteristic) and appears to be the result of passive modelling. Degree of convergence is not correlated with sex, age or dominance status. Natural flocks retain their unique call structure throughout the winter. For individuals, the degree of flock call is a function of time associated with the flock.


Avian predators elicit freezing behaviour from all members of chickadee flocks. However, only certain flock members broadcast high-frequency alarm calls, which warn others. In 1989, I began examining behavioural correlates of alarm-calling in captive birds, to determine why certain flock members should engage in this presumably risky behaviour. Chickadees trapped at local feeders were held in large outdoor aviaries. Once dominance status was determined, the birds were exposed to two sorts of predator stimuli: (1) playback of a hawk call and (2) a hawk model. The anti-predator responses of each flock member with respect to age, sex, status and flock familiarity are being analysed. I am also conducting an experiment with free-ranging flocks, in which the distance of the predator (hawk model) from a feeder is varied.

Publications:

Weisman, R. and L. Ratcliffe. 1989. Absolute and relative pitch process-


**DR. RALEIGH J. ROBERTSON**

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

Studies on Tree Swallow breeding strategies were continued on grids on the Hughson tract and in the Northeast Sanctuary, with the team involvement of Lisa Venier, Peter Dunn, Wally Rendell and Larissa White. Caroline Tomlin helped by checking the scattered boxes. High school volunteer Jennifer Dow helped for a few days during banding. George Lozano from Western visited the grids during the OECC.

"Infanticide and Anti-infanticide Strategies in Tree Swallows"

Having established that replacement male Tree Swallows are infanticidal and that males which arrive during incubation do not disrupt eggs, but wait and kill the nestlings as they hatch, experiments during 1989 focussed on behaviour of replacements which arrive during the egg-laying and incubation period. Receptivity and copulation behaviour of females with replacement males were examined to test the hypothesis that prolonged copulation is a female tactic to confuse paternity and prevent infanticide. Males which arrive before about day 3 of incubation adopt nestlings, while those arriving later kill them. Copulation alone is not sufficient to prevent infanticide, but copulation coupled with a time span of about 12 days is correlated with adoption.

One case of infanticide by a female was observed when the resident female deserted due to blood sampling and the replacement female began to build a nest over the nestlings. A detailed study of female infanticide is planned for 1990.

Assistant: Larissa White

Wallace B. Rendell - "Influence of Cavity Volume on Clutch Size in Tree Swallows" - Research Assistant

Robertson and Rendell (1990) showed that Tree Swallows nesting in tree cavities laid smaller clutches than conspecifics nesting in nest-boxes at the New Land grid. Also, the volume of cavities used in natural sites was half the volume of nest-boxes in the grids. We tried to determine if cavity volume was responsible for the observed difference in clutch size. At Bridget's grid, approximately half of the nest-boxes were fitted with wooden inserts that reduced the total nest-box volume by half. The remaining boxes were unmanipulated. Preliminary results showed that females using smaller boxes typically laid fewer eggs (about 5), whereas larger clutches were laid in larger boxes (about 6). Further, when Tree Swallows had a choice to either lay in smaller or larger nest-boxes, 87% chose to nest in larger boxes. We suggest that females "prefer" larger boxes because this allows them to lay larger clutches,
thereby increasing their potential lifetime reproductive success. Similar experiments will be conducted in 1990 to enhance our data set.

Publications:


Stutchbury, B.J. and R.J. Robertson. Do Tree Swallows use nest cavities as overnight roosts during territory establishment? J. Field Ornithol. in press.


This year, manipulations of clutch size were used to alter patterns of effort Phoebes used to raise each of their two annual broods. Ninety-nine nesting attempts were monitored, of which 49 were first attempts. The clutch size of 28 of these were manipulated, 14 up by two eggs, 14 down by two eggs. Manipulations of first nests did not alter any measures of success in second nests, such as number of eggs, number of hatchlings, number of fledglings and time between nests, but birds having first clutches of 4 or less were more likely to renest. In addition, the effect of mites on growth of nestlings was studied by removing mites from nests (only second attempts are infested) using an acaricide. Nestlings in infested nests weighed ca. 20% less on day 11 and were less likely to live to fledging.

Assistant - Saul Schneider

Saul Schneider - "Mite Communities of Phoebe and Barn Swallow Nests" - BSc Honours Project, Acadia University

Phoebes and Barn Swallows frequently nest in similar locations and will remodel each other's nests to use as their own. Both can become heavily in-
fested with northern fowl mites (Ornithonyssus sylviarum) but the infestation of Barn Swallow nests appears to occur earlier in the season. Samples of nests and nesting materials were collected throughout the season and mite levels in nests were monitored to characterize the population and community dynamics of mites, especially in Phoebe nests.

Jessie Deslauriers - "Phoebe Response to Cowbird at the Nest"

Since nesting failure of small passerines can often be attributed to Brown-headed Cowbird parasitism, many passerines may have learned to recognize female Cowbirds as a possible threat, and react aggressively to their presence near the nest. Indeed, some may recognize female Cowbird chatter. In an ongoing experiment to test possible song recognition, as well as male vs. female response, model presentations were made of female Cowbirds and Song Sparrows (non-threatening controls), accompanied by tape recordings of typical songs, to several Eastern Phoebe nests at the incubation stage. Tests of possible habituation to the Cowbird model were also carried out.

As well, further efforts in a mist-netting program begun three years ago were carried out, to study differences in temporal movement during spring migration of selected passerine groups and Parulid species.

Dr. Peter O. Dunn - "Breeding Ecology of Tree Swallows" - Post-Doctoral Research

During April-June 1989 we investigated two aspects of the breeding ecology of tree swallows. First, we began a study of the costs and benefits of various mating strategies in tree swallows. Tree swallows are typically monogamous, but they also engage in copulations with more than one partner (extra-pair copulations, EPC's). This behavior may allow apparently monogamous males to increase their reproductive success. However, until recent advances in DNA technology allowed one to determine parentage accurately, it was not possible to estimate the gametic success of males that engaged in EPC's. This spring we collected blood samples from families of males that engaged in EPC's and males that had two mates (polygynous males) to compare their gametic success. Parentage of these nestlings will be estimated using DNA fingerprinting. Second, we examined the need for male parental care in an area of low food abundance. It has been suggested that tree swallows are monogamous because males must provide parental care in areas where food abundance is low. Male swallows were removed from territories as part of another experiment and food abundance was measured near the nests. These results will be compared with similar data from a study area in Alberta where food abundance appears to be much greater and male parental care has little effect on female reproductive success.

Susan Meek - "Parental Investment and the Maintenance of Monogamy in Eastern Bluebirds" - M.Sc. Thesis

This is my second year on this project. 38 nesting attempts were monitored and 10 male bluebirds were temporarily held in avairies in order to assess the importance of male parental care. In pairs of birds, males and females fed the young and defended the nest against predators equally, but males played a greater role in defense against Tree Swallow competitors. "Widowed" females increased their feeding and defense, but were not able to
fully compensate for the lack of a male, and consequently raised fewer young than pairs. However, young successfully raised by "widows" and pairs of birds were of equal weight.

Replacement males were observed at most (74%) nests with "widows". Most of these males defended the territory and courted the "widow" but ignored the nestlings. Only 4 replacement males fed the nestlings, and they did so at a much lower rate than parental males.

Thirteen pairs were observed when the female was fertile and when she was not in order to examine whether males guard their mates. Males remained with their mates 61% of the time when they were fertile and only 22% of the time when they were not fertile. Mate guarding in Eastern Bluebirds is moderate; in many species, males remain with their fertile mates over 85% of the time.

Assistant: Caroline Tomlin

Caroline Tomlin - "Is Food Distributed Non-randomly in a Brood of Tree Swallow Nestlings?" - B.Sc. Honours Thesis

Tree swallow boxes were placed around QUBS property and were monitored until a clutch of eggs had been laid. New boxes with windows then replaced the original boxes, and upon hatching, the brood was filmed using video equipment. It is thought that food should be delivered non-randomly to nestlings, and the strongest begging nestlings should receive the food.


Male Tree Swallows provide about half of all feedings to the nestlings. It should thus be advantageous for males to assure their paternity in the nestlings that they are feeding. Males of some species of birds guard their mates in order to protect their paternity in their mate's offspring. Tree Swallow males do not guard so I hypothesize that the copulation patterns of Tree Swallows will reflect a "sperm swamping" technique. This technique involves frequent copulation by pairs which would devalue any extra-pair copulations in which the female might engage. This strategy would give the male a high confidence of paternity in the nestlings that he is feeding. I examined copulation patterns of tree swallows under normal conditions. I also examined copulation patterns under conditions where the male would perceive a high risk of extra-pair copulations. The results from this study are currently being analysed. Further data will be collected in May 1990.

DRS. JOHN SMOL and JOHN KINGSTON

Michael D. Agbeti - "Phytoplankton Succession and the Relative Importance of Allogenic and Autogenic Factors" - Ph.D. Thesis

This research focusses on comparing seasonal phytoplankton succession in Lake Opinicon and Upper Rock Lake. These two lakes have similar water chemistries, but very different physical regimes, with Lake Opinicon being polymeric and Upper Rock being a more typical stratified system. A large number of autogenic and allogegenic factors can determine the outcome of phytoplankton
succession, and this project attempts to decipher the relative importance of many of these factors. In addition to the biological sampling in these two systems, a large number of physical and chemical variables are being monitored.

Assistants: Brian Cummings, Roland Hall, Ian Walker

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

DR. ROB BAKER - Dept. of Zoology, Erindale College of University of Toronto, Mississauga

"Aspects of Mating Behaviour and Success in Aquatic Arthropods"

Mark Forbes - "Parasites (Arrenurus spp.) and Mating Success of Male Damselflies (Enallagma ebrium)" - Ph.D. Thesis

Recently, there has been much research directed at what effects natural levels of parasitism have on the mating success of their hosts. At least three hypotheses: host-castration by parasites, parasite-mediated reductions in host competitiveness for access to mates, and mate choice of parasite-resistant individuals (typically referred to as the Hamilton and Zuk hypothesis) can account for observed negative correlations between male mating success and their parasite loads. I have evidence that ectoparasitic mites (principally Arrenurus drepanophorus) reduce mating success of male Enallagma ebrium which I believe is due to the combined effects of parasite-mediated reductions in mate-searching ability and overall level of parasitism present in the local population. In 1989, I also examined whether condition of larval damselflies influenced their likelihood of being colonized by water mites, and I am presently examining whether mites influence the fecundity of males or females.

Assistant: Mark Delcantero, Mark Skyleryk

Publications:


Heather C. Proctor - "The Evolution of Mating Behaviour in Water Mites" - Ph.D. Thesis

Water mites (Acari: Parasitengona) are ideal subjects for studies of the evolution of mating behaviour because they show all degrees of proximity between mating partners, from complete dissociation of male and female to direct sperm transfer by venter-to-venter copulation. QUBS is remarkable for the diversity of mites in its lakes and ponds and is an excellent site to collect both common and rare species. I have visited the station on many occasions in 1989 and will continue collecting water mites at QUBS in spring, summer and
fall of 1990.

CHRISTOPHER ECKERT - "Causes and Consequences of Mating System Variation in a Wide-Ranging Clonal Plant, Decodon verticillatus (L.) Ell. (Lythraceae)" - Ph.D. Thesis

Recent quantitative approaches to studying plant mating behaviour have revealed considerable variation in parameters such as the outcrossing rate and functional gender. Variation within species is of particular evolutionary significance since it can strongly influence the distribution of genetic diversity within and among populations, and may set the stage for speciation through evolutionary shifts in the mating system. My research at QUBS focuses on the causes and consequences of mating system variation in a clonal, tristylos, emergent perennial, Decodon verticillatus.

Heterostylos species such as Decodon provide good material for studying mating system variation in nature since mating types ('style morphs') are simply inherited and easily identified by floral features, and mating system modification is readily detected and interpreted. A survey of 93 natural populations from across the species' eastern North American range conducted in 1988 and 1989 has revealed wide mating system variation in Decodon. The 30 populations I sampled around QUBS possess highly skewed morph structures as well as floral variants typically associated with increased self-fertilization and gender specialization. I am using a combination of population surveys, detailed field studies, greenhouse experiments, controlled crosses, electrophoretic analysis and theoretical modelling to determine the source(s), significance and evolutionary fate of this variation. Preliminary results suggest that the population structures observed around QUBS are probably not a result of genetic drift at style morph loci, or pleiotropic effects of style morph alleles causing asymmetries in reproductive performance among morphs. Current work addresses the possibility that morph-specific differences in outcrossing rate and functional gender are associated with, or possibly underlie the observed variation in morph structure.

DR. D. CHRIS DARLING - Department of Entomology, Royal Ontario Museum

"Ecology of Blowfly Larvae in Nesting Boxes for Birds"

Assistant: Julie Thompson-Delaney

DR. J.H. FULLARD - Insect Behaviour Group, Department of Zoology, Erindale College, University of Toronto.

"Insect Neuroethology and Sensory Ecology"
I. Neuromuscular Organization of the Arctiid Moth Tymbal (with B. Heller, University of Western Ontario)

Certain species of tiger moths (Lepidoptera: Arctiidae) respond to ultrasonic stimulation resembling bat echolocation calls by emitting trains of high-frequency clicks, presumably to dissuade the bat from attacking. The clicks are generated by a pair of thoracic tymbals that buckle when the moth is acoustically or tactually stimulated. The tymbals are serviced by a branch of the metathoracic leg nerve that innervates a variety of pleural muscles in close association with the tymbal. Tymbal nerve branches in a variety of local arctiid species were isolated and subjected to neural staining techniques to allow for the identification of the individual neurons within the nerve. These studies revealed five motor neurons within the tymbal branch of which three are unusually large. We propose that the three largest neurons within the tymbal branch are responsible for activating the muscles that drive the tymbal. Comparative stains of other species show a consistent neuromorphology within the family and a strong resemblance to the patterns in the related family, Noctuidae, moths that do not possess the ability to produce sounds. These studies suggest that tymbals in the Arctiidae arose from minor modifications of the thoracic exoskeleton and did not involve extensive rearrangements to its neuromuscular organization.

Assistant: Mark DelCantero

II. Auditory Defences of Noctuid Moths Against the Gleaning Attacks of the Western Big-eared Bat, *Myotis evotis* (with P. Faure and R.M.R. Barclay - University of Calgary)

Most moths protect themselves from the aerial attacks of bats by listening for the bats' echolocation calls and taking evasive flight actions. The ears of these moths are tuned to the characteristically intense, mid-frequency signals of the bats and possess sufficient sensitivity to the calls to ensure the moths ample time to detect and avoid the bats. The western big-eared, *Myotis evotis*, bat routinely uses another mode of foraging, gleaning to locate its prey. When in the gleaning mode this bat emits faint, higher-frequency calls and detects its prey by listening for the sounds the insects produce (e.g., wing fluttering or leaf rustling). I analyzed two species of noctuid moths from the Kananaskis field centre in Alberta that were sent to the lab at QUBS to determine if the moth could detect the gleaning echolocation calls of *M. evotis*. The sensitivity curves of the moths' ears indicate they are deaf to these calls and would not detect them in time to avoid the bat. Flight trials in Alberta have confirmed these predictions where free-flying bats are able to repeatedly attack and consume moths producing passive sounds. These data demonstrate a method of feeding behaviour in bats against which moths have no auditory defences.

Scott Morrill (Boston University) - "Flight Defences of Deaf Moths against Insectivorous Bats" - NSERC Summer Undergraduate Research

Most moths possess a pair of ears that alert them to the approach of echolocating, hunting bats. These moths evade bats either with controlled avoidance or erratic flight responses. Certain lepidopteran taxa do not possess
ears (e.g., Sphingidae (Hawk Moths), Bombycoidea (Silk-worm Moths), Cossidae (Carpenter Moths), Papilionoidea (Butterflies)) and the anti-bat defences of these moths are not known. Roeder suggested that inauditive moths avoid bats by means of ground-hugging or sluggish flight and Jayne Yack has demonstrated that at least some of these moths seasonally isolate themselves from bats by emerging, as adults in the spring before bats have arrived from their winter hibernation sites. We tested the following hypotheses: 1. summer-emerging deaf moths spatially isolate themselves from aerially-feeding bats by flying low to the ground and 2. these moths exhibit reduced flight tendency (slug-gishness). Flight heights were measured by erecting black-light illuminated sticky traps at 1, 3 and 6 meters and counting all moths captured. These results suggest that inauditive moths (particularly the tent-caterpillar moths, Malacosoma americanum and M. disstria) a. fly more in forested areas where bats do not frequent and, b. fly significantly closer to the ground than do auditive moths (noctuids and geometrids). Flight tendency was measured by allowing auditive and inauditive moths to gather at black-light illuminated sheets and then recording their times of departure after the lights were extinguished. These data indicate that eared moths resume flight significantly sooner than non-eared moths. These two evolutionarily-derived flight defences represent methods of anti-predator spatial isolation that, although protect deaf moths have had their costs in reproductive success.

Assistant: Mark DelCantero

Publications:


DR. M.R. GROSS - Department of Zoology, University of Toronto, Toronto, Ontario.

"Evolutionary Ecology of Fish Reproduction"

For more than a decade my research group has studied the behavioural ecology and reproductive strategies of fish in Lake Opinicon and surrounding waters. With my recent move to the University of Toronto, I requested an expansion of my program at the Station and this was approved by QUBS management. The expansion led to several changes in 1989 including more research personnel and new facilities.

The 1989 research team included myself, Lucy Dueck (Research Assistant), Drs. Tim Ehlinger and Chris Petersen (Post-Doctoral Fellows), Julie Claussen
and Isabelle Cote (Graduate students), Dr. David Philipp and his group from the Illinois Natural History Survey, five field assistants and Peter Scoones (cinematographer from the British Broadcasting Corporation, London and a delightful addition).

We were also visited for academic research by Ian Fleming, John Reynolds and Anna Tolwho from my lab in Toronto to discuss life history evolution and mating systems in fish, and Michael Tlusty, Ph.D. student at Syracuse University, who is embarking on a new study of sunfish coloniality.

Many changes occurred in our facilities. Our "Pool Facility" was constructed, thanks to the arms and backs of all the ones who pitched in to help position the five heavy pools. Rooms #1 and #2 in the Aquarium House were modified with benches and air conditioning, and we started a Daphnia rearing system along the East wall. We improved the storage facilities in the Dive Shop and moved our main laboratory from the White House basement into the Boathouse Lab. Altogether it was a busy year!

"Cuckoldry in Bluegill" (Mart Gross and David Philipp)

In 1989 this research had three objectives. First, to quantify the cuckoldry that occurs in the various bluegill colonies throughout our 2 km study area. David supervised a team of skin divers and recorded intrusions into the nests of several hundred parental male bluegill during their spawning. Second, to determine if nests were invaded, David and Mart collected eggs from nests in which intrusions had occurred. The fry were frozen for DNA fingerprinting in Mart's Toronto lab. Finally, to separate behavioral defense from sperm competition, Lucy and Mart attempted to "sterilize" parental males and then check their nests for successful fertilization. The sterilization experiments will be continued in 1990.

Assistants: Richard Armstrong, Peter Emptage, Dan Schmidt

"Filming Bluegill Sunfish Reproductive Behaviour" (Peter Scoones - BBC, London)

Peter, British cameraman and underwater specialist, spent two weeks at Opinicon filming bluegill reproductive behaviour. The film is to be used by the BBC. David Attenborough is preparing a new television program for the BBC called "Trials of Life", which will be aired in the fall of 1990, and the producer, Marion Lunz wanted a story and film on bluegill. Apparently the Lake Opinicon bluegill are known even to the BBC, and they hoped to include cuckoldry in bluegill as part of their show "Continuing the Line". Peter did such a professional job of filming the life of bluegill and fit in so well with our research group, that we are presenting him the Honourary Bluegill Membership Award. (You are reading it here first, Peter)


This research has several objectives. First, it documents the overall spawning patterns of bluegill within our 2 km study area bordering QUBS (colony locations, seasonality, fry production etc.). The data, first collected in 1985, provide one of the longest continuous records on spawning dynamics for any fish population. Second, it determines the frequency of desertion and
renesting by males, including who, why, when and where this occurs. One of the surprising results of this study is that few males renest during the summer even though each spawning bout lasts less than ten days. Finally, it provides an experimental test of energy limitations underlying desertion and renesting. To influence current and future decisions regarding parental investment, we are providing food supplements to nesting males. The investment decisions of fed males from 1989 will be compared with the unfed controls in summer of 1990.

Isabelle Cote - "Evolution of Colonial Breeding" - Ph.D. Thesis

Bluegill sunfish generally nest in dense colonies of up to 200. However, a small percentage of males nest solitarily. To understand the evolution of colonial breeding, an investigation of costs and benefits of breeding solitarily and in colonies of various sizes was started in 1988 and continued in 1989. It appears that colonial males, particularly males in central positions suffer less egg predation and fungal infection than solitary males. Fungal infection has not previously been identified as a major selective pressure on colonial breeding, and in 1990 it will be studied in greater detail.

A preliminary experiment in the new pool facility involved the distribution patterns of male pumpkinseed and bluegill during nesting. In the homogeneous environment of the pools, pumpkinseed showed an overdispersed nesting pattern and we therefore conclude that they are non-colonial breeders. The bluegill, which had been manipulated by selective feeding, unfortunately did not nest. This and other experiments will be repeated in the pools in 1990, and with a new handling design, successful bluegill nesting should occur.

Assistant: Karen Haberman

Dr. Tim Ehlinger - "Trophic Polymorphism in Bluegill Sunfish" - NSF Post-Doctoral Fellow

Based on his 1988 results, and a two-year NSF Postdoctoral Research Fellowship, Tim expanded his studies to include the morphology of cuckold and parental males and females in Clear and Mosquito Lakes as well as Lake Opinicon. This inter-lake field study provides information on the evolution of morphologies in different ecological settings, and parallels the within-lake studies at Opinicon. Tim also experimented with predation risk to cuckolders using the new pool facility, and with the foraging behaviour of cuckolders using room #2 of the Aquarium House. Further information can be found under Ehlinger.

Assistants: Karen Haberman and Dan Schmidt

Dr. Chris Petersen - "Parental Care Decisions in Bluegill Sunfish: Reproductive Value and Offspring Relatedness" - NATO Post-Doctoral Fellow

This was the first year in a two-year study to investigate two aspects of parental decision-making in bluegill sunfish, a species with paternal care of eggs and fry. In one experiment, clutch sizes were reduced to varying levels in nests of parental males to determine if males that had higher expectations for future reproductive success (either because they had larger initial clutches or were older, larger males) would be more likely to abandon clutches than
males with lower future expectations. First-year results indicate that initial size of the clutch, and not the size of the male, was used as a basis of parental abandonment decisions. In the second experiment, the genetic relatedness of a male to the clutch he was guarding was increased by reducing intrusions of smaller cuckolding males with a small fence that reduced male intrusions but did not affect female visitation rate to the nest. It was predicted that males with increased probability of genetic relatedness to their offspring would increase their level of parental investment to these broods. However, preliminary results indicate that males do not change behaviour based on the number of male intrusions during spawning.

Both projects will be continued and hopefully completed during the 1990 bluegill spawning season.

Assistant: Markus Schmidt

Publications:


DRS. LAWRENCE D. HARDER and SPENCER C.H. BARRETT (Department of Biological Sciences, University of Calgary and Department of Botany, University of Toronto, respectively)

"The Role of Floral Morphology in the Dispersal of Pontederia cordata Pollen"

The showy flowers of most outcrossing, animal-pollinated angiosperms serve two major functions: to attract pollinators and to promote the movement of pollen between plants. Most flowering plants are hermaphrodites and hence can contribute genes to offspring through either male (pollen dispersal) or female function (seed production). However, enhancement of paternal success seems to have dominated the evolution of floral morphology, in part because seed production is often constrained by the availability of resources, rather than pollen.

Our research project considers the extent to which variation in pollen dispersal depends on floral morphology. Heterostylyous plants, such as Pontederia cordata, are ideally suited for such a study, because populations comprise three morphs which differ in stamen and style characteristics, but not in corolla characteristics. This project includes two parts: a detailed study of pollen removal from Pontederia flowers by two generalist bumblebees (Bombus impatiens and B. vagans) and a specialist anthropophilic bee, Melissodes apicata; and an assessment of pollen dispersal between morphs. The pollen removal study (field work completed during August 1989) will provide information on the pattern of pollen removal during first, second, etc. visits, which is necessary
to predict the extent of successful pollen dispersal resulting from all pollinator visits. The dispersal study addresses the question "how much of the pollen leaving a flower during a single pollinator visit reaches the stigmas of other plants?"

We measure pollen removal by subtracting the number of pollen grains in a flower after a bee visit from the number of grains produced by adjacent, unvisited flowers on the same inflorescence. To measure pollen dispersal we take advantage of the production of different-sized pollen by the three possible stamen types in a Pontederia flower. This study involves coaxing a bee to visit flowers on a donor inflorescence with one size of pollen and then visit 30-50 flowers of recipient inflorescences which do not produce pollen of the same size as the donor's. This latter study began in 1989 and will continue in 1990.

Assistant: Michael Vander Meulen, Josh Kohn and Sean Graham

DR. R.S. MILLER - School of Forestry, Yale University

"Behavioural Ecology of Hummingbirds"

Drs. Glenn Morris and Darryl Gwynne - Erindale College of University of Toronto, Mississauga

John Tuckerman - Mate Preference in the Curve-tailed Katydid, Scudderia curvicauda - M.Sc. Thesis

Scudderia curvicauda is unusual among Orthopterans since the female of this species possesses a tick-like acoustic signal with which she responds to male song. Males are only able to locate females through the use of this female response. My previous work in 1988, which was also carried out at QU8S, demonstrated that songs of different males varied in the lengths of the song phrases which make up a complete male song. I found that larger males produced songs containing longer phrases. This past summer I used playback tapes to test a female's preference for songs containing phrases of different lengths. Songs on the playback tape were constructed from the song of one male so that the only variable being tested was that of phrase length. I found that females preferred songs containing longer phrases since they answered those phrases more often and with more ticks. By looking at the female response to specific phrases over time, I was also able to demonstrate that females employ a falling threshold mate choice strategy. In this type of strategy, females initially are very choosy, only responding to the longest phrases. With time, however, they will respond to shorter phrases produced by smaller males.

DR. D. P. PHILIPP - Center for Aquatic Ecology, Illinois Natural History Survey, Champaign, IL

"Bluegill Reproduction Studies"
Our group at the Illinois Natural History Survey has continued its collaborative efforts with Dr. Mart Gross and his research team at the University of Toronto to study a number of aspects of bluegill reproduction. The bulk of our studies center on assessing the genetic, physiological, and environmental factors which may influence alternative reproductive behaviors among male bluegill. During 1989, these studies included a large scale field study involving underwater visual assessments of spawning activity in Lake Opinicon. The objectives of this study were to quantify cuckold intrusion frequencies in many colonies throughout the study site and throughout the breeding season, and to use electrophoretic methods to compare these frequencies with fertilization success. In addition, at our INHS facility we have continued selective breeding experiments designed to construct all-parental and all-cuckolder strains of Lake Opinicon bluegill.

Assistants: Mark Kubacki, Davey Philipp, Mike Ward, Krista Watson, Dan Schmidt, Richard Armstrong, Peter Emteage

"Largemouth/Smallmouth Bass Reproductive Success"

In 1989, we initiated a preliminary study to assess the impact of presea-son catch-and-release fishing on the reproductive success of largemouth and smallmouth bass. This study involved daily underwater observation of the nesting, spawning, and parental care behavior of these two species in a 2km study site in Lake Opinicon. We assessed the number of hook wounds incurred by male bass and how that affected their ability or willingness to guard their broods. All techniques needed to conduct a more in-depth, controlled study over the next three years were perfected.

Pawel Kindler - "Hormonal Analysis of Male Bluegill during the Spawning Season" - Ph.D. Thesis

Pawel has developed the radioimmune assay (RIA) techniques to quantify hormone levels in the sera of male bluegill. Using this technique, Pawel has determined the pattern of production among male bluegills throughout the annual cycle and for various hormones during the spawning season in detail. In addition, during 1989, Pawel conducted a series of experiments in which he manipulated prolactin levels among parental male bluegill through exogenously implanted pellets. Behavioral observations of the ensuing spawning and parental care activities were then made to determine effects of these treatments.

Blake Konkle - "Interspecific Hybridization of Bluegill and Pumpkinseed" - Ph.D. Thesis

Blake is using a combination of field and laboratory studies to assess not only the extent of hybridization that occurs between these two sunfish species in Lake Opinicon, but also how and why it occurs. In 1989, he continued his lakewide population sampling during both pre- and post-spawning periods using a standardized quantitative electrofishing protocol. In addition, based upon his earlier finding using mtDNA analysis that hybrids were formed between pumpkinseed females and bluegill males, Blake instituted an in-depth underwater behavioral study to determine which individuals were involved.
Publications:


DR. DAVID SHERRY - Department of Psychology, University of Toronto

Christine Hitchcock - "Communication and Social Organization of Black-capped Chickadees" - M.Sc. Thesis

DR. BRUCE P. SMITH - Department of Biology, University of New Brunswick.

"Water Mite Parasitism of Aquatic Insects"

In 1989, I continued research on the influence of differential parasitism by mites on two species of water strider. Gerris comatus carries a nine-fold heavier burden of larval Limnochares aquatica than does Gerris alacris, both in nature and in laboratory infestations. The two species of water strider co-occur in shoreline habitats during spring, but G. comatus disappear from shorelines in early summer, just before the period of intense parasitism by L. aquatica. During the summer months, Gerris comatus can only be found on offshore mats of floating vegetation.

My hypothesis was that parasitism is more severe in shoreline habitats, and that G. comatus minimize parasitism by moving offshore. In one experiment, first instar G. comatus were maintained in cages on offshore mats of floating vegetation and in shoreline habitats. In three trials of 8-10 cages per treatment, caged insects were significantly more heavily parasitized in shoreline habitats than in offshore habitats, and mortality was proportional to infestation by mites. I also suggest that parasitism is negatively correlated with reproductive success. To test this, single and in copulo water striders were collected from a natural population. Both genders were significantly less heavily infested when collected as copulating pairs than when collected singly, and there was a significant positive correlation in number of mites on males and females caught in copulo. In 1990, I intend to test whether parasitism is the cause of reduced mating frequency, or whether both parasitism and reduced mating activity are actually indicators of reduced vigour or greater age.

Assistant: Vicky Morin

In 1989, research continued on the interaction of the mite *Limnochares americana* with a community of dragonflies. Adult dragonflies at Hebert Bog were censused and examined for the presence of mites. An intensive mark-recapture study was conducted on the small libellulid, *Leucorrhina frigida*, to determine the distributional patterns of the mite on this species. Adhesive traps were used to determine the spatial and temporal distribution of host-seeking larval mites, which was then correlated to changes in intensity of parasitism among dragonflies.

Abundance of parasitic mites could be correlated with inter- and intraspecific differences in behaviour. Species of dragonflies that spend most of their time perching are much more likely to be hosts than those that spend most of their time flying, because the mites locate hosts by climbing emergent vegetation. Territorial male *L. frigida* spend 95% of their time perching on marginal vegetation, defending reproductive territories, and carry the vast majority of larval mites. Females and teneral males spend most most of their time perching on inland vegetation, and have very few mites.

Publications:


DR. S.P. VANDER KLOET - Department of Biology, Acadia University

"Demography of *Vaccinium corymbosum* in the Hebert Bog"
"Mate Choice and Sexual Selection in Red-Winged Blackbirds"

This long-term project has two general objectives. The first is to use molecular biological techniques to determine the "genetic" mating system of red-winged-blackbirds. This species has been the focus of many mate choice and sexual sexual selection studies and to date, no one has successfully explained how females choose their mates and therefore the factors responsible for the high level of polygyny observed. It is possible that the "phenotypic" mating system (in who's territory a female nests) may poorly reflect with whom females mate. By collecting blood from all breeding birds and their offspring, our intention is to use the DNA from the blood to determine the rates of cuckoldry and the factors that influence those rates. Related to the question of mate choice, the second objective of this study is to test the Hamilton and Zuk parasite hypothesis of sexual selection. By collecting blood smears for parasite analysis, we will be able to determine whether a male's parasite load influences either its plumage or behaviour and in turn, whether these influence female mate choice.

Collaborators: Dr. Lisle Gibbs and Dr. Peter Boag (Queen's)
Dr. Gordon Bennett (Memorial)

Assistants: Drew Hoysak, Kit Muma, Peter Hurd, Mike Ohh

"Ecology and Behaviour of Black Rat Snakes"

In 1989 we completed our ninth summer of study on the local black rat snake population. Although the detailed radio-telemetry studies were completed several years ago, the long term goals are to examine basic features of the population such as age and sex structure, mortality patterns, rates of reproduction, etc. This information is relevant to monitoring this rare species and to understanding basic ecological principles regarding factors influencing sexual dimorphism and geographical ranges. These goals are being met by marking and measuring all black rat snakes encountered each summer at the Biological Station.

Assistant: Ian Robertson

"Thermal Constraints on Northern Water Snake Behaviour"

This study built on the research conducted by Ian Robertson for his B.Sc. thesis. In addition to collecting further data on habitat selection relative to thermoregulatory considerations, we assessed how the snakes' anti-predator behaviour was affected by water temperature. Contrary to our prediction, water snakes did not vary flight distance from an approaching observer with water temperature, even though swimming speed declined with body (and thus water) temperature. Water snakes did vary their escape behaviour with the height of their basking site.

Assistants: Ian Robertson, Frances Barry
Dave Shutler - "Rules of Territory Acquisition by Red-Winged Blackbirds" - Ph.D. Thesis

In 1989, I completed a second summer of research on red-winged blackbird floaters. I tested whether owners were morphologically or competitively superior to floaters, but found limited evidence to support this hypothesis. A second aspect of the research was to use radio-telemetry to test whether floaters wandered randomly, or whether they endeavoured to restrict themselves to visiting a few territories. My data suggest that they wander extensively, but this may simply be because available territories are widely spaced. Additional experiments are planned for 1990.

Assistant: Frances Barry


Colour bands used to identify individual birds have been shown to influence behaviours such as mate choice in several field studies, but these data have been correlative rather than experimental. To assess the possibility of such an effect in red-winged blackbirds, an experiment was conducted in which half the territorial males were banded with black bands and half were banded with red bands. Red-banded males were significantly more likely to lose their territories, apparently due to increased aggression from neighbours. Furthermore, red-banded males that lost their territories had larger epaulettes than those that retained their territories, indicating that the red bands are interacting somehow with the red epaulettes. Additional experiments are planned for 1990.

Assistant: Frances Barry

Peter Hurd - "Consumption vs. Disposal of Fecal Sacs by Passerines" - B.Sc. Thesis

Parent passerines keep their nests sanitary by removing their nestlings' feces, which are conveniently produced encompassed in a mucous sac. To determine why fecal sacs are sometimes eaten by the parents and at other times carried away from the nest and dropped, detailed observations of nest sanitation behaviour were made for American robins, red-winged blackbirds and tree swallows. In addition, fecal sacs were collected from nestlings of all ages from these three species to determine energy content by microbomb calorimetry. In all three species, parents ate fewer sacs and carried away more as nestlings got older, despite increasing caloric content of the sacs. The results indicate that as nestlings get older, the cost associated with staying at the nest and eating larger fecal sacs outweighs the caloric benefit derived.

Publications:


Thesis:


Note: Weatherhead and Prosper (Canadian Journal of Zoology) paper listed last year was a mistake. There is no such paper.

DR. CAM WYNDHAM - Department of Biology, Carleton University

Robert Fulthorpe -"Bacterial Degradation of Simple Chlorinated Aromatics in a Natural System" - Ph.D. Thesis

Commamonas testosteroni strain BR60 (previously Alcaligenes sp BR60), is a gram negative bacteria harbouring an 85 kb plasmid that in turn carries a 14 kb transposon (mobile DNA element) that encodes for the breakdown of chlorobenzoate. Previous work at QUBS has shown that when this species is introduced to flow through lake microcosms constructed using Lake Opinicon water and sediment, the transposon survives in proportion to the amount of chlorobenzoate added to those microcosms, but not necessarily in conjunction with BR60 itself. Considerable potential for genetic transfer to other bacteria in the indigenous microflora exists. This summer, simple chlorinated aromatic chemicals related to chlorobenzoate were used to dose the microcosms and the survival of the transposon monitored. The breakdown pathway of chlorobenzoate, chloroaniline, chlorobiphenyl and 2,4 diphenoxycetic acid (2,4D) converge after the first two intitial steps and in theory genes instrumental in the breakdown of one can play a role in the breakdown of the others. After 4 months of exposure, tanks
Dr. Peter Siver (Univ. of Connecticut)
Roland Hall (Queen's)
Christine Watters (O.M.N.R.)
Anne Davies
Mike Hart (O.M.N.R.)
Don Franklin
Aaron Schneider
Linda Whittingham (Queen's)
Bob Bell (Queen's - Safety)
Lesley Duke (Queen's - Safety)
Lori Laughland
Trisha Armstrong
Rab Cabral
Anne MacPherson
Jim and MaryAnne Complak
Bodril Hansson
Randy Shenkot
Jeanne Ehlinger
Guy and Laura Morin
Hamish McIntosh (Project DARE)
Sheila Macfie (Univ. of Alberta)
Ron and Susan Vinkle and Family
T. Michael and Winkey Harrison and Family
Catherine Vardy (Queen's)
Christopher Pfaff (U of T)
Doug Menard
Dr. Don Rainnie (Univ. of Prince Edward Island)
Helen Quilliam
Dr. Ron Weir (R.M.C.)
Morgan Hull
Jennifer Smith
Dr. Tom Sherry (Tulane Univ.)
Don Cuddy (O.M.N.R. - Parks Branch)
Dr. Irwin Brodo (National Museum of Natural Sciences)
### Documentation of Research Use of QUBS in 1989

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<td>Total External</td>
<td>469</td>
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<td>GRAND TOTAL</td>
<td>812</td>
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<th>% Queen's</th>
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<td>Total</td>
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<td>GRAND TOTAL</td>
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- User days in teaching activities: 2035 (up 10% over 1988)
- Conference and field trip use: 317
- Other: 930

**TOTAL USER DAYS 1989**: 8733 (up 19% over 1988)

(* up 32% over 1988)
<table>
<thead>
<tr>
<th>Organizer</th>
<th>Function</th>
<th>Number of Participants</th>
<th>Duration</th>
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<tbody>
<tr>
<td>Caroline Tomlin (Queen's-Biology)</td>
<td>Station Reunion</td>
<td>36</td>
<td>Jan 13-15</td>
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<tr>
<td>Dr. R. Harmsen (Queen's-Biology)</td>
<td>Bio 439 (Population Ecology) Weekend</td>
<td>14</td>
<td>Jan 27-29</td>
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<tr>
<td>Dr. R. Harmsen (Queen's-Biology)</td>
<td>Bio 439 (Population Ecology) Weekend</td>
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<td>Feb 3-5</td>
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<td>Mrs. Bark (Queen's-Spanish)</td>
<td>Spanish Club - Spanish Immersion Weekend</td>
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<td>Feb 10-12</td>
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<td>Jocelyne Devi-Leyton (Queen's-Biology)</td>
<td>Yoga Retreat</td>
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<td>March 18</td>
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<tr>
<td>Rose Jones (Lasalle High School)</td>
<td>Grade 13 Environmental Science Field Trip</td>
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<td>April 27</td>
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<td>Dr. Nag (Rideau Trail Ass'n)</td>
<td>Rideau Trail Association Annual Meeting</td>
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<td>Bruce Cameron (Queen's-Biology)</td>
<td>SCUBA Course Checkout Dives</td>
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<td>June 17</td>
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<td>Bob Bell (Queen's-Safety)</td>
<td>Fire Extinguisher Training Course</td>
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<td>July 5</td>
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<td>Colin Gaskell (Ottawa Field-Nat's)</td>
<td>Ottawa Field Naturalists Field Trip and Picnic</td>
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<td>August 6</td>
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<tr>
<td>Dr. M. Brock Fenton (York U.-Biology)</td>
<td>Bat Study Field Course</td>
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<td>August 9-18</td>
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<td>Dr. Robert Montgomery (Queen's-Biology)</td>
<td>Bio 848 Graduate Student Field Course</td>
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<td>Dr. Ed Kott (Wilfrid Laurier U.)</td>
<td>Bio 491 Senior Undergrad Field Course</td>
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<td>Heather Higeth (K.C.V.I.)</td>
<td>Grade 13 Environmental Biology Field Trip</td>
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<td>Sept 19</td>
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<td>Bio 339 (Limnology) Field Trip</td>
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<td>Sept 22-24</td>
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<td>Rose Jones (Lasalle High School)</td>
<td>Grade 13 Environmental Biology Field Trip</td>
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<td>Adele Mullie</td>
<td>Bio 202 (General Ecology) Field Trip</td>
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<td>Roger Lupton (Lasalle High School)</td>
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<td>Ross Hawkins (South Crosby Public School)</td>
<td>Grades 7-8 Pond Ecology Field Trip</td>
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<td>Dr. P. Duprey (Queen's-Art)</td>
<td>Art History Field Trip</td>
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<td>Oct 13-14</td>
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<td>Adele Mullie</td>
<td>Bio 202 (General Ecology) Field Trip</td>
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<td>Bill Hardy (O.M.N.R.-Brockville)</td>
<td>James Auld Waterway Forum Planning Meeting</td>
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<td>Oct 18</td>
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<td>Date</td>
<td>Speaker</td>
<td>Institution</td>
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<td>May 11</td>
<td>Dr. Patrick Colgan</td>
<td>Department of Biology, Queen's University</td>
<td>&quot;Current Issues in Animal Communication&quot;</td>
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<td>May 23</td>
<td>Dr. Kenneth Storey</td>
<td>Department of Biology, Carleton University</td>
<td>&quot;Life below 0°C: Freezing Tolerance in Vertebrates&quot;</td>
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<td>May 23</td>
<td>Terence Dickinson</td>
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<td>&quot;Introduction to Astronomy and Cosmology&quot;</td>
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<td>May 24</td>
<td>Dr. David Philipp</td>
<td>Illinois Natural History Survey</td>
<td>&quot;Fish Genetics and Fisheries Management&quot;</td>
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<td>May 24</td>
<td>Dr. Katherine Wynne-Edwards</td>
<td>Dept. of Physiology, University of Kansas Medical Centre</td>
<td>&quot;Interactions between Field Observations of Social Behaviour in Soviet Asia and Behavioural Physiology in the Laboratory in Dwarf Siberian Hamsters&quot;</td>
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<td>May 30</td>
<td>Dr. Nigel West</td>
<td>Dept. of Psychology, University of Saskatchewan</td>
<td>&quot;The Control of Intermittent Breathing and Pulmonary Bloodflow in Amphibians and Turtles - Tadpoles, Toads and Turtles&quot;</td>
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<tr>
<td>June 1</td>
<td>Dr. Tillman Benfey</td>
<td>Ministry of Agriculture, Fisheries and Food</td>
<td>Fisheries Lab., Lowestoft, Suffolk, G.B.</td>
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<td>June 1</td>
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<td>&quot;The Use of Triploid Fish for Research and Aquaculture&quot;</td>
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<td>June 2</td>
<td>Dr. Richard Playle</td>
<td>Department of Biology, McMaster University</td>
<td>&quot;Physiological and Toxicological Effects of Aluminium: From Whole Lake Manipulations to Effects on Individual Fish&quot;</td>
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<td>June 6</td>
<td>Dr. Glen vander Kraak</td>
<td>Department of Zoology, Univ. of Guelph</td>
<td>&quot;Applications of Endocrine Techniques in Aquaculture&quot;</td>
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<td>June 8</td>
<td>Dr. Bruce Tufts</td>
<td>Department of Biology, Dalhousie University</td>
<td>&quot;Blood Gas Transport in Migrating Fish&quot;</td>
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<td>June 21</td>
<td>Mark Forbes</td>
<td>Department of Zoology, Erindale College of U of T</td>
<td>&quot;Mating Success of Male Enallagma ebrium: Are Ectoparasites Important?&quot;</td>
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<td>June 28</td>
<td>Mike Ward</td>
<td>Department of Biology, Humboldt State University</td>
<td>&quot;Ecology of Summer Steelhead in the Middle Fork Eel River, California&quot;</td>
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<td>July 5</td>
<td>Dr. Tim Ehlinger</td>
<td>NSF Post-Doctoral Fellow</td>
<td>&quot;Adaptive Phenotypic Variation in Bluegill: The Relationship between Morphology and Behaviour&quot;</td>
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<td>July 10</td>
<td>Dr. Allen Keast</td>
<td>Department of Biology, Queen's University</td>
<td>&quot;Africa: Biogeography and Evolution of Fauna&quot;</td>
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</table>
July 13  Wallace Rendell - Department of Biology, Queen's University
"The Galapagos"

July 19  Karen Metz - Department of Biology, Carleton University
"Leg Bands as Signals in Red-winged Blackbirds"

Ian Robertson - Department of Biology, Carleton University
"Water Snakes: Temperature Probes and Thermoregulation"

July 26  Peter Hurd - Department of Biology, Carleton University
"A Cost-Benefit Analysis of Fecal Sac Removal in Birds"

Caroline Tomlin - Department of Biology, Queen's University
"Brood Division in Tree Swallows ?"

July 28  Tarmo Poldmaa and Karen Holder - Dept. of Biology, Queen's Univ.
"Arctic Visions"

August 2  Lisa Venier - Department of Biology, Queen's University
"Copulation Behaviour of the Tree Swallow: Paternity Assurance
   in the Presence of Sperm Competition"
Fee Schedule for 1990

**Board Charges** - Meals only

$390/month/person - no obligation for chores
$270/month/person - includes obligation for chores on a rotating schedule

**Accommodation Charges** - Housing only

$15/month/person - Dormitory (White House and Curran Cottage)
$30/month/person - Small Cabin (cabins 1-7, 10 and shaker)
$60/month/person - Medium Cabin (cabins 12,13,14)
$80/month/person - Large Cabin (cabins 8,11 and White House Apartment)
$110/month/person - Cottage (Keast, Earl or Sumac)

**Room and Board Rates for Short-Term Visitors**

$145/person - weekly R&B for field courses - includes lab fee
$20/day/person - 24 hr. room and board
$3.75 - breakfast or lunch only
$7.25 - dinner only
$8.50/person - overnight accommodation - academic purposes - Queen's
$14.00/person - overnight accommodation - academic purposes - non-Queen's
$14.00/person - overnight accommodation - non-academic purposes - Queen's
$22.00/person - overnight accommodation - non-academic - non-Queen's

**NOTE**
Fees for groups and conferences are negotiated directly with the Manager or the Director

**Boat Rental**

$175/month, $80/week - includes maintenance from normal use - gas and oil not included

$37/day - includes gas and oil for one day rental

**Bench Fees**

$4.20/day - non-Queen's staff or major researcher (M.Sc. or Ph.D. candidate, project coordinator or PostDoctoral Fellow)

$1.45/day - each non-Queen's assistant

If sufficient research funds are not available, bench fees may be waived or reduced upon written application to the Director