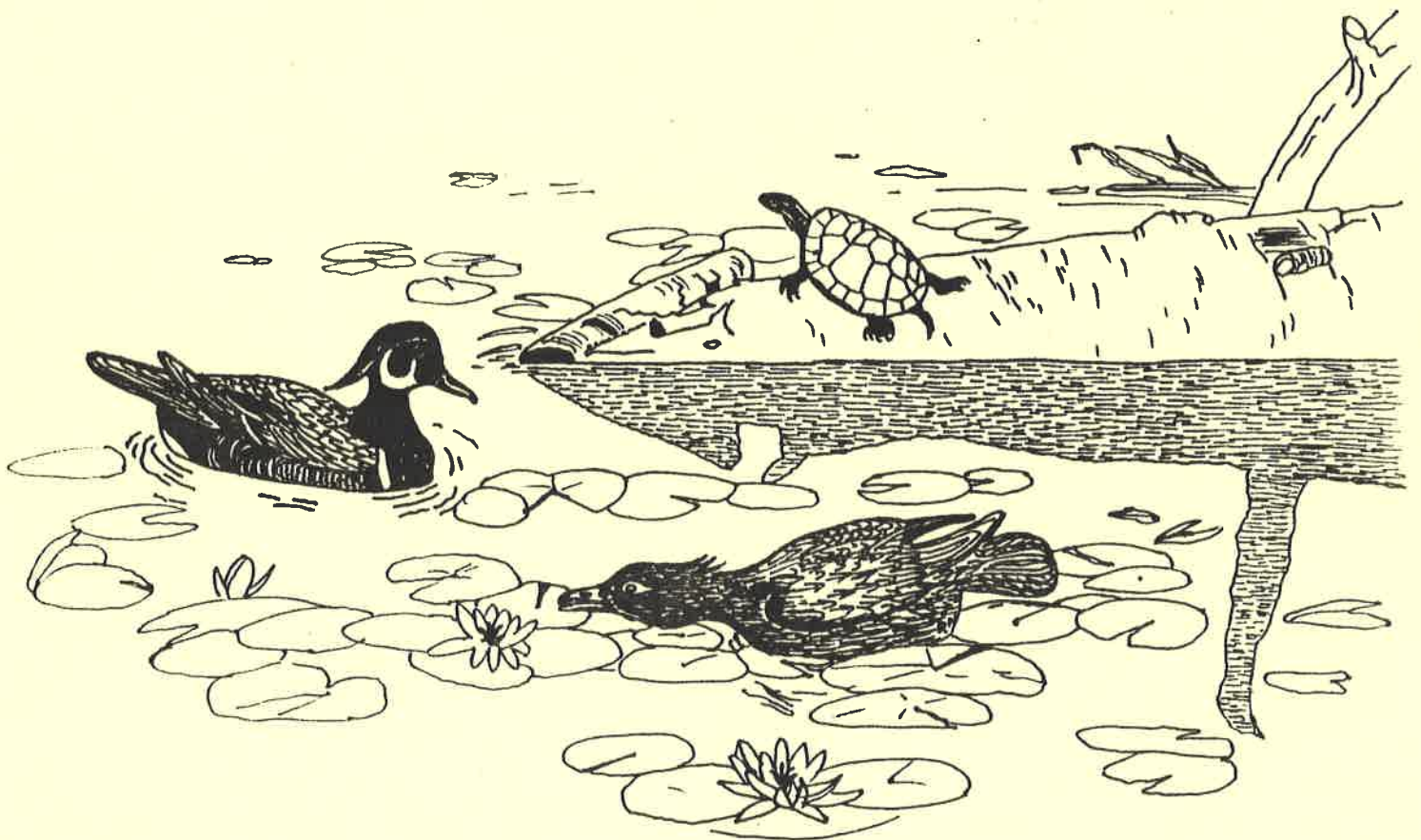


Queen's University Biological Station

Annual Report and Newsletter

1991



Director: Dr. Raleigh J. Robertson

Manager: Frank J.S. Phelan

Introduction

Nineteen ninety-one was another successful and busy year at Queen's University Biological Station. User-days were up by 3% over 1990 levels (User-day data are displayed in tabular form later in this report). On average, 37 researchers (professors, graduate students, honours students and assistants) were in residence throughout the summer (up from 36 in 1990). Abstracts of research projects and personnel involved are contained in the following pages.

In teaching activities, QUBS hosted seven modules, including six full-time, and one (Bats and Caves - Fenton) part-time in the Ontario Universities Program in Field Biology. Titles and enrolments for modules held at QUBS and for the OUPFB program in general are found in Tables 1 through 3. In addition to the modules mentioned above, Dr. Ed Kott (Wilfrid Laurier University) brought his field course for senior undergraduates to QUBS for two weeks in late summer. The thirteenth edition of the Naturalist's Workshop, described in more detail later in this report, was held in May.

In 1991, QUBS hosted both Dr. George Eickwort (Cornell) and Dr. Michael Clarke (McGill) under the Visiting Field Scientist Program. Details of these visits are found in a separate section later in this report.

In 1991, there were several small conferences and workshops held at the field station. In April, QUBS hosted a two-day 'Northern Lights' conference, a Leeds and Grenville Counties program on environmental topics aimed at Elementary and Secondary School students. This was a thoroughly enjoyable and novel experience for QUBS staff. Frank and Floyd offered a module within the program entitled "microclimate and adaptation".

The Biological Station continues to be an important facility for a variety of field trips, especially those associated with fall and winter term field 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 1991 appears later in this report.

In recognition of their generous donation of equipment to the field station, QUBS held a Hewlett-Packard Appreciation Day on June 27. Hewlett-Packard representatives, university officials and station users were present for a brief expression of thanks to Hewlett-Packard. A tour of the environmental monitoring and computer network system was conducted along with a tour of QUBS facilities and properties. Details of this event are found in a separate section later in this report.

Despite some initial difficulties with the big 386 computer, and problems with lightning at the weather tower, this fall we were able to get the system revamped and up and running. The computer now automatically interrogates the weather station

and all of the leads have been repaired or replaced. New guy wires and a large lightning rod were added to the weather tower and the micrologger moved further from the tower and all leads from the tower to the micrologger routed through junctions with fusible links. Hopefully, this will keep the system operating without meltdown. A new float system for the water temperature leads was devised and tested this summer. Preliminary results are good - a few refinements and the water sensors should be dependable. The data/word processing portion of the computer system has been getting a workout this fall and winter. With the exception of a basic data analysis package, software for most applications (Wordstar, WordPerfect, Lotus, Freelance, DBase) are available on the machines. The laserjet printer is a delight to use and produces excellent quality print and graphics.

Just recently, QUBS purchased a FAX machine. This is now housed in the collections room of the Brown Lab. Despite assurances to the contrary, it was necessary to have a separate phone line installed for it to work effectively. The number is 359-6558. This should be a boon to our senior researchers, facilitating instant information transfer.

In 1991, a number of changes and improvements were made to QUBS facilities. These included: (1) A new lawn tractor was purchased for the purposes of grounds maintenance. We no longer have to abuse the old mower, more apt for suburban lawns than our acreage. (2) Over the course of the year, all of the docks were rebuilt in the tip-up style. It takes but a few minutes to take out (or put in) all the docks and minimal effort. What a change from the onerous task of previous years! (3) After several episodes of miring down the big tractor, new rubber was installed on all four wheels. This change, albeit expensive, has facilitated several projects - we haven't been stuck yet! (4) In spring, the Rappinicon was sandblasted to remove all the paint. It was reprimed with a quality primer and fully repainted. The old Tremclad-based paint job was not very good, peeling off and exposing metal after only a single season. Hopefully, the new paint will be more durable. Inspection after haulout this fall showed that only minor touchup should be necessary in spring. (5) A new deck extension was fabricated for the Rappinicon. This greatly reduces splash on the main deck and adds extra deck space for sampling. (6) The engine of the Rappinicon was completely rebuilt in spring. Finding a 1964 Buick engine adapted for marine purposes was no small feat. After months of trying, another engine was found, reconditioned, and installed for the 1991 season. Despite some minor outdrive problems, the engine itself worked flawlessly this season. (7) Floyd moved into the newly-constructed Assistant Manager's House in April. With the exception of the cement block work, trowelling the cement floor and drywall finishing, Frank, Floyd and Dave did all of the construction work. This project was entirely funded from the QUBS trust. There are still finishing touches to apply, but the new building is fully serviceable and comfortable. (8) In summer, the pink bathroom in the White House was gutted and a new fibreglass shower stall installed. In addition, in both upstairs bathrooms in the White House, new, high-velocity ventilating fans were installed, operated by timers.

Both bathrooms received new paint on the ceilings and walls. (9) In Keast Cottage, the old tub enclosure was removed and a new one installed. The old tileboard had buckled and come loose from the walls. (10) In fall, the old walkway into the Boathouse was removed and replaced. The new walkway is cedar, much stronger than the old one and provides a little more headroom under the walkway than did the previous model. This might reduce the risk of head-banging in that area. (11) A few more bunks were removed from cabins and rebuilt. This refurbishment will continue until all bunks in cabins have been changed. (12) The compressor for the main lodge refrigerator finally gave up the ghost after some 40 years. The new compressor was mounted outside, enabling more useful area in the rear of the lodge and ensuring quieter mealtimes - no more clattering of the old compressor on hot summer days. (13) In spring, some extensive welding repairs were done on Dinah Moe Humm, our 24' pontoon boat. These repairs were necessitated by metal fatigue of many of the welds between the pontoons and the superstructure. At the end of last season, one of the pontoons was one-third full of water. After the 1991 season, the pontoons were still watertight.

1991 may be remembered as the year of the composting caper. Partly in response to the limitations on waste imposed by the Township, residents at QUBS were faced with reducing the overall amount of waste. The alternative is to pay \$1 for each bag of garbage over and above 200 - new regulations impose this waste limit on landfill garbage from QUBS. Compostable material makes up a considerable proportion of the waste stream (studies document from 20% to 50% by weight of all waste), so it is reasonable to divert this from landfill, creating a reusable fertilizer or soil conditioner in the process. With this intention, a compost duty was created, with all QUBS regulars participating. This has turned out to be an inglorious task and our system of burial leaves something to be desired. Presently, the plan is being revamped. If we are to continue, we need a simpler system, a varmint-proof repository and a location which will not attract animals to the vicinity of experiments or aviaries. Hopefully, we will have a new system in place for 1992. This is a worthwhile project - we haven't hit on the appropriate methodology just yet.

In 1991, Parks Canada - Rideau Canal, via Canal Superintendent, Mr. John Bonser, provided free canal passes to the field station for both of our pontoon boats. This generosity is greatly appreciated and facilitates our study of a variety of water bodies in both teaching and research initiatives.

The field station was the subject of several media articles in 1991. However, perhaps the biggest single item was the publishing in the Whig-Standard Weekend Magazine of February 1, 1992, the history of the Biological Station titled "The Laboratory on the Lake". This article is an excerpt from the book **Queen's Biology: An Academic History of Innocence Lost and Fame Gained**, the history of Queen's University Department of Biology by Drs. Bev Smallman, Harold Good and Al West. The book is due to appear very shortly. It is far from a dry citation of historical fact,

if the section on the field station is representative of the whole. Copies of the book are available from the general office at the Department of Biology, Queen's University.

Through the Principal's Development Fund, QUBS was the recipient of ten quality dissecting microscopes. These will be available for teaching and research use at the field station, greatly reducing the necessity of transporting microscopes back and forth from university to field station. Presently, storage cabinets are being remodelled for ultimate installation in the rear of the Brown Lab conference room.

The Open House was held on July 14 in 1991. As usual, there was a good turnout from the area. In all, some 275 visitors toured the displays of current research topics. A hearty thank you is well-deserved by all the QUBS regulars for their efforts in making this an annual success. The 1991 version (eleventh edition) of the Community Newsletter was distributed in early July to 700 households and cottages in the vicinity of Chaffey's Lock, Elgin and Perth Road Village. Both of these public relations efforts are important in maintaining contact with the neighbouring community. It is encouraging to witness the increasing involvement of the community in activities at the field station. QUBS has truly become a valued part of the local community.

In the continuing development of relations between the field station and interested individuals, groups and organizations, the initial foundations of a new organization have been laid. The brainchild of Adele Crowder, Raleigh Robertson, Floyd Connor, Frank Phelan and Nasrene MacDonald, this new organization will be titled **Friends of Opinicon**. This embryonic organization is visualized as fostering involvement in activities of the field station and its locality with alumni, current researchers, participants in past workshops and field courses, local service groups and organizations with interests in environmental issues. **Friends of Opinicon** may become an outreach arm of the field station, offering activities for members, information transfer about activities at QUBS, items of local interest on an environmental theme and providing a means of interaction with anyone having parallel interests. Keep watch for developments in 1992. Nasrene MacDonald has agreed to become the coordinator of the **Friends of Opinicon** and will be largely responsible for its development. Please provide suggestions for avenues of operation and advice concerning its functioning. We want you to become involved.

Dr. Raleigh Robertson organized the seminar series at QUBS in 1991. The Visiting Field Scientist seminars are always a highlight of this series. In general, the seminars are an interesting facet of life at the field station, providing a forum for the expression of ideas and allowing interchange between researchers on an interesting array of biological topics. The list of speakers and topics appears in tabular form later in this report.

Since inflation rates have been substantially lower in 1991 than in recent years,

and since there is likely to be severe restraint during these recessionary times, we have decided to freeze most fees for 1992. The only change made in 1992 fees over 1991 fees is in the charge for field courses. This is to enable the inclusion of a charge for course supplies within the field course fee. The new fee schedule for 1992 appears on the last page of this report.

We are attempting to keep a current list of theses and publications emanating from research carried out at QUBS. This is especially important when applications are made for funding. Please forward copies of theses (we will have them bound as necessary) and publications (or at least citation of same) as they become available. It is hoped that QUBS can develop a comprehensive collection of these publications for ready reference.

The operation of the field station owes its success to the contributions made by and cooperation of its staff. Many thanks to Floyd Connor, Assistant Manager at QUBS, for his continuing contributions to maintenance, research and teaching programs at the field station. Thanks also to Dave Fleming for his efforts as maintenance assistant in 1991. A special thank you to our kitchen staff for their fine food in 1991 - Diane Coutts, Marg Phelan and Rhonda Wilson.

On October 3, 1991, Julie Grace Weatherhead was born. Congratulations to parents Dr. Pat Weatherhead (Department of Biology, Carleton University) and Karen Metz, two longtime QUBS regulars.

On November 10, 1991, Thomas Howard Boag, the most recent addition to the Boag/Ratcliffe clan was born. Congratulations to parents Drs. Peter Boag and Laurene Ratcliffe (Department of Biology, Queen's University).

In late summer, one of our neighbours and friends, John MacDonald, passed away. John will be remembered for his interest in field station matters, the many discussions of politics and other heady topics and his graciousness in all his dealings with people. Our sympathies to his family, especially to his wife, Nasrene.

The cover sketch was provided by Richard Norman, a QUBS alumnus who now resides in Quebec, making a living at his art, especially decoy carving. Merci, Richard.

This report is printed on recycled paper.

Table 1: Summary of course credits in the Ontario Universities Program in Field Biology earned at Queen's University Biological Station in 1991.

Module Topic	Professor and Affiliation	Dates	Credit/ Student	Q	C	Y	B	W	Wo	Wi	Tr	To	Total Students/ Module	Total 1/2 crse credits
Acoustic Communication in Birds	Raccliffe (Q)	Apr 28-May 4	1/4	6	1	1	-	-	-	2	-	-	10	5
Vertebrate Reproductive Physiology	Wyrne-Edwards (Q)	May 12-18	1/4	4	-	2	1	-	1	-	1	1	10	5
Plant Sex	Shore (Y)	Aug 25-31	1/4	1	1	6	1	-	-	-	1	1	11	5.5
Small Mammals	Boag (Q)	Aug 25-31	1/4	1	1	1	2	-	2	-	1	2	10	5
Pollination Ecology	Montgomery (Q)	Sept 1-7	1/4	2	2	3	-	-	2	-	-	1	10	5
Limnology	Zeeb, Duff & Agbedi (Q)	Sept 1-7	1/4	1	-	1	1	-	1	-	1	2	7	3.5

Total Number of Student-Weeks
Half-course Credits

15 5 14 5 - 6 2 4 7 58 -
7.5 -2.5 7 2.5 - 3 1 2 2 3.5 - 29

NOTE:

Q = Queen's
C = Carleton
Y = York
B = Brock
W = Western
Wo = Waterloo
Wi = Windsor
Tr = Trent
To = Toronto

Table 2: Summary of course credits in the Ontario Universities Program in Field Biology earned at locations other than QUBS in 1991.

Module Topic	Professor and Affiliation	Dates	Location	Credit/ Student	Q	C	Y	B	W	Wo	Wi	Tr	To	Total Students/ Module	Total 1/2 course credits
Desert Ecology	Handford (W)	Apr-May	Arizona	1/2	3	1	-	-	4	1	-	-	3	12	12
Field Ornithology	Parsons (To)	May 18-Jun 1	Georgia	1/2	1	2	2	1	-	1	-	-	12	19	19
Arctic Climatology	Weis (Wi)	Jun 1-15	Great Whale P.Q.	1/2	1	1	-	-	1	-	9	-	2	14	14
Marine Developmental Biology	Bates (C)	Jun 2-15	Huntsman	1/2	1	1	1	-	1	-	-	-	4	8	8
Bat Ecology	Fenton (Y)	Aug 6-16	S.Ontario	1/2	-	-	3	-	-	-	-	-	1	4	4
Great Lakes Biology	Halfner (Wi)	Aug 18-31	Windsor	1/2	6	-	1	-	3	1	-	1	2	14	14
Marine Biology	Malloch (To)	Aug 19-Sep 1	Huntsman	1/2	7	1	-	-	-	1	-	-	11	20	20
Alpine Ecology	Miller (W)	Aug 23-Sep 7	Alberta	1/2	8	-	-	-	3	1	-	1	2	15	15
Terrestrial and Freshwater Biology	Eckenwalder (To)	Aug 23-Sep 7	Dorset	1/2	2	-	1	-	-	-	-	-	17	20	20
Boreal Landscape Ecology	Middleton (B)	Aug 24-Sep 1	Lake Superior	1/2	1	1	1	2	2	-	-	2	1	10	10
Freshwater Ecology	Bailey (W)	Aug 25-Sep 7	Algonquin	1/2	2	1	-	1	5	-	-	-	1	10	10
Fisheries Ecology	McQueen (Y)	Aug 25-31	Algonquin	1/4	2	1	4	-	-	2	-	-	3	12	6
Tropical Insect Biodiversity	Wood (C)	Aug 25-Sep 7	Costa Rica	1/2	3	-	1	-	-	-	-	1	5	10	10
Terrestrial and Aquatic Biology	Hawthorn (Wo)	Aug 31-Sep 13	Algonquin	1/2	4	1	2	1	-	1	-	1	5	15	15
Total Number of Student-Weeks					80	19	28	10	38	14	18	12	135	354	-
Half-course Equivalents					40	9.5	14	5	19	7	9	6	67.5	-	177

Table 3: Overall Summary of the Ontario Universities Program in Field Biology for 1991.

	Q	C	Y	B	W	Wo	Wi	Tr	To	Total Student Weeks in Modules	Total Half Course Credits
Total Student-weeks not at QUBS	80	19	28	10	38	14	18	12	135	354	177
Total Student-weeks at QUBS	15	5	14	5	--	6	2	4	7	58	29
Total Student-weeks in Field Modules	95	24	42	15	38	20	20	16	142	412	---
Total Half-course Equivalents in Field Modules	47.5	12	21	7.5	19	10	10	8	71	---	206

14.1% of credits in entire program earned at QUBS in 1991.

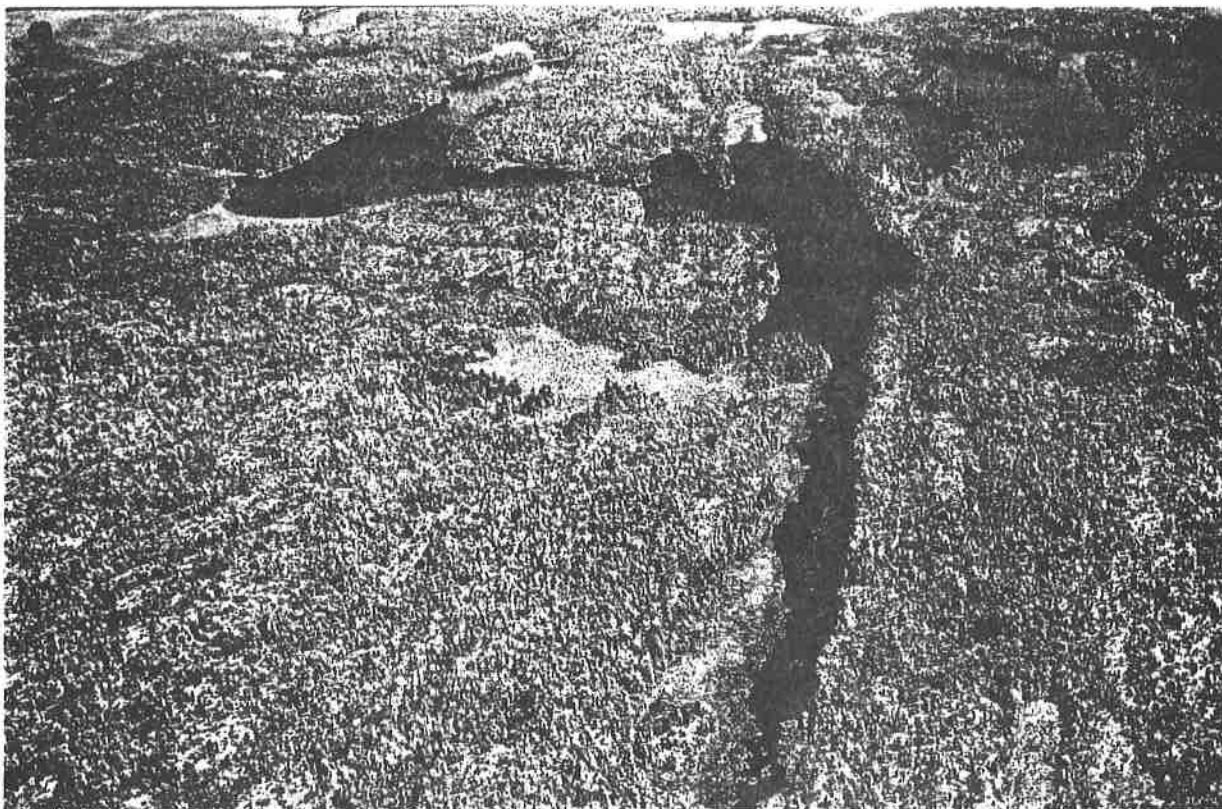
(16.3% in 1990; 29.2% in 1989; 15.6% in 1988; 14.3% in 1987; 22.4% in 1986)

15.8% of Queen's student credits earned at QUBS in 1991.

(24% in 1990; 51.4% in 1989; 22.5% in 1988; 31.4% in 1987; 30.9% in 1986)

Cape-Sauriol Environmental Studies Area

The John M. Cape - Charles Sauriol Environmental Studies Area has begun to play an important role in teaching and research at QUBS.



One of Lou Wise's photographs, looking north at Hart Lake from a point above the Loughborough Lake Creek

Shortly after the dedication ceremony held June 25, 1990, naming the Cape-Sauriol Environmental Studies Area, Queen's received a donation of \$25,000 from the McLean Foundation. This donation brought the total funds raised to \$300,000, meaning that the entire purchase price was achieved with a combination of funding from individual, organization and foundation donations. Many thanks to McLean Foundation which put us over the top. Charles Sauriol deserves thanks in this effort too, wielding his influence on our behalf to secure this donation.

Presently, we are beginning to focus on the Cape-Sauriol Environmental Studies Area for long-term teaching and research uses. As a first step, we are becoming more aware of the possibilities as we begin to appreciate the size and diversity of the area

itself. Two initiatives immediately come to mind in appreciating the extent of the property and its unspoiled nature. First, a long-time friend and associate of Charles Sauriol, Lou Wise, has put his love of flying to good use in photographing the property from the air. The Biological Station has purchased a complete set of photographs from Mr. Wise to serve as a record of the landscape as it is now. The value of these dramatic photographs will not be fully realized until sufficient time passes for observable differences to occur in the landscape. This collection will serve as the baseline for long-range changes due to climate or plant succession. Second, in 1990, an intrepid duo of German forestry students, Rainer Barthel and Jens Mackensen, began the long process of inventorying the plant associations and habitats found in the Cape-Sauriol tract. Their surveys are available for reference at the Biological Station, and will ultimately form the first data set entered into our computer inventory system. The recent Hewlett-Packard computer equipment donation enables the establishment of an electronic reference network, the basis of a long-term biological inventory system, the heart of climatological monitoring and analysis, and eventually, links to a geographical information system.

In 1991, several studies made use of the Cape-Sauriol Environmental Studies Area for various research projects. Beth MacDougall (supervisor, Dr. Raleigh Robertson) installed Great Crested Flycatcher nesting boxes along the lake margins of the property. Suzanne Weissenborn, another German forestry student from the University of Gottingen (supervisor, Dr. Lonnie Aarssen) travelled extensively in the upland areas of the tract sampling White Pine trees for growth characteristics. In the water along the shores of the area, Dr. David Philipp and his research crew studied the nesting habits of Largemouth and Smallmouth Bass. Details of these research projects can be found in the following research reports.

The Cape-Sauriol Environmental Studies Area was also used as an example of a relatively undisturbed local habitat. The abandoned farmland (last farmed in the 1950's) and the older growth uplands formed an interesting mosaic of habitat with high plant and bird diversity during field programs carried out under our Naturalist Workshop and community outreach programs.

On March 27, 1991, Charles Sauriol and Lou Wise were invited to Queen's to offer a special lecture to the General Ecology (Biology 202) course. The lecture was titled "Conservation of Wetlands: Strategies for Land Acquisition and Funding". Mr. Sauriol, an ardent conservationist and tireless advocate of preserving wetlands and natural habitat offered his personal perspective on the need for and means of preserving natural areas for the future. During the lecture, many different projects were referred to, especially the recent acquisition of the Cape-Sauriol Environmental Studies Area by Queen's and the role of Mr. Sauriol and Mr. Wise in that acquisition. Mr. Wise, a freelance aerial photographer involved in assisting with land acquisition and preservation strategies, showed his recent aerial photographs of the Cape-Sauriol Environmental Studies Area.

Visiting Field Scientist Program

The Visiting Field Scientist Program was established to enable a prominent field researcher to meet and to interact with the residents of the Biological Station even as the field season is in progress. This program is sponsored by the School of Graduate Studies and Research at Queen's University, through the Associate Dean of The School of Graduate Studies and Research and Director of Research Services, Dr. Tony Eastham. Under the program, a Visiting Field Scientist, a researcher who would not otherwise make use of the field station, becomes a part of the field station for a brief period (usually a week). During their stay, a Visiting Field Scientist gives a couple of formal presentations on his/her current research interests. By sharing the field station with the 'regulars', meaningful interaction is possible across a cup of coffee on the porch or during conversations at mealtimes or in the field. This interchange of ideas and the encounter of a new point of view is the essence of the program.

In 1991, we were fortunate in having two Visiting Field Scientists. The first, Dr. George Eickwort (Department of Entomology, Cornell University) and son Jeff were hosted at QUBS from July 1 through July 6. The second, Dr. Michael Clarke (McGill University) and his wife, Cathie and their young daughter, Anna, visited the field station from August 5 through August 11. With two Visiting Field Scientists, having such different interests and backgrounds in residence within the same field season, there was no shortage of opportunities for interaction with regulars.

Dr. Eickwort and Dr. Clarke are both lively, outgoing personalities who were very keen at having a first-hand look at ongoing research projects and offering unique perspectives on biological questions and phenomena. Each gave two formal presentations during their period of residence. Dr. Eickwort is an entomologist, whose forte is bees. His seminars dealt with social behaviour and specialization in bees. Dr. Clarke is a behavioural ecologist with broad interests. One of his presentations dealt with food storage in chipmunks, while his second seminar discussed cooperative breeding in Australian birds. Presently, Dr. Clarke has accepted a post at La Trobe, Australia and has recently moved 'down under'.

Because of the interest shown in the Visiting Field Scientist Program and the opportunity for interchange of ideas and interaction with prominent researchers, we anticipate that this program will continue. Please forward suggestions for future Visiting Field Scientists to Dr. Raleigh Robertson, Director of QUBS.

Hewlett-Packard Appreciation Day

In recognition of the Hewlett-Packard donation of computer equipment to the Biological Station, an appreciation day was held June 27, 1991 at QUBS. The H-P equipment forms the heart of a computerized environmental data network based at the field station. This donation represents part of Hewlett-Packard's commitment to the environment. In its own packaging, products, processes and philanthropy, Hewlett-Packard has stressed corporate responsibility for the environment.



Floyd Connor discusses the Environmental Monitoring Network with Michael Van Dusen

Representatives of Hewlett-Packard and Queen's University and the Biological Station were on hand for the appreciation day. Representing Hewlett-Packard were Mr. Michael Van Dusen (Executive Director of Public Relations), Ms. Judy Dorak (Public Relations Officer) and Mr. Chuck Freeman (Kingston Office of H-P). From the university, Mr. John Heney (Director, Department of Development), Mr. Bob Burnside (Department of Development), Dr. Tony Eastham (Director of Research Services, School of Graduate Studies), Dr. David Dennis (Chairman, Department of Biology), Mr. Tim Loughheed (Public Relations), Dr. Adele Crowder (Curator, Fowler Herbarium), Dr.

John Smol (Department of Biology) and Dr. Raleigh Robertson (Director, QUBS) were in attendance. In addition, many of the researchers at the field station were present along with some invited guests from the local community.

The occasion was marked by a brief appreciation ceremony, with Dr. Robertson acting as Master of Ceremonies. In his address, Dr. Robertson stated his appreciation of the Hewlett-Packard donation. It is regarded as critical to the establishment of an environmental monitoring network at the field station. As ecologists, entomologists, behavioural or evolutionary biologists, we seek to interpret patterns and changes that we observe in individual organisms, populations and communities. To do this, we require accurate information about both the physical and biological environments. This new environmental monitoring network will allow the establishment of a data base that will be central to a large number of research and teaching programs at the field station.

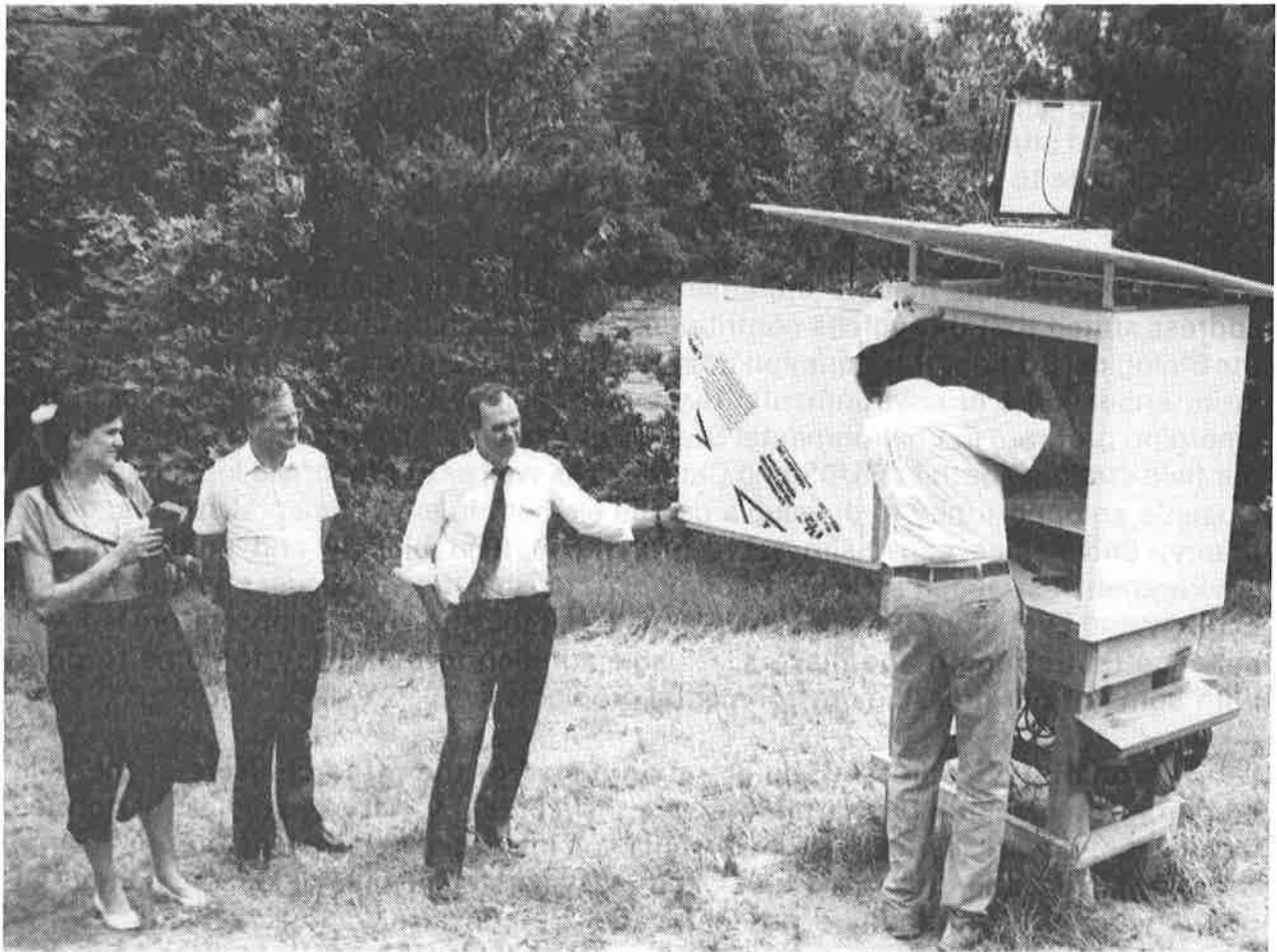
Dr. Tony Eastham spoke on behalf of the university, citing the donation as an excellent example of industry-university cooperation. The network will enhance both the teaching and research environment of the university. It will enable more sophisticated studies of the interaction between organisms and their environment and will contribute to the program in Environmental Studies currently being developed at Queen's.

Dr. David Dennis made a statement on behalf of the Biology Department. His address stated that through its contribution to the teaching and research programs at the Biological Station, this donation from Hewlett-Packard will benefit the Department in its endeavours in environmental research. Biology will play a major role in the emerging program in Environmental Studies at Queen's. The strength and vitality of our field stations, both at QUBS and Churchill, as well as at other field locations, gives Queen's an opportunity to develop a unique element in environmental studies. Few, if any, universities can claim such strength in field biology and studies of the environment as Queen's. This is demonstrated by recent success in the NSERC Ecology and Evolution GSC, and their appraisal at the site visit. Support from H-P will enhance that strength and make a valuable addition to our ability to come to grips with some of our pressing environmental problems.

Dr. John Smol addressed the group on behalf of the research users of the field station. The research use of the network will serve a variety of studies, performed by a variety of researchers from a range of institutions (a list of current users, research topics and affiliations was cited). These studies involve a large number of graduate and undergraduate students and all consider various aspects of the interactions between organisms and their environment. All will contribute toward a better understanding of how environmental change, as caused by such human impacts as lake acidification, global warming, or even more local habitat disturbances will impact on populations of plants and animals.

Dr. Adele Crowder spoke to the assembly on behalf of the teaching users of the field station. This network will be valuable in the teaching program at QUBS. This includes General Ecology (Biology 202, 190 students) and field courses (Biology 307/407, about 30 Queen's students half-courses, but involving some 50 students from many Ontario universities: Queen's, Carleton, Western, Waterloo, Toronto, Brock, Trent). Students examine such phenomena as water and soil temperature profiles and relate plant and animal distributions to aspects of the physical and biological environment. Monitoring of the physical environment is essential if we are to assess the effects of human impacts on the natural environment.

At the conclusion of the appreciation ceremony, Floyd Connor conducted a tour of the weather monitoring station and the computer network. To provide an overview of the research properties of the field station, Frank Phelan took the H-P personnel and some of the guests on a barge tour of the lake.



Tour of QUBS Weather Station
L to R: Judy Dorak, Dr. Tony Eastham, Chuck Freeman and Floyd Connor

The Weather Report

15

The new weather-monitoring system at QUBS, consisting primarily of a Campbell Scientific 21XL micrologger and sensors, a Hewlett-Packard RS/25C computer (386 level), and telecommunications link between them is now fully installed and functional. After a somewhat prolonged period of installation, debugging, acquisition of new software, and programming, all aspects of the system appear to be working well. With solar-panel power and new lightning rod and ground to reduce the chance of voltage surges, and with automatic data transfer from micrologger to computer hard drive, we expect (and find) that data collection and filing should be both much more reliable and much more up-to-date.

Sensors at the present time monitor essentially the same environmental variables as have been monitored for the last couple of years. These are air temperature, water temperature at three depths, soil temperature, relative humidity, sky and solar radiation, wind direction and speed, and rainfall. At the present time, sensors are scanned every 10 seconds, and a "final data" summary is produced every 20 minutes (averages and extremes, for example), with an additional summary being produced every 24 hours. The new micrologger is much more sophisticated and versatile than its predecessor, and can be programmed to scan the sensors at a wide range of intervals, from a fraction of a second to many minutes. It can also be programmed to produce a variety of summaries at widely different intervals, and to record a wide range of extrema and calculated values and statistics using the input from the sensors. In the long run, it has a large capacity for addition of new sensors. Please keep all of these features in mind, and contact us (especially Floyd) at QUBS if you have any inquiries or special requests.

We are using some rather elegant file management software called "Split" to generate a variety of spreadsheet-type ASCII files. The contents of these files, including a variety of summaries in addition to those generated by the micrologger itself, are largely the prerogative of the weather station operator working for you. We welcome your suggestions and participation in making these outputs maximally useful for you; these summaries can now be made available on disk or paper, or via Email, on considerably shorter notice than in the past. A couple of brief excerpts, as examples, follow:

Averages and totals:

Date	Time	Temp	Temp	Temp	Temp	RH	Rain
	Invl	Wat	Wat	Soil	Air	Air	Total
	Ends	1.0m	3.0m	0.15m	1.5m	1.5m	
MM DD	EST	C	C	C	C	C	mm/day
11 1	2400	10.148	10.177	9.525	7.1048	95.756	0
11 2	2400	9.8163	9.8279	9.5083	8.266	85.828	0
11 3	2400	8.6543	8.9286	8.0535	3.0248	73.112	0

Date	Time	Avg	Avg	Avg	Max	Min
	Invl	Wind	Rad	Wind	Wind	Wind
	Ends	Dir		Speed	Speed	Speed
MM DD	EST	DegTru	kW/m**2	m/s	/inv	/inv
11 1	2400	47.584	.02101	3.2725	8.03	.607
11 2	2400	182.56	.01976	6.5257	21.19	.447
11 3	2400	239.81	.05387	7.2614	15.45	2.123

Maxima and the times at which they occur:

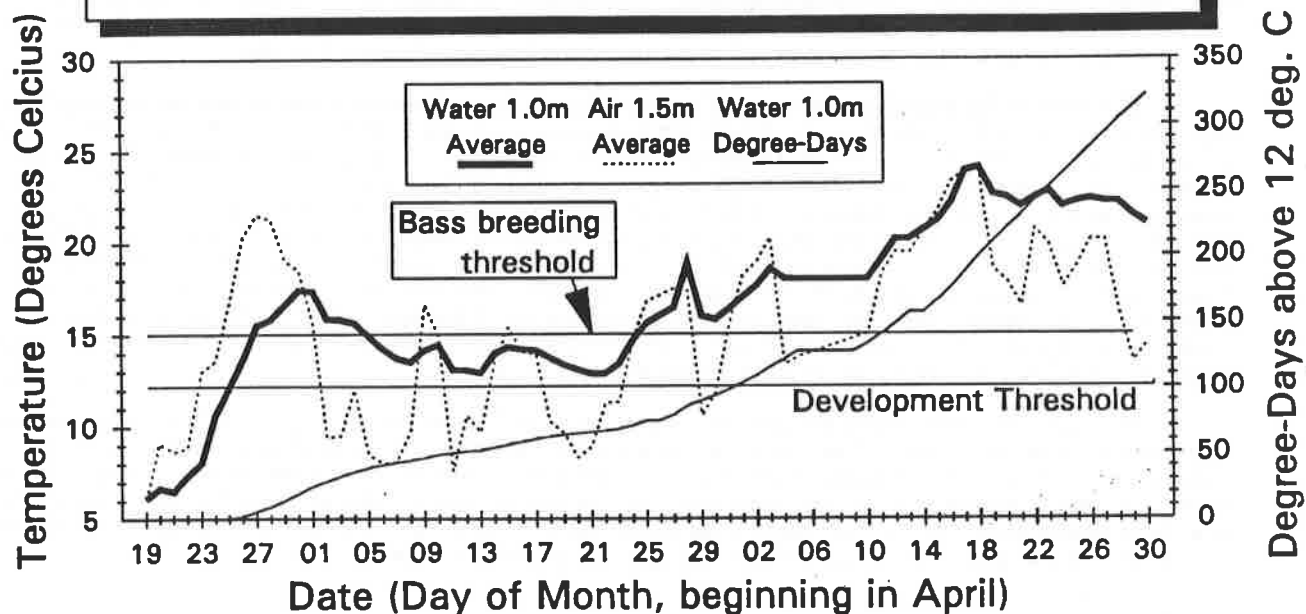
Date	Temp	Time	Temp	Time	Temp	Time	Temp	Time	Wind	Time
	Wat	1.0m	Wat	3.0m	Soil	Soil	Air	Air	Speed	Wind
	1.0m	Max	3.0m	Max	1.5m	Max	1.5m	Max	Max	Max
MM DD	C	EST	C	EST	C	EST	C	EST	m/s	EST
11 1	10.24	1535	10.29	415	9.82	1	8.6	1530	8.03	420
11 2	10.09	943	10.09	13	9.74	1428	12.47	927	21.19	1344
11 3	9.31	0	9.49	0	8.92	0	5.533	0	15.45	1655

Averages and extremes:

Date	Time	Avg	Avg	Avg	Max	Min
	Invl	Wind	Rad	Wind	Wind	Wind
	Ends	Dir		Speed	Speed	Speed
MM DD	EST	DegTru	kW/m**2	m/s	/int	/int
11 1	100	42.097	0	4.1773	7.15	2.123
11 1	200	43.457	0	3.5603	6.592	1.405
11 1	300	44.26	0	3.3547	6.352	1.484

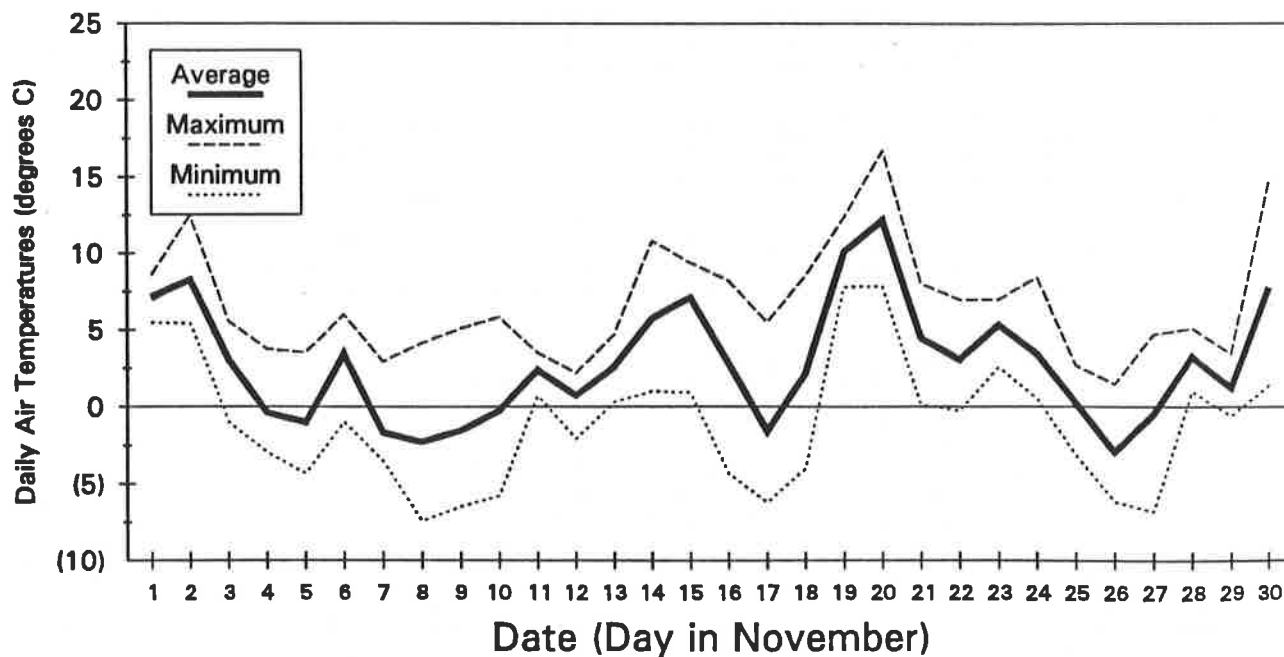
The graphics on the following pages are presented as examples of the kinds of weather data summaries which can now be prepared with relative ease at QUBS. The micrologger data files are directly importable to Lotus 123 and Freelance, which were used to generate the following figures.

Daily Temperatures (C) and Degree-Days QUBS April to June 1990



Note: A development threshold of 12 degrees C has been arbitrarily chosen as an example.

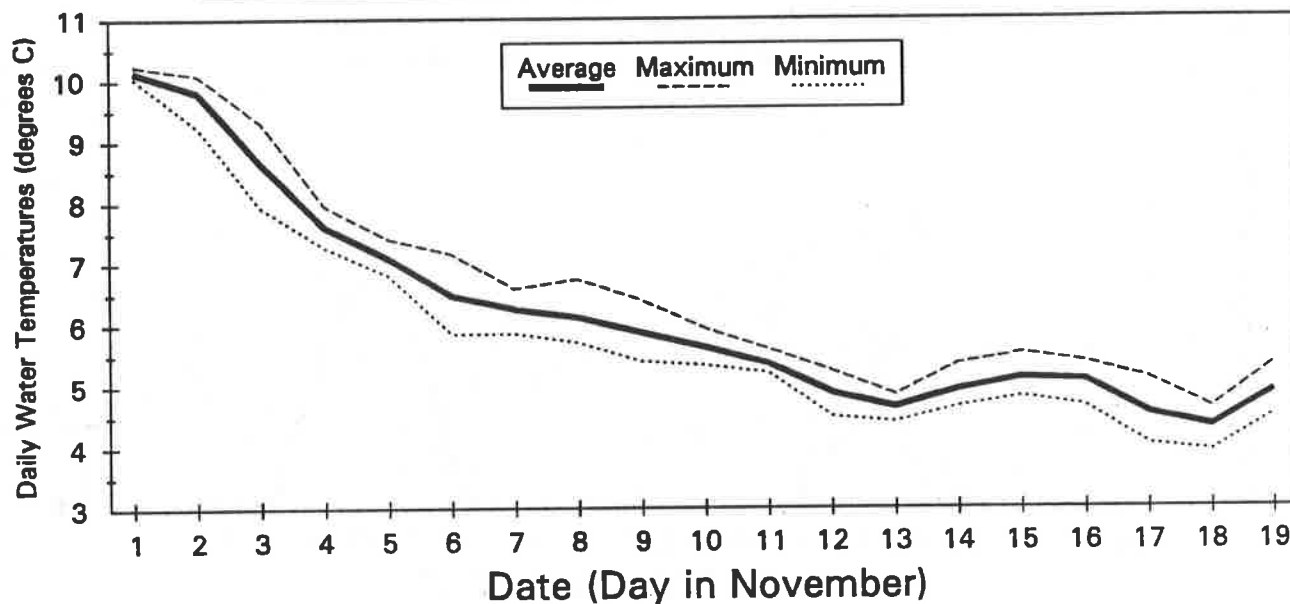
Daily Air Temperatures at 1.5 m Inside Stevenson Screen



Daily Water Temperatures at 1.0 m

QUBS November 1991

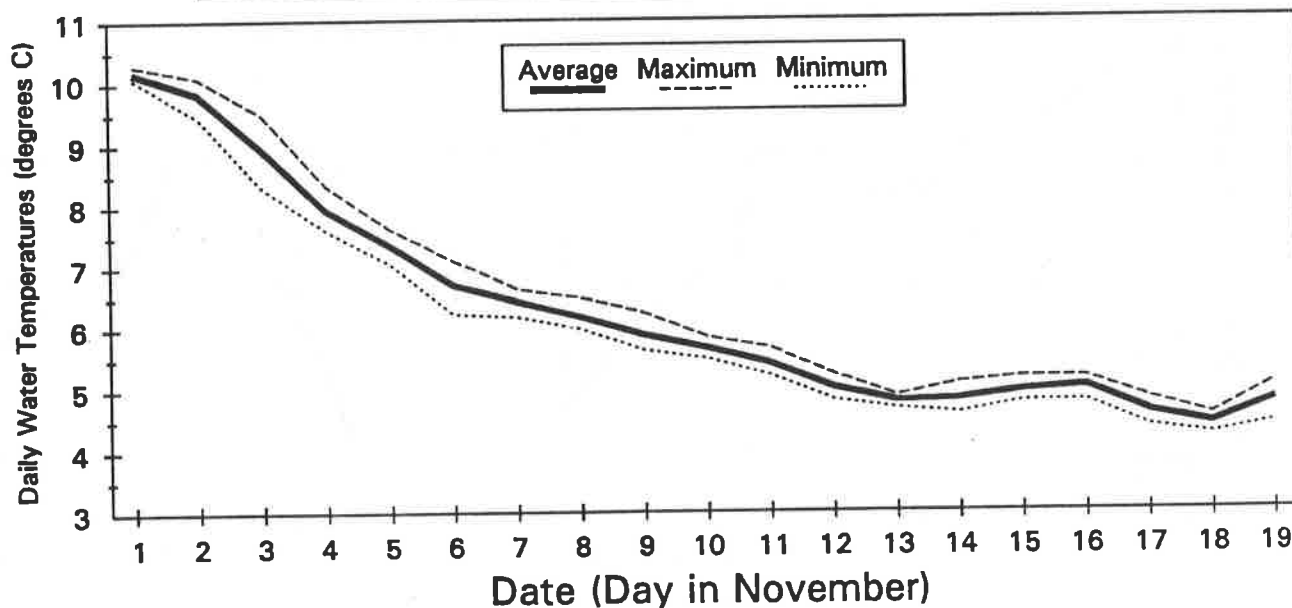
20-30 Nov: Electrodes removed for servicing



Daily Water Temperatures at 3.0 m

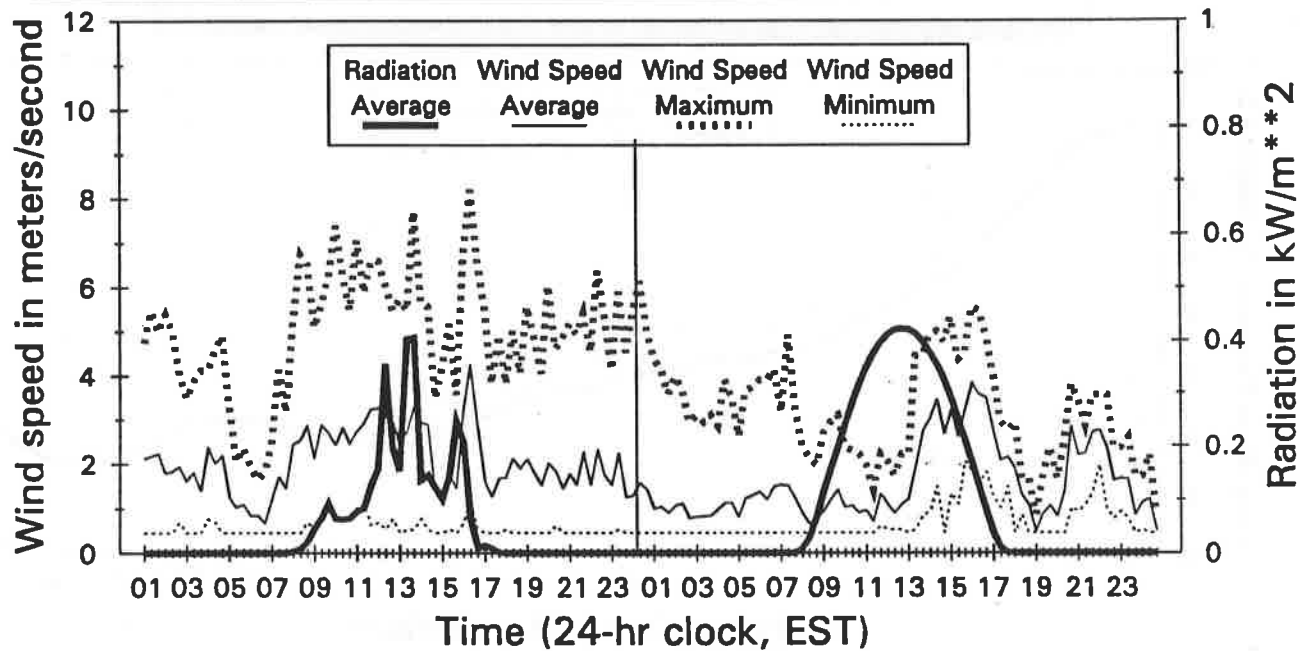
QUBS November 1991

20-30 Nov: Electrodes removed for servicing



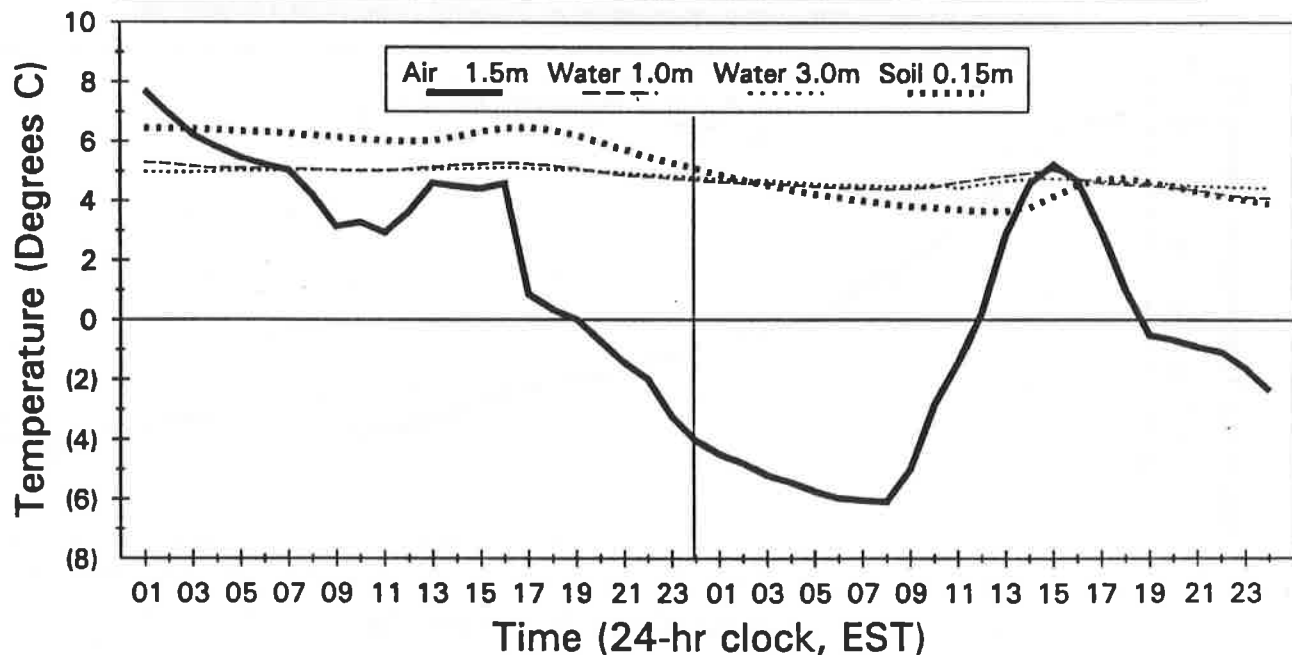
Wind and Radiation: 20-min Summary Interval

QUBS 16 and 17 November 1991



Mean Temperatures for Preceding Hour

QUBS 16 and 17 November



Naturalist Workshop

In 1991, the thirteenth edition of the naturalists' workshop was held. As usual, the workshop was filled to capacity. It seems that the demand for such a program continues to rise. Hopefully, this is a reflection of changing concerns and interests. A new environmental consciousness is stimulating interest in natural history and environmental issues. It was in just this spirit that the workshop was established.

The week-long workshop was held from May 18 through May 25 in 1991. Despite limiting the enrolment to 18, we again exceeded this limit, hosting 19 participants in 1991. The extra person, Mary Lynn Lackie, we agreed to take on as a contribution to the summer education program run by the Rideau Environmental Action League. After the workshop, Mary Lynn was the coordinator of a summer program aimed at schoolchildren and with a decidedly environmental theme running through all activities.

Participants in the workshop represented a cross-section of interest groups: two teachers, four students, six amateur naturalists, three staff from the Ministry of Natural Resources, one staff from the Canadian Parks Service, one staff from a Conservation Authority and two other professional naturalists.

Two scholarships were awarded to workshop participants in 1991. The Kingston Field Naturalists awarded their Stirrett Scholarship to Gary Ure, a local student and KFN member. The McCorquodale Scholarship was awarded to Kelly Murphy, a Quebec schoolteacher who plans to return to university to pursue a Master's degree. These scholarships are important parts of the workshop program, allowing attendance of participants who might not otherwise be able to because of financial constraints. The generosity of our scholarship benefactors is greatly appreciated. The Kingston Field Naturalists will not offer their Stirrett scholarship in 1992. However, Shannon McCorquodale has kindly agreed to continue to sponsor the scholarship named for her in 1992. Thank you Shannon.

This year's team of instructors was headed by Dr. Adele Crowder and Dr. Jim Pringle (Queen's - Biology and Royal Botanical Gardens, respectively). Thank you for your continued involvement in the program. The workshop is a success because of the devotion of time and effort of all our instructors: Floyd Connor (QUBS), Dr. Laurene Ratcliffe (Queen's - Biology), Adele Mullie (Queen's - Biology), Frank Phelan (QUBS), Dr. Francis Cook (Curator, Herpetology - National Museum of Natural Sciences), Dr. Bruce Smith (Ithaca College - Biology), Scott Shackleton (Queen's - Biology), Dr. Allen Keast (Queen's - Biology), Dr. Sandra McBride (Queen's - Geological Sciences), Don Cuddy (Regional Ecologist - Ministry of Natural Resources), Jennifer Harker (M.M. Dillon Consultants) and Dr. Raleigh Robertson (Queen's - Biology). A special thank you is extended to the Biology Station regulars - workshop participants benefit greatly from experiencing an active biological research station and

interaction with avid researchers.

In 1991, the environmental trend in workshop themes continued. The week was designed to look at disturbed versus undisturbed habitats. This theme was pursued in several ways - diversity trends with vegetation, shorelines, patch sizes, human disturbance across several types of communities. Of great interest was the correlation of plant species and foliage height diversity with bird community species richness. We will probably repeat this exercise in the future.

Dr. Laurene Ratcliffe's segment on bird song and acoustic communication was again one of the highlights of the workshop. Everyone seems to enjoy the challenge of hands-on investigation of the dynamics of bird song and the technology involved. Although Laurene will be unable to assist in the 1992 version of the workshop, we hope to be able to entice her to participate in future workshops.

The day-long road trip on the Friday was a series of visits to patches of habitat, with an eye to human impacts on these patches. A few sites of geological interest were also of interest en route. Thanks to Don Cuddy, Jenny Harker and Sandra McBride for their input throughout the day. Everyone especially enjoyed the slog through Westport Bog.

Plans for 1992 are now finalized. The environmental theme of the workshops continues. In 1992, the theme will be wetlands, biodiversity and impact of mining on local environments - perhaps a little diffuse this time, but these are all interesting avenues of exploration.

Abstracts of Research Conducted at QUBS in 1991

I: Research by Queen's University Staff and Students

Dr. Lonnie W. Aarssen

"Plant Population and Evolutionary Ecology"

Our research encompasses a variety of studies on strategies for growth, survival and reproduction in plants. The first three projects are examining the ecological implications of apical dominance. We are testing the general prediction that apical dominance represents a 'cost' to plants grown singly (because of the suppression of lateral meristems and thus, the suppression of overall growth potential) but a 'benefit' to plants grown in competition (because the disproportionate commitment to vertical extension minimizes the chances of being overtopped by neighbours).

Deborah Irwin - "Compensatory responses to simulated herbivory of the shoot apex" - M.Sc. Thesis

The 1990 experiment showed that shoot apex removal had no effect on biomass or flower production (i.e. compensation occurred) for three local herbaceous species but resulted in changes in above ground architecture (branching pattern). In 1991, the effects of competitors on the compensatory response was examined in a field experiment involving Clinopidium vulgare (wild basil). Clipped plants grown both singly (with neighbouring canopies removed) and in competition compensated in terms of height, biomass and flower production, indicating that growth from the shoot terminal is not a necessary requirement for maintaining height within a competing canopy. Vertical growth was maintained by increasing branch and internode length in clipped competing plants. Plants grown singly showed a compensatory response to clipping by adopting a laterally spreading prostrate growth form.

Beth Chamberlin - "Is growth in White Pine greater in multi-stemmed trees than in single-stemmed trees?" - B.Sc. Thesis

When the terminal shoot is destroyed in white pine (most commonly a result of attack by the white pine weevil), two or more of the four lateral branches from the next highest live whorl are released from suppression due to apical dominance and commonly turn upward to produce new terminal shoots. Thus, as the tree ages, the growth form can be permanently altered from a single-stemmed tree to a multi-stemmed tree. We recorded age, height and radial growth data to test the prediction that trees growing in open sites generally benefit from this release from apical dominance (because of the release of more lateral growth points) but that trees growing in closed, crowded stands are disadvantaged because of reduction in the

potential to maximize vertical growth and hence avoid shading by neighbours.

Assistant: Suzanne Weissenborn

Stephen Bonser - "Does early growth form variability in Sugar Maple reflect adaptive responses to light availability?" - B.Sc. Thesis

Age, height, number of branch endings, neighbour density and overhead cover from local neighbours were recorded for young sugar maple ranging from the seedling stage to saplings approximately 3 m tall and growing in open versus closed upper-canopy sites. These data will be used to test the prediction that branching (release from apical dominance) begins at an earlier age and/or a shorter height as competition for light decreases. In this study, competition for light should be greater with increasing neighbour density or with decreasing light availability (i.e. in closed versus open sites). This is consistent with the assumption that, by a certain age (or size), growth is maximized by increased branching (to expose more photosynthetic surface area) when canopy competition is weak, whereas growth is maximized by greater height extension (to minimize shading by neighbours) when canopy competition is intense.

Jennifer Bosy - "The effect of seed orientation on germination in a uniform environment: Differential success without genetic or environmental variation" - B.Sc. Thesis

The general objective of this study is to explore whether chance can be distinguished from genotype and environment as a causative factor in affecting differential success in plants. In particular, when effects of genetic variation are controlled, does seed orientation affect germination in a uniform environment? Seeds from several locally common herbaceous plants were collected for germination tests. Seeds were embedded in agar to provide uniform local environmental conditions around each seed, but seeds were inserted with different orientations. Preliminary results indicate that both the rate and the total percent germination are affected by orientation. Hence, the particular environmental experience of a seed can potentially be independent of the environment and controlled entirely by the circumstance of the seed itself.

Liette Vasseur and Teresa Bennett - "Flowering occurrence and allozymic variation in local populations of Lemna minor"

Flowering in Lemna minor has rarely been observed in nature. Weekly surveys were conducted throughout the growing season to detect the presence of flowering in eight populations near QUBS. Not a single flower was found. We predict that the rarity (or absence) of flowering, combined with founder effects and genetic drift may limit the level of genetic diversity within these populations. Samples were collected

from each population to: (1) determine the level of allozymic variation within and among these populations and compare this with the level of genetic variation among genotypes representative of the species cosmopolitan distribution and (2) relate any genetic differences between populations to microgeographical and environmental differences between sites. The highly successful strategy of prolific vegetative propagation in this species suggests the interesting possibility that Lemna minor may have largely lost the genetic potential to initiate flowering. This may have been a consequence of selection (since flowering expends vegetative meristems) and genetic diversity may be maintained by somatic mutations in meristematic pouches, resulting in a genetic mosaic of daughter fronds that literally fall apart as they grow.

Stephen Murphy - "The occurrence and consequences of improper pollen transfer: Allelopathic pollen in Phleum pratense L. (Poaceae) and the Hieracium L. aggregate (Asteraceae)" - Ph.D. Thesis

When pollen is transferred 'improperly' (i.e. between different species), many phenomena may occur. One of these is 'pollen allelopathy' wherein the pollen recipient suffers a loss of its pollen viability, stigmatic receptivity and, ultimately, seed production. Such allelopathic pollen exists in the forage grass Phleum pratense and in the weedy hawkweed aggregate Hieracium aurantiacum, H. floribundum and H. pratense. *In vitro* studies have revealed that chemicals contained in the same acidic fraction as the pollen pigments cause a dose-dependent reduction in pollen germination in the heterospecific pollen recipients.

The field studies at QUBS have tested the ecological significance of allelopathic pollen. The experiments have quantified pollen dispersal, pollen contamination and the efficiency of pollen transfer. Further, isolation experiments have tested the effect of known quantities of the allelopathic pollen of Phleum pratense on Agropyron repens (= Elymus repens, quackgrass), Bromus inermis (bromegrass) and Danthonia compressa (povertygrass). To date, the results indicate that the allelopathic pollen in Hieracium is not ecologically significant, however, that of Phleum pratense is. It is suggested that pollen allelopathy may be an important aspect of interspecific competition among grasses in mid-successional fields and may have implication for agricultural management.

Assistant: Jennifer Bosy

Stephen Murphy and Liette Vasseur - "Limitation of sexual reproduction in a population of Hepatica acutiloba DC (Ranunculaceae) near its northern range limit"

Like plants at higher altitudes and latitudes, individuals of species near the northern range limit may be subject to shortages of pollinators, especially if they bloom in the cool spring. In the case of such plants, the narrowing of 'pollinator windows' may result in pollen or pollinator limitation of seed set, changes in pollinator

utilization and/or shifts in the breeding system relative to southern populations.

Hepatica acutiloba is a clonal, perennial, long-lived (perhaps 400 years) herb that is usually the first to bloom every spring. It has been found that zoophilous xenogamy, hybridization (with H. americana) and autogamy may exist, although the pollen to ovule ratio (3100:1) indicates that H. acutiloba is primarily a facultative outcrosser. Results to date indicate that there is pollen limitation, rather than limitation of some other resource, in this population of H. acutiloba. Here, pollen limitation appears to be related to the low visitation rate of a single, main pollinator, Asclera ruficollis (Coleoptera:Oedemeridae). The lack of apparent shifts in the breeding system and the reliance on less-efficient pollinators may have implications for the continued survival of northern populations of spring wildflowers.

Publications:

Murphy, S.D. (in press). The determination of the allelopathic potential of pollen and nectar. In: Linskens, H-F. and J.F. Jackson. (eds.) Modern methods of plant analysis (new series), Volume 13, plant toxin analysis. Springer-Verlag, Berlin-Heidelberg.

Dr. Fred Cooke

Dr. Jeffrey Kopachena - "Polymorphism in the White-throated Sparrow" - Post-Doctoral research

Plumage (white-striped morph and tan-striped morph) and behavioural polymorphisms among breeding White-throated Sparrows (Zonotrichia albicollis) are associated with the presence or absence of pericentric inversions among the second pair of chromosomes. The occurrence of these inversions in natural populations is maintained by negative assortative mating among plumage morphs. The purpose of this project is to examine why individuals choose mates of opposite rather than similar phenotypes. Two principal hypotheses are to be examined: first, that positive assortative mating is inhibited by behavioural mechanisms (e.g. aggression), and second, that positive assortative mating is avoided because such pairings are genetically incompatible.

To test these hypotheses, we initiated a captive breeding program in the summer of 1991. We constructed 10 aviaries that, in conjunction with an existing aviary, enabled us to create 16 mated pairs (we switched some females over the course of the summer). These included 2 tan-striped male/tan-striped female pairs, 1 tan-striped male/white-striped female pair, 8 white-striped male/tan-striped female pairs and 5 white-striped male/white-striped female pairs. Despite a late start, breeding activities (nest building and egg-laying) occurred among 13 of the 16 pairs from 4 June through

14 August. A total of 49 eggs were laid among the 13 pairs. Of these, only 2 eggs hatched. Reasons for hatch failure included 24 eggs that did not develop, 12 that disappeared (eaten by mice?), 7 that broke during incubation and 4 that were abandoned. By providing an earlier start to breeding activities, by trapping predators within the aviaries, by increasing the amount of insects in the diet and by supplementing the diet with calcium, we expect greater success rates in the 1992 field season.

The preliminary findings from 1991 are interesting. Behavioural observations indicated that white-striped males often chased and attacked white-striped females, and of the two pairs that laid eggs, laying dates were later than those of white-striped male/tan-striped female pairs. Low intensities of breeding behaviour exhibited by tan-striped males appeared to be insufficient to stimulate breeding behaviour from the females with which they were paired. These observations suggest that behaviour may interfere with the formation of white-striped male/white-striped female pairs. There is insufficient data to test the hypothesis that such pairings are genetically impossible.

We will continue these studies in the 1992 breeding season without change, except those noted above. We intend to put birds into the aviaries around 1 May and maintain these pairs until about the middle of August. Offspring will be collected for genetic analyses shortly after the eggs hatch.

Assistant: Nishan Sharma

Drs. Adele Crowder and Dolf Harmsen

"Plant Succession and the Effects of Grazing by Insects"

The data on the plant succession plots from 270 quadrats over 15 years for 140 vascular plant taxa has now been entered on the mainframe computer at Queen's. We are now entering data on soil and climatic variables and will be ready to start analyzing in 1992. Already the predictable rise of woody versus non-woody species is clear, but both interplot and interyear variance have to be explained. We did not sample the vegetation this year, leaving the poison ivy undisturbed.

Assistant: Catherine Vardy

Dr. Allen Keast

"Diets and Growth Plasticity in Fish: Comparative Interlake Studies"

Work continued on four species (Yellow Perch, Golden Shiner, Pumpkinseed Sunfish, Banded Killifish), that are exceptional in the wide range of water-bodies inhabited, to document degrees of diet and growth plasticity that permit such versatility. They were rated relative to the different prey resources available and range of potential fish competitor species present. Growth and diet were closely correlated. For example, amongst 12 water-bodies analyzed, perch grew best in Atkins Lake where they became piscivorous at an early age; slower where they remained planktivorous through to Year 3. Best growth occurred in Cataraqui River Golden Shiner (a specialized planktivore) where, in addition to consuming the very abundant zooplankton, a diversified range of prey was available and used; growth was poor in smaller lakes where plant material made up much of the diet. Pumpkinseed, a specialized molluscivore, achieves rapid growth in alkaline lakes with high mollusc populations, and does least well in oligotrophic Little Round Lake where chironomids and zooplankton form the bulk of the diet.

"Changes in Fish Communities with Time: Birch Bay, Lake Opinicon after 25 years"

A detailed study of this community, adjacent to the Field Station, in 1965 showed it to regularly contain ten fish species, subsisting on a diversified zoobenthos and zooplanktonic resource base. This initial study on the Birch Bay community formed the prototype for later comparative work. In 1991, a repeat study involving reanalysis of fish species community composition, diets, zooplankton and zoobenthos, was initiated to determine what changes had taken place in the intervening 25 years, and to define invertebrate populations relative to the anticipated arrival of the Zebra Mussel in Lake Opinicon. Marked changes have taken place in the physical environment, the formerly exposed sandy bay now being quite silted (probably in part due to colonization of the exotic European milfoil, Myriophyllum spicatum, about 1974). The dense growth form of this plant slows down water movement along the shoreline. Associated with the silting has been colonization of the shallows by diverse flora of macrophytes. The bay still remains highly productive of fish. The fish community, however, now incorporates large numbers of small-bodied weed dependent young-of-year Yellow Perch and Bluegill that were formerly absent.

"Temperature and Growth in Pumpkinseed, Bluegill, and Yellow Perch"

Data on the annual initiation of growth, and growth rates through the season was reworked in the framework of temperature summation patterns in different years. The question of why annual growth ceases when it does in August is being rephrased relative to a more complete assay of food availability during the later half of the season.

"Resource Division in Members of Different Fish Communities"

This study on the nature and taxonomic composition of fish communities in

contrasting types of water-bodies, and the division of the zoobenthic and zooplanktonic prey resource bases continues. Cluster diagrams demonstrate that the dietary relationships of species within different communities may differ strikingly.

Assistants: Christine Watters, Grace Erb, Erica Dunning, Wendy Shepherd

Publications:

Keast, A. and S. Saunders. 1991. Ecomorphology of the North American Ruby-crowned (Regulus calendula) and Golden-crowned (R. satrapa) kinglets. Auk 108: 880-888.

Keast, A. and M. Fox. 1992. Space used and feeding patterns of an offshore fish assemblage in a shallow mesotrophic lake. Env. Biol. Fish. In press

Keast, A. 1991. Panbiogeography: then and now. Quart. Rev. Biol. 66: 467-472.

Keast, A. 1991. Avian evolution of southern Pacific islands groups: an ecological perspective. Proc. 20 Intern. Ornith. Congr. (Christchurch, NZ): 435-446.

Dr. Robert Montgomerie

"Sexual Selection and Paternal Care in Barn Swallows"

In 1991 I continued sampling blood from barn swallow families nesting in the QUBS boathouse to obtain baseline data on natural levels of extra-pair paternity using DNA fingerprinting. Similar work was done at other colonies away from QUBS where I also gathered data on paternal care and both copulation and extra-pair copulation (EPC) rates. We are currently analyzing samples using DNA fingerprinting to determine extra-pair fertilization rates and the true father of each nestling. Most work on this project will be done away from QUBS in future to minimize the chance of human disturbance - the boathouse is just too busy a place!

Assistants: Tarmo Poldmaa, Karen Holder

"Sperm competition in passerine birds" (with Dr. J. Briskie, University of Sheffield)

We continued our survey of sperm characteristics and sperm storage mechanisms (in females) in passerine birds, collecting data from several additional species in 1991. Our analysis has revealed that the best explanation for the extensive variation (more than 5-fold) in sperm size across species is the size of female sperm storage tubules (SSTs). We interpret this as an indication that there may be an arms race between males and females with respect to sperm competition: females trying to induce

competition through longer SSTs and males trying to reduce it by evolving longer sperm. Our work has revealed that the diversity of male and female strategies at the gametic level provides a new perspective on the usual view of mating systems in birds.

"Sexual selection and parental care in American robins" (with Dr. Pat Weatherhead - Department of Biology, Carleton University, Ottawa)

While we did no extensive field work for this study in 1991, we did begin a DNA fingerprinting analysis of paternity and maternity based on samples collected in 1988 and 1989. Preliminary results indicate extensive extra-pair paternity but no intraspecific brood parasitism in this species. Pending completion of the fingerprinting analysis in February 1992, we plan to return to the field in the summer of 1992 to test hypotheses resulting from the fingerprinting analysis.

Publications:

Briskie J.V. and R. Montgomerie. 1992. Sperm size, sperm storage and sperm competition in birds. *Proc. Roy. Soc.* (in press)

Montgomerie, R. and P.J. Weatherhead. 1991. How robins find worms. Paper presented at the Northeastern Regional Meeting of the Animal Behaviour Society, Amherst, Massachusetts, November

Smith, H.G. and R. Montgomerie. 1991. Nestling American robins compete with siblings by begging. *Behav. Ecol. Sociobiol.* 29:307-312

Smith, H.G. and R. Montgomerie. 1991. Sexual selection and the tail ornaments of North American barn swallows. *Behav. Ecol. Sociobiol.* 28:195-201

Smith, H.G. and R. Montgomerie. 1992. Male incubation in barn swallows: the influence of nest temperature and sexual selection. submitted to *Condor*.

Smith, H.G., Montgomerie, R., Poldmaa, T., White, B.N. and P.T. Boag. 1991. DNA fingerprinting reveals relation between tail ornaments and cuckoldry in barn swallows, *Hirundo rustica*. *Behav. Ecol.* 2:90-98

Weatherhead, P.J. and R. Montgomerie. 1991. Good and bad news about DNA fingerprinting. *Tree*, 6:173-174

Weatherhead, P.J., Montgomerie, R. and S.B. McRae. 1991. Egg-laying times of American robins. *Auk*, 108:965:967.

Dr. Laurene Ratcliffe

"Vocal Behaviour in Black-capped Chickadees"

Scott Shackleton - "Singing behaviour of Black-capped Chickadees" - M.Sc. Thesis

This study investigated how male chickadees perceive relative frequency characteristics in conspecific song. In addition, of interest was how males use their song repertoires in intrasexual aggressive signalling. Playback experiments with 18 colour-marked territorial males showed conclusively that the frequency sweep (glissando) affects song potency, perhaps aiding in distance estimation of singing neighbours. Analysis of frequency shifts during aggressive encounters showed a significant association between the tendency to "match" the absolute frequency of neighbour's song and the likelihood of escalating into a fight.

Assistant: Paul Martin

Linda Webster - "Effect of speaker location on individual recognition in Black-capped Chickadees" - B.Sc. Thesis

This project investigated whether male chickadees use a singer's location to discriminate neighbours from strangers. Playback experiments in which the loudspeaker was placed on the correct and incorrect boundaries showed (1) that birds discriminate neighbours' songs from those of strangers and (2) that neighbours' songs played from the incorrect boundary elicit a stronger aggressive response than those of strangers. The last result contrasts with other neighbour/stranger studies in which stranger song usually elicits the most aggression. Other studies have shown that female chickadees engage in extra-pair copulations with neighbouring males, thus, neighbours may pose a real threat early in the breeding season.

Assistant: Paul Martin

Publications:

Horn, A.G., Leonard, M.L., Ratcliffe, R., Shackleton, S. and R. Weisman. (in press). Frequency variation in the songs of black-capped chickadees. *Auk*,

Leonard, M.L., Horn, A.G. and L. Ratcliffe. 1991. Parent-offspring conflict in black-capped chickadees. *Behav. Ecol.* 2:

Ratcliffe, L. and R. Weisman. 1992. Pitch processing strategies in birds: a comparison of laboratory and field studies. In, McGregor, P.K. (ed.), *Playback and Studies of Animal Communication: Problems and Prospects*. NATO Advanced Research Workshop. Plenum Press, N.Y. (in press)

Thesis:

Shackleton, S.A. 1991. Singing behaviour of Black-capped Chickadees. M.Sc. Thesis, Department of Biology, Queen's University, Kingston, Ontario

Dr. Raleigh J. Robertson**"Evolution of Breeding and Life-history Strategies in Birds"**

Nineteen-ninety-one saw major changes in the make-up of the RJR bird lab and field crew. Sue Meek spent the spring and summer in the lab and Kelvin Conrad worked from his home in Nova Scotia, both writing their theses which they defended in September. Andrew Chek, having completed his study of mate-guarding in Tree Swallows, spent the field season in Norway, working with Jan Lifjeld on Pied Flycatchers. Andrew defended his MSc thesis in November.

Following the completion of the field portion of several graduate programs in 1990, our field studies in 1991 focused primarily on continuing investigations of Tree Swallow mating systems. In a new initiative, RJR with Kathy Wynne-Edwards, did a pilot study (at RJR's farm grid) involving implanting testosterone in males as a possible tool for examining the role of testosterone in copulation frequency, mate acquisition, and paternal care.

As follow-up to his thesis work, Kelvin Conrad spent a few days at QUBS checking for banded Eastern Phoebes and RJR kept track of many of the Eastern Bluebird nests in the area and took family-group blood samples with the goal of examining age and experience patterns of extra-pair paternity (Sue Meek had obtained blood samples from marked pairs in 1989 and 1990). At the time of writing, Sue is doing the fingerprinting of these samples as a mini-post-doc.

Dr. Peter O. Dunn - Post-doctoral Research Associate**"Morphological and behavioural correlates of extra-pair paternity in Tree Swallows"**

Last year we found that half of tree swallow families had at least one nestling that was produced by extra-pair fertilization. In 1991 we tried to determine if there were any correlates of this high level of extra-pair paternity. We sampled an entire grid of tree swallow families (Hughson's) in an attempt to identify as many of the extra-pair fathers as possible. Our DNA fingerprinting analyses have so far found that in 1991, in HU, approximately 90% of males had at least one extra-pair nestling in their nest. This is almost twice the frequency of extra-pair paternity that we found in 1990. We have found no correlates of the percentage of extra-pair young in a male's own nest and several morphological and behavioural variables. However, we have yet to

identify the extra-pair fathers and compare them with the males that they cuckolded.

Linda Whittingham - "Relationship between male parental care and confidence of paternity in Tree Swallows" - Ph.D. Thesis

The level of male parental care may decrease as the male's paternity in the brood decreases; or a male may invest a certain level of parental care until paternity is very low, at which point male parental care is expected to drop to zero. The latter situation is predicted to apply to species of birds where males cannot recognize and preferentially feed genetically descendent offspring, and where male parental care significantly influences offspring survival. These conditions are found in tree swallows. We studied the relationship between male parental care and confidence of paternity in tree swallows breeding at BG, SP, and NB grids. We held males in captivity for 1 or 3 days during the pre-laying, laying or incubation period of their mate. Males were held in cages with one-way mirrors that allowed them to see their mates engage in extra-pair copulations. Females increased their rate of extra-pair copulation when their mates were held in captivity during the pre-laying and laying periods. Therefore, the confidence of paternity of these captive males was lower than unmanipulated males or males held during incubation. Although we reduced the male's access to his mate by up to 57%, we found no effect of the timing or length of captivity on the male's share of feeding nestlings or his defense of the brood.

Jeremy Mitchell - I. "Multiple nest site defense in the tree swallow" - B.Sc. Thesis

Previous studies on tree swallows have demonstrated that nest sites are a limiting resource. Despite this, single pairs may defend a second site. I increased the difficulty of double defence by placing visual barriers between paired nest boxes at a grid constructed on Stan Teeple's hayfield. Swallows unable to directly observe the second nest site were less successful in defending it, and additional pairs of birds moved in to breed successfully. This refutes the suggestion that multiple site defense is an artifact, caused by avoidance of some nest sites by unsettled birds. The willingness of tree swallows to defend a second site therefore strengthens the claim that nest predation and polygyny, though relatively infrequent occurrences, are nonetheless important in tree swallow breeding strategies.

II. "Cavity volume and clutch size in Tree Swallows"

In collaboration with RJR and Wallace Rendell, I continued a study of the influence of cavity volume on tree swallow clutch size. Frames were inserted into nest boxes in the North-East Sanctuary in order to reduce the volume of some boxes. Swallows nesting in these boxes were found to lay smaller clutches. This result explains the lower clutch sizes of tree swallows breeding in natural cavities, where mean cavity volume is smaller. Measurements of nestling growth were taken, and will be taken again in the 1992 field season, in order to determine the adaptive significance of

reduced clutch size.

Melanie Sharman - "The structure and function of Tree Swallow vocalizations" - B.Sc. Thesis (co-supervised by Dr. Laurene Ratcliffe)

The purpose of this study was to identify the songs and calls of the tree swallow and determine their behavioural context. Recordings were made at grids of nest-boxes (mainly HU), established by RJR in 1976. Recordings were analyzed on a sonagraph and various parameters measured to compare variation within and between individuals. This should lay the ground work for playback studies, which would pinpoint the parameters involved in individual and species recognition.

Beth MacDougall - "Paternity defence in Great Crested Flycatchers" - B.Sc. Thesis

My study investigated whether male Great Crested Flycatchers use mate guarding and/or territory defence during the female's fertile period as tactics to avoid cuckoldry. Six breeding pairs at or around QUBS were studied. Male mate-following in the fertile period was more common than either females following males, or male following after the fertile period. This suggests that males are indeed mate guarding. Territory size peaked in the fertile period; this may be a second paternity defence tactic. These results suggest that the risk of cuckoldry has been an important selective force in this species.

Jessie Deslauriers - I: "Phoebe response to cowbirds at the nest"

Further presentations of female Brown-headed Cowbirds and Song Sparrow controls, accompanied by tape recordings of typical songs, were made at several Eastern Phoebe nests, to test the degree of male and female aggression toward female cowbirds near a nest at the incubation stage. It is hoped to determine if phoebes have learned to recognize female cowbirds as a possible threat.

II: "Least Flycatcher calls and possible 'honest advertisement'"

If a male is advertising his quality as a mate, he should sing most in early morning at colder temperatures. If he is singing when sound carries best, then he should sing most in early morning regardless of temperature. The number of calls made over a five-minute period by individual Least Flycatchers were recorded, as was the temperature at 1 m height, and the hour since sunrise for a total of 66 sequences at varying times of day. An attempt was made to develop a procedure for netting and colour-banding Least Flycatchers to identify specific individuals, using mist nets, a flycatcher model and a tape of Least Flycatcher song. Further refinements to the procedure are needed (the tape was poor!).

Publications:

Chek, A.A. and R.J. Robertson. 1991. Infanticide in female Tree Swallows: a role for sexual selection. *Condor* 93: 454-457.

Conrad, K.F. and R.J. Robertson. In press. Intraseasonal effects of clutch manipulation on parental provisioning and residual reproductive value of eastern phoebes (Sayornis phoebe). *Oecologia*.

Dunn, P.O. and R.J. Robertson. In press. Extra-pair paternity in polygynous Tree Swallows. *Animal Behaviour*.

Dunn, P.O. and R.J. Robertson. In press. Geographic variation in the importance of male parental care and mating systems in Tree Swallows. *Behavioural Ecology*.

Lifjeld, J.T., P.O. Dunn, R.J. Robertson and P.T. Boag. In press. Extra-pair paternity in monogamous Tree Swallows. *Animal Behaviour*.

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Meek, S.B. and R.J. Robertson. In press. How do floater male eastern bluebirds benefit by filling vacancies on territories where widows have young? *Behavioural Ecology*.

Rendell, W.B. and R.J. Robertson. 1991. Competition for cavities among Great Crested Flycatchers, Myiarchus crinitus, Northern Flickers, Colaptes auratus, and Tree Swallows, Tachycineta bicolor. *Canadian Field-Naturalist*

Venier, L.A. and R.J. Robertson. 1991. Copulation behaviour of the Tree Swallow, Tachycineta bicolor: paternity assurance in the presence of sperm competition. *Animal Behaviour* 42:939-948.

Whittingham, L.A., P.D. Taylor and R.J. Robertson. In press. Confidence of paternity and male parental care. *American Naturalist*.

Theses:

Chek, A.A. 1991. Mate guarding in Tree Swallows. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.

Conrad, K.F. 1991. Allocation of reproductive effort in Eastern Phoebes (Sayornis phoebe). Ph.D. thesis, Department of Biology, Queen's University, Kingston, Ontario.

Meek, S.B. 1991. Parental investment and the maintenance of monogamy in Eastern Bluebirds Sialia sialis. Ph.D. thesis, Department of Biology, Queen's University, Kingston, Ontario.

Venier, L.A. 1990. Copulation behaviour of Tree Swallows (Tachycineta bicolor): paternity assurance in the presence of sperm competition. M.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.

Drs. John Smol and John Kingston

"Limnology"

Michael D. Agbeti - "Phytoplankton succession and species composition: autogenic and allogenic factors" - Ph.D. Thesis

This research is the continuation of an ongoing 3-year intensive research program designed to investigate the relative contribution of autogenic factors (e.g. competition for nutrients and grazing) and allogenic factors (in this case, wind-induced mixing) to phytoplankton succession and species composition. Sampling was started in February 1989 and continued through 1991.

The study lakes are Lake Opinicon (shallow and polymictic) and nearby Upper Rock Lake (much deeper and dimictic). The lakes were sampled once every two weeks during the ice-free period and once a month during the winter for water chemistry, phytoplankton and zooplankton (the zooplankton samples are being counted by Christine Watters). In addition, profiles of oxygen, temperature and conductivity and Secchi depth measurements were recorded. Current meters were also deployed to provide us with direct current measurements in the lakes. These data will be supplemented with meteorological data (wind speed and direction, solar radiation and air and water temperatures) supplied by QUBS.

In addition, sediment traps were deployed in the two lakes to monitor the following: (1) the long- and short-term preservation of phytoplankton in lake sediments, (2) sediment accumulation (production and resuspension) in a polymictic and dimictic lake, (3) the cues responsible for the formation of chrysophyte stomatocysts, (4) the onset of heterocyst formation in blue-green algae (Nostocales) and (5) the use of sediment traps in biomonitoring.

Assistants: Members of Smol Labs Inc.

Dr. Bruce Tufts and Jim Kieffer

"Physiological Responses of Fish to Stress"

For a number of years, we have been investigating the physiological responses of hatchery salmonids to a variety of exogenous and endogenous stresses in the laboratory. We are now interested in broadening our perspective to the wild species at Lake Opinicon. This past summer, we ventured to QUBS to determine whether our techniques, which are well refined for species like hatchery rainbow trout, could be applied to wild species at Lake Opinicon like the Largemouth Bass. Our preliminary experiments on Largemouth Bass were successful and we are now poised to carry out a more extensive study. At this time, we have applied to the Ontario Ministry of Natural Resources to investigate the physiological responses of species like Largemouth Bass to angling stress (i.e. catch and release). If funded, the experiments will be carried out at Lake Opinicon this summer.

II: Research by Non-Queen's Students and Staff

Dr. Allan J. Baker - Department of Zoology, University of Toronto and Royal Ontario Museum, Toronto

Anna Toline - "Population genetics of Phoxinus eos (Northern Redbelly Dace)" - Ph.D. Thesis, Department of Zoology, University of Toronto

Our objective is to test the processes of population differentiation (i.e. the importance of selection, gene flow, drift and mutation). We will use this knowledge to investigate the relative importance of founder-induced population differentiation relative to the role of gradual change. Phoxinus eos is attractive as a model species for the investigation of population differentiation since it is abundant and widespread throughout Ontario.

Using baited minnow traps, we have collected fish from three regions of Ontario, one of which is located near the Queen's University Biological Station (the other sites are near Sudbury and in Algonquin Park). Specifically, we have collected from seven populations located within 10 km of QUBS.

Once the samples were collected, fish were kept frozen until they were transported to the University of Toronto for morphometric and genetic analysis (isozyme and mitochondrial DNA). To date, the morphometric data are being analyzed and the isozyme analysis has begun.

Dr. Robert Baker - Department of Zoology, Erindale College of University of Toronto, Mississauga

"Aggressive Interactions and Development of Larval Dragonflies"

Previous research using field enclosures has suggested that aggressive interactions between larval odonates may affect rate of development and gain in mass. Unfortunately, these previous studies have used extremely small enclosures which may have restricted the range of substrate heterogeneity encountered by larvae under normal conditions and may artificially elevate frequencies of encounter with resultant artificial decreases in rate of development and gain in mass. I am testing for the effects of spatial scale (determined by various enclosure sizes) and population density on frequency of interactions and gain in mass of larval Enallagma boreale in Upper Dowsley Pond.

Dr. John Eadie and David Bell - Division of Life Sciences and Dept. of Zoology, Scarborough College, University of Toronto

" Alternative Female Reproductive Tactics in the Basswood Lacebug"

We are continuing studies on the ecology and evolution of alternative reproductive tactics in basswood lacebugs (Gargaphia tiliae). Lacebug females often act as brood parasites, in which they lay eggs in the clutches of conspecific females. Intraspecific brood parasitism (IBP) is a common phenomena in many species of birds, but has only recently been discovered in other groups of organisms. We are conducting manipulative field experiments and observational studies to determine the costs and benefits of such behaviours, and to identify the ecological factors that promote the evolution of parasitic reproductive tactics. These studies will allow us to assess the generality of theories on brood parasitism that, to date, have only been considered for birds.

Dr. Michael Fox - Environmental and Resource Studies Program, Trent University, Peterborough, Ontario

"Relationship between Population Structure and Reproductive Life-History Traits in Pumpkinseed"

The purpose of my study is to explain the high degree of variation exhibited by pumpkinseed (Lepomis gibbosus) and other centrarchid populations in their reproductive life-history patterns. As part of this study, I examined pumpkinseeds collected from 24 water bodies in eastern and central Ontario. Sixteen of these water bodies were assessed in 1991, including Upper Rock Lake and Smiths B from the

QUBS area. I assessed age and size-class structure, growth rates and reproductive traits (average age and length at maturation, body weight-gonad weight trajectory). Mean age and length at maturation was highly variable in these populations, ranging from 1.5 to 5.8 years in males and 1.5 to 5.6 years in females. Mean length and age at maturation were highly correlated in both males ($r^2 = 0.78$) and females ($r^2 = 0.83$). Mean age at maturity was highly correlated with measures of size and age structure in these populations, but not with measures of lifetime growth rate. The latter result runs counter to the predictions of several life-history models. Pumpkinseed populations in the Cataraqui watershed mature late, whereas those in the Kawartha watershed mature early. I am currently collaborating with Dr. David Philipp (Illinois Natural History Survey) to determine, through electrophoretic analysis, whether there is a genetic basis for these maturation differences between watersheds.

Assistants: Ian McDonald, Andy Danylchuk

Publications:

Keast, A. and M.G. Fox. (in press) Space and resource use patterns in an offshore open-water lake fish community. *Env. Biol. Fish*

Fox, M.G. and A. Keast. 1991. Effect of overwinter mortality on reproductive life history traits of pumpkinseed (Lepomis gibbosus) populations. *Can. J. Aquat. Sci.* 49:1792-1799.

Dr. James H. Fullard - Department of Zoology, Erindale College, University of Toronto, Mississauga, Ontario

"Insect Sensory Ecology and Neuroethology"

I. Neural bases for sound production in tiger moths - J. Fullard, Erindale College.

Tiger moths use specialized thoracic structures (tymbals) to generate trains of high frequency clicks that have been implicated in anti-bat defences in some species and social behaviour in others. The sounds are generated as part of a cyclic right side/left side rhythmic behaviour that can be elicited by activating the insect's uniquely simple ears and therefore serves as a model for the sensory activation of adaptively significant rhythmic behaviour. This summer I completed three years of work some of which was done at QUBS, some of which at our laboratories at Erindale. I have verified this summer that the motor output that controls the tymbals originates in 2-3 ipsilateral motor neurons that fire in extreme synchrony. Those cells were characterized by neural stains and future work will involve recording intracellular responses of these cells to auditory input.

Assistants: Francine Lewis, Jeff Dawson

II. Auditory inadequacy in moths against the gleaning bat, Myotis septentrionalis -
P. Faure, Section of Neurobiology and Behavior, Cornell University, Ithaca,
N.Y. and J. Dawson, Erindale College.

Gleaning behaviour in bats, the ability of certain species to locate their insect prey by listening to their sounds, represents a presently unstudied predation pressure on moths. The types of echolocation calls that these bats characteristically produce (high frequencies, low intensities, short durations) predicts that moths will not be able to effectively detect the approach of these bats. This summer we tested the auditory sensitivities of Catocala spp moths (Noctuidae) against the types of calls emitted by this area's resident gleaning bat, Myotis septentrionalis. Moths were electrophysiologically tested to determine their sensitivities to tones ranging from 5 to 125 kHz, 1 to 10 milliseconds in durations and with their ears either exposed or covered by the wings (as they would be in a resting condition). These measurements revealed that the moths are significantly deafer to the calls emitted by the bat. Moths then had their auditory nerves monitored in a flight room as a free-flying bat approached it. These direct measurements indicate that the noctuid moth ear is unable to cope with the inconspicuous echolocation calls of this gleaning bat. Gleaning may therefore be a foraging pressure to which moths possess no auditory defences and may face high mortality from bats that express this type of hunting behaviour.

Assistants - Francine Lewis, James Fullard

III. Behavioural defences of earless moths against aerially-hunting insectivorous bats. - F. Lewis, Erindale College.

Certain moths (e.g., silk-worm moths) do not possess ears as adults and their methods of defending themselves against the attacks of flying bats was examined this year. We tested the hypothesis that earless moths use flight patterns that result in their isolation from bats. Individual moths of known species and ear conditions were gathered from the collecting light in the leach field and released from a chair in the middle of the field. Using a dim red light, the flight characteristics of each moth was recorded (e.g., time taken to leave chair, number of times moth touched ground, time taken to leave circumscribed area around the chair). Records were also kept of the mean flight height that the moth attained as it left the chair. The results from these empirical flight observations support the hypothesis that earless moths fly less, fly closer to the ground and spend more time on the vegetation than do moths with ears. These flight defences represent an example of a passive response to the foraging pressure exerted upon them by bats and may have had costs in these insects' reproductive success.

Publications:

Boyan, G., Williams, L. and J.H. Fullard. 1990. Organization of the auditory pathway in the thoracic ganglion of noctuid moths. *J. Comp. Neurol.* 295:248-267

Fullard, J.H. and B. Heller. 1990. Functional organization of the arctiid moth tymbal (Insecta, Lepidoptera). *J. Morph.* 204:57-65

Morrill, S. and J.H. Fullard. 1992. Auditory influences on the flight behaviour of moths in a Nearctic site. I. Flight tendency. *Can. J. Zool.* (in press)

Yack, J.E. and J.H. Fullard. 1990. The mechanoreceptive origin of insect tympanal organs: a comparative study of similar nerves in tympanate and atympanate moths. *J. Comp. Neurol.* 300:523-534

Dr. Mart R. Gross - Department of Zoology, University of Toronto, Toronto

"Evolutionary Ecology of Fish Reproduction"

My research group continued its long-term studies of reproductive strategies in Lake Opinicon fishes. We are investigating their mating systems, parental care and life histories.

"Spawning Dynamics in Bluegill Sunfish"

James McGuire supervised the study of bluegill spawning bouts including dates, colony sites, nest numbers and male reproductive success. These data add to the 1985-89 study by Julie Claussen (she successfully defended her M.Sc. thesis in October 1991) and the 1990 study by James, providing seven years of continuous records in the Fish Reproduction Study Area. James was assisted in this work by Luca Cargnelli, who is analyzing the data as part of an undergraduate project in my lab. Julie Claussen provided advice as needed.

"Cuckoldry in Bluegill Sunfish"

Lucy Dueck supervised the study of cuckoldry in bluegill sunfish, collecting behavioural data and then fry and adults to determine paternity electrophoretically. She was assisted in this project by James and Luca. John Colbourne is responsible for the electrophoresis and is conducting his work at our Toronto lab. John is using cellulose acetate gels which require minimum protein loading. Lucy has decided to pursue an M.Sc. at Guelph starting in January 1992.

"Experimental Pool Research on Sunfish Spawning"

Jonathan Woods supervised the study of female mate choice and male nesting decisions in pumpkinseed and bluegill sunfish using the experimental pool facility. The study was helped by the experience gained in previous years by Lucy and James. Jonathan obtained excellent data on pumpkinseed but an unfortunate bloom of algae prevented observations and possible spawning of bluegill. Jonathan is analyzing the pumpkinseed data as part of an undergraduate project in my lab.

Assistants: Lucy Dueck, James McGuire, Luca Cargnelli, John Colbourne, Jonathan Woods

Dr. Darryl Gwynne - Insect Behaviour Group, Department of Zoology, Erindale College of University of Toronto, Mississauga, Ontario

"Sexual Selection and Insect Behaviour"

Al Jaramillo - "The response of female Conocephalus katydids to the calling songs of conspecific and heterospecific males (Orthoptera: Tettigoniidae: Conocephalinae)" - B.Sc. thesis (Dr. Darryl Gwynne and Dr. Glenn Morris, cosupervisors)

Conocephalus nigropleurum, C. brevipennis and C. fasciatus are common in Southern Ontario. Previous work with C. nigropleurum revealed that females respond (with phonotaxis) to conspecific song and several other song models and to the song of C. brevipennis, a species that co-occurs in the same habitat. In the present study we examined the song preferences of females from two populations of C. fasciatus, one near QUBS, where the other two species occur sympatrically, and from north of Thunder Bay where there are no sympatric congeners. Females from the two populations showed similar phonotactic behaviour: unlike female C. nigropleurum, they responded only to conspecific song and did not respond to the songs of C. brevipennis, C. nigropleurum or to a "white noise" model, even when these stimuli were played back in the absence of conspecific song. QUBS C. fasciatus females and Thunder Bay C. fasciatus females did not prefer sympatric male song over allopatric conspecific song.

These results suggest (1) that C. fasciatus females have not evolved the broad song preference shown by female C. nigropleurum, and (2) there is sufficient gene flow between populations of this (fully-winged) species that intraspecific differences in phonotactic behaviour due to different environments have not evolved.

Ian Robertson - "Nest intrusion, risk of offspring predation and duration of parental care in the burying beetle, Nicrophorus orbicollis (Coleoptera: Silphidae)" - M.Sc. thesis

1991 was the second and final year of a study examining the effect of nest intrusion on duration of paternal care by the burying beetle, Nicrophorus orbicollis. Burying beetles bury mouse-sized vertebrate carcasses as food resources for themselves and their offspring. If conspecifics locate these carcasses, they attempt to displace one or both residents, kill progeny and use the carcass for their own reproduction. Although two parents are more successful than one at preventing such takeovers, male parents abandon their broods several days before females. In addition to recording the natural occurrence of takeovers throughout brood development, I performed an experiment to determine whether males extended the duration of care when risk of intrusion at nests is high. I found that (1) almost 50% of nests were taken over by conspecifics within 10 days (92% occurring 3 to 5 days after carcass burial), (2) broods following a takeover were less successful than initial broods, and (3) males remained with their broods for approximately 11 days, even when intruders were experimentally excluded from their nests. The frequent occurrence of takeovers, along with the low success of replacement broods, suggests that reproductive opportunities on other carcasses were rare. That males remained with their broods until the carcass was almost depleted by larvae, even in the absence of intruders, is further evidence of this. I suggest that male burying beetles behave as if they have little or no chance of securing more than one carcass for reproduction, and that males abandon when the carcass is no longer capable of supporting a replacement brood.

Thesis:

Robertson, I.C. 1992. Parental care behaviour in two species of burying beetles in eastern Ontario (Coleoptera: Silphidae). M.Sc. Thesis, Department of Zoology, Erindale College, University of Toronto, Mississauga, Ontario.

Dr. Erica Nol - Department of Biology, Trent University, Peterborough, Ontario

Lara Hutton - "The effect of predation and nutrients on the size and number of young in the freshwater snail, Viviparus georgianus" - B.Sc. thesis

Freshwater, viviparous snails inhabiting rocky shorelines of the large lakes in eastern Ontario have thicker shells and fewer, large offspring than snails from marshy, nutrient-rich parts of the lakes. It is hypothesized that snails from rocky shorelines experience greater predation pressure, and their smaller size and larger offspring are a phenotypic response to differences in nutrients and predation between the two sites. This study documents extensive life-history variation within a small geographic area.

Dr. David Philipp - Center for Aquatic Ecology, Illinois Natural History Survey,
Champaign, Illinois

"Hormonal Analysis of Male Bluegill during the Spawning Season"

This research is investigating what controls reproductive hormone production among male bluegill during their annual breeding cycle. Bluegill spawn in synchronous "bouts", so that males throughout the lake begin to form colonies and build nests all within a few days of each other. Our goal was to measure hormone concentrations, particularly 11-keto-testosterone during these bouts of reproductive activity and relate them to male characteristics and male reproductive success. A number of experiments were conducted in which blood samples were collected from males during the different phases of reproduction, including pre-nesting, nest building and spawning. These blood samples will be analyzed at the University of Illinois for their hormonal concentrations using radioimmune assay techniques.

Assistant: Julie Claussen

"Hybridization between Bluegill and Pumpkinseed Sunfish in Lake Opinicon"

Research in this area has been going on for a number of years. Recently, Blake Konkle, a Ph.D. student in our lab, discovered that hybridization between bluegill and pumpkinseed was the result of small sneaker male bluegill cuckolding (stealing fertilizations from) spawning pairs of pumpkinseed. Hybridization is often thought to occur because individuals are making a mistake in species identification. However, our investigations show that this is most likely not the case. In addition, using electroshocking techniques, we are continuing to assess the relative proportions of the two sunfish species and their hybrids in the population.

Assistant: Julie Claussen

Dr. David Philipp and Frank Phelan - Center for Aquatic Ecology, Illinois Natural History Survey and Queen's University Biological Station

"Largemouth and Smallmouth Bass Reproductive Success"

In association with the Ontario Ministry of Natural Resources and the Ontario Federation of Anglers and Hunters, we have completed the second of a three year study of largemouth and smallmouth bass reproductive success. This year the research group was expanded to include an undergraduate student from Queen's University sponsored by OMNR and OFAH. This increase in personnel allowed us to more intensively monitor the spawning success, the duration of nesting and parental

care behaviour in both bass species. We were also able to begin the first of a two year project testing the effects of catch-and-release angling on the parental males during the nest guarding period. Additionally, underwater filming equipment was used to record nest predation during the absence of the guarding male due to experimental angling as well as record male and female spawning behaviour at four test sites: Lake Opinicon, Charleston Lake, the Mississippi River (Little Mississippi) and the St. Lawrence River. At the end of the study, we hope to offer suggestions for effective protection of nesting bass.

Assistants: Mark Kubacki, Mike Fuhr, Jeff Stein, Matt Deters, James Fotheringham

Kent Prior, Dr. P.J. Weatherhead and Dr. C. Strobeck - Natural Resource Conservation, Canadian Parks Service, Ontario Region, Department of Biology, Carleton University and Department of Zoology, University of Alberta

"Ecological Genetics and Conservation of Black Rat Snakes (Elaphe o. obsoleta) in Canada"

The black rat snake (Elaphe o. obsoleta) is uncommon in Canada and is restricted to three disjunct regions within Ontario (i.e. the Rideau Lakes region, Skunk's Misery wetlands complex in Middlesex County and Haldimand-Norfolk County west of Big Creek). Because geographic isolation can limit gene flow in species with low dispersal ability (e.g. snakes), resulting in a loss of polymorphism and a reduction in fitness, it is necessary to determine the genetic structure of black rat snake populations prior to the implementation of any recovery strategies that include genetic management (e.g. translocation).

In 1991 we began a study to investigate the genetic variability in two large populations in the United States (Michigan and New York) and all Canadian populations of black rat snakes in order to (1) measure levels of heterogeneity within demes, (2) estimate the degree of relatedness between allopatric populations, and (3) assess the viability of smaller populations. During our 1991 pilot work we sampled blood and tissue from populations at four study sites in the Rideau Lakes region (Chaffey's Lock, Charleston Lake Provincial Park, Murphy's Point Provincial Park and St. Lawrence Islands National Park).

We expect the results of this study to provide insight on the evolutionary history of disjunct populations and allow further refinement on the prospects for population survival. We hope to have preliminary results of an analysis of the mitochondrial DNA from samples collected to date by the spring of 1992.

Assistant: Dan Nuttall

Dr. Bruce P. Smith - Biology Department, Ithaca College, Ithaca, NY.

"Water Mite Parasitism of Aquatic Insects"

In 1991 I devoted much of my time to data analysis and writing, but I did continue research on an apparent correlation between parasitism by larval Limnochares aquatica mites and reproductive success of Gerris comatus water striders. In previous years, I collected samples of gerrids taken in copulo; each sample was from one date and one specific locality, with at least 25 copulating pairs per sample. There was a significant positive correlation between the number of mites on the male and female of each pair, suggesting assortative mating based on intensity of parasitism. However, samples from 1991 did not show this relationship.

My new hypothesis is that there is assortative mating by age: adults in the summer population vary from several weeks to almost one year in age, and my previous experiments have shown old males are less successful than young males in obtaining mates. From previous work with Wanda Cook, we found that limnocharid mites on odonates accumulate with time, so older individuals carry heavier parasite burdens. In water striders, the apparent assortative mating by intensity of parasitism could actually be assortative mating by age, with intensity of mite infestation also being determined by age. I have noted differences between years in synchrony of larval mites and the adult stage of water striders, and this may explain why there is apparent assortative mating by infestation in some years but not others.

I also continued my survey of the dragonfly fauna of the QUBS region, begun in 1990. My purpose is to develop a checklist, key, and reference collection of local species to aid further research on dragonflies and their parasitic mites. Many thanks to all who helped by collecting specimens.

Publications:

Smith, B.P., and W.J. Cook. 1991. Negative Covariance between larval Arrenurus sp. and Limnochares americana (Acari: Hydrachnidia) on male Leucorrhinia frigida (Odonata: Libellulidae) and its relationship to the host's age. Canadian Journal of Zoology, 69:226-231.

Dr. Patrick Weatherhead - Department of Biology, Carleton University, Ottawa, Ontario

"Parasites, Sexual Selection and Mate Choice in Red-winged Blackbirds"

Collaborators: Karen Metz, Dr. Gordon Bennett (Memorial University), Dr. Rebecca Irwin (University of Montana), Dr. Peter Boag (Queen's University), Dr. Kevin Teather (Cambridge) and Dr. Kathy Wynne-Edwards (Queen's University)

This project proceeded on two fronts in 1991. First, we continued monitoring the reproductive activity of our marked population in three marshes. All new breeding birds were banded and blood samples were collected from all young and breeding adults. DNA will be extracted from the blood for use in paternity analysis. A Collaborative Special Project Grant from NSERC also allowed progress on analyzing samples collected over the past five years. These data will be used to analyze true male choice (i.e. genetic) relative to variation in male secondary sexual traits and will also provide the first genetic analysis of lifetime reproductive success.

Prior to 1991 we had sampled haematozoa extensively to assess the relationship between a male's blood parasite status and his secondary sexual traits. To broaden the scope of this investigation, we conducted a study in 1991 in which a comprehensive analysis of parasites (ectoparasites, haematozoa and endoparasites) was undertaken for a sample of males for which extensive data on behaviour, song, plumage, testosterone and morphology had been collected. Preliminary analysis reveals almost no correlations either among parasites or between parasites and testosterone or between parasites and secondary sexual traits.

"Ecology and Behaviour of Black Rat Snakes"

1991 was our eleventh summer of study on the local black rat snake population. 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 understanding the 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.

Assistants: Frances Barry, Stephen Scribner

"Locomotorory Performance, Predator Avoidance and Habitat Selection in Three Species of Semi-Aquatic Snakes"

Northern water snakes, common garter snakes and eastern ribbon snakes occur throughout the marshes of southeastern Ontario, often sympatrically. This study employed a comparative approach to investigate the differences in locomotory performance and its thermal dependence among these species. Performance of water snakes was superior, followed by ribbon snakes and then garter snakes, although garter snake locomotory capability was adapted to a broad temperature range. Locomotory performance was related to antipredator behaviour; water snakes had the greatest flight distance, and ribbon snakes and garter snakes used defensive behaviours most, under different scenarios. In an enclosure constructed to observe habitat use by snakes, the habitat preferred by each species for foraging, basking and as refugia was related to its swimming and crawling ability.

Assistant: Stephen Scribner

Dr. Kevin Teather - "Patterns of food acquisition in male and female red-winged blackbird nestlings" - Post-Doctoral Fellow, Cambridge University, U.K.

In species of birds in which males are substantially larger than females, size differences often become apparent shortly after hatching. If successful food acquisition is size-related, either because parents actively choose to feed the largest nestlings or because larger nestlings can better compete with their siblings, then males, in such species, should have an advantage. In this investigation, I examined the feeding behaviour and success of nestling red-winged blackbirds (Agelaius phoeniceus), a species in which males are approximately 30% heavier than females by fledging. By observing interactions at nests in which brood size, nestling age and the sex ratio of nestlings had been controlled experimentally, my aim was twofold: First, I attempted to determine the relative importance of a nestling's height, distance from its feeding parent, and the sequence in which it begged in influencing its success in obtaining food. Second, I compared males and females with respect to these three characters.

Analysis of videotapes obtained from cameras set up at ten experimental nests indicated that nestlings that could reach highest while begging were most successful at obtaining food from parents during individual feeding bouts. However, while there was a tendency for nestlings that begged earlier to be offered food first, a nestling's position in the nest during these bouts did not influence its feeding success. Males begged more often than females and were offered more food by parents. Males were also more likely to be fed when they begged. This was most likely because males, being larger than females, were able to reach higher while begging. Neither sex was more likely to beg sooner or to occupy certain positions in the nest. However, while males that had been transferred from other nests received less food than natal males, there were no differences in food acquisition between transferred and natal females. Differences in relative success of males and females under different conditions may help to explain differences in fledging sex ratios observed in many dimorphic species.

Frances Barry - "Sexual size dimorphism in northern water snakes" - M.Sc. Thesis

Work was completed in 1991 on this investigation of sexual size dimorphism in northern water snakes. Although highly male-biased operational sex ratios result in intense competition among males to breed, males are only half the size of females. This apparent paradox may be explained by the advantage that males in good condition realize in participating in many mating aggregations, and the fact that condition declines with male body size. In addition, from work in 1990 it was found that most broods are multiply-sired, which suggests that males are unable to monopolize individual females.

Assistant: Stephen Scribner

Stephen Yezerinac - "Sexual selection in yellow warblers" - Ph.D. Thesis

Preliminary field work was conducted in the summer of 1991, prior to entering the degree program in the fall. Breeding males were banded and blood samples were collected for both parasite analysis and DNA fingerprinting. This project will start in earnest in 1992.

Publications:

Barry, F.E., P.J. Weatherhead and D.P. Philipp. 1992. Multiple paternity in a wild population of northern water snakes (Nerodia sipedon). Beh. Ecol. and Sociobiol. (in press).

Dufour, K.W. and P.J. Weatherhead. 1992. A test of the condition bias hypothesis using brown-headed cowbirds trapped during the breeding season. Can. J. Zool. (in press).

Gibbs, H.L., P.T. Boag, B.N. White, P.J. Weatherhead and L.M. Tabak. 1991. Detection of a hypervariable DNA locus in birds by hybridization with a mouse MHC probe. Molecular Biol. and Evol. 8:433-446.

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Hurd, P.L., P.J. Weatherhead and S.B. McRae. 1991. Parental consumption of nestling feces: good food or sound economics? Behav. Ecol. 2:69-76.

Metz, K.J. 1991. The enigma of multiple nest building by male marsh wrens. Auk, 108:170-173.

Metz, K.J. and P.J. Weatherhead. 1991. Color bands function as secondary sexual traits in red-winged blackbirds. Behav. Ecol. and Sociobiol. 28:23-27.

Metz, K.J. and P.J. Weatherhead. 1992. Seeing red: uncovering coverable badges in red-winged blackbirds. Animal Behaviour, in press.

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Robertson, I.C. and P.J. Weatherhead. 1002. The role of temperature on microhabitat selection by northern water snakes (Nerodia sipedon). Can. J. Zool., in press.

Shutler, D. and P.J. Weatherhead. 1991. Basal song rate variation in male red-winged blackbirds: sound and fury signifying nothing? *Behav. Ecol.* 2:123-132.

Shutler, D. and P.J. Weatherhead. 1991. Owner and floater red-winged blackbirds: determinants of status. *Behav. Ecol. and Sociobiol.* 28:235-241.

Weatherhead, P.J. 1990. Nest defence as shareable paternal care in red-winged blackbirds. *Animal Behaviour*, 39:1173-1178.

Weatherhead, P.J. 1990. Secondary sexual traits, parasites and polygyny in red-winged blackbirds. *Behav. Ecol.* 1:125-130.

Weatherhead, P.J. and G.F. Bennett. 1991. Ecology of red-winged blackbird parasitism by haematozoa. *Can. J. Zool.*, in press.

Weatherhead, P.J. and G.F. Bennett. 1992. Ecology of haematozoa parasitism in brown-headed cowbirds. *Can. J. Zool.*, in press.

Weatherhead, P.J., D.J. Hoysak, K.J. Metz and C.G. Eckert. 1991. A retrospective analysis of red-band effects on red-winged blackbirds. *Condor*, in press.

Weatherhead, P.J. and S.B. McRae. 1990. Brood care in American robins: implications for mixed reproductive strategies by females. *Animal Behaviour*, 39:1179-1188.

Weatherhead, P.J. and R.D. Montgomerie. 1991. Good news and bad news about DNA fingerprinting. *Trends in Ecology and Evolution*, 6:173-174.

Weatherhead, P.J., R.D. Montgomerie and S.B. McRae. 1991. Egg-laying times of American Robins. *Auk*, 108:965-967.

Weatherhead, P.J. and I.C. Robertson. 1990. Homing to food by black rat snakes (*Elaphe obsoleta*). *Copeia*, 1990:1164-1165.

Weatherhead, P.J. and I.C. Robertson. 1992. Thermal constraints on swimming performance and escape response of northern water snakes. *Can. J. Zool.*, in press.

Weatherhead, P.J. and K.L. Teather. 1991. Are skewed fledgling sex ratios in sexually dimorphic birds adaptive? *American Naturalist*, in press.

Thesis:

Barry, F.E. 1991. Sexual size dimorphism of northern water snakes *Nerodia sipedon*. M.Sc. Thesis, Department of Biology, Carleton University, Ottawa.

User	Supervisor	Post-Doc	Graduate Student	Assistant	Total
INTERNAL (QUEEN'S)					
Aarssen	5	0	190	189	384
Colgan	0	0	0	5	5
Cooke	0	111	0	14	125
Crowder	0	0	0	33	33
Forsyth	0	0	0	36	36
Gibbs	0	0	4	0	4
Harmsen	5	0	30	50	84
Keast	131	0	0	388	519
Montgomerie	9	0	9	10	28
Phelan	n/a	0	0	94	94
Ratcliffe	5	0	23	74	102
Robertson	95	70	79	272	516
Smol/Kingston	0	0	23	38	61
Tufts	2	0	6	6	14
Wynne-Edwards	4	0	0	0	4
Total Internal	256	181	364	1209	2010
EXTERNAL					
University of Toronto					
Baker, A. (R.O.M.)	0	0	3	0	3
Baker, R. (Erindale)	3	0	0	3	6
Eadie (Scarborough)	2	0	4	37	43
Fullard (Erindale)	87	0	0	244	331
Gross	2	0	41	245	288
Gwynne (Erindale)	4	0	100	3	107
Carleton University					
Weatherhead	79	191	73	295	638
Illinois Natural History Survey					
Philipp	34	0	57	210	301
Ithaca College					
Smith	102	0	0	0	102
Trent University					
Fox	2	0	2	2	6
Nol	0	0	0	4	4
University of Cambridge					
Teather	0	54	0	0	54

User	Supervisor	Post-Doc	Graduate Student	Assistant	Total
Canadian Parks Service Prior	0	0	0	81	81
Rideau Lakes Fisheries Assessment Unit - Smith	10	0	0	14	24
Total External	325	245	280	1138	1988
TOTAL RESEARCH USER-DAYS	581	426	644	2347	3998
% Queen's	44	43	57	51	50
% Non - Queen's	56	57	43	49	50

USER-DAYS IN TEACHING ACTIVITIES: 1682

CONFERENCE AND FIELD TRIP USE: 644

OTHER* 847

Grand Total User-Days in 1991 7171 (up 3% from 1990)

(* QUBS staff, family and their visitors are not included)

Summary of Conference, Meeting and Field Trip Use of QUBS in 1991

Organizer	Function	Number of Participants	Duration
Frances Barry (Carleton - Biology)	Reunion Weekend	12	Jan 11-13
Connie Annetta (Queen's - Italian)	Italian Club - Language Immersion Weekend	9	Jan 18-20
Bonnie Fenton (Queen's - German)	German Club - Language Immersion Weekend	10	Jan 25-27
Dr. Dolf Harmsen (Queen's - Biology)	Bio 439 (Population Ecology) Weekend	18	Feb 1 - 3
Dr. Dolf Harmsen (Queen's - Biology)	Bio 439 (Population Ecology) Weekend	21	Feb 8 - 10
Floyd Connor (QUBS)	Winter Ecology Weekend	4	Feb 23-24
Dr. Ed Kott (Wilfrid Laurier - Biology)	Fish Ecology Course Field Trip	14	Mar 2 - 3
Dr. H. Lisle Gibbs (Queen's - Biology)	DNA Fingerprinting Workshop	42	Mar 8 - 10
Mrs. Marilyn Tedford (S. Crosby Public School)	Northern Lights Environmental Conference	250	Apr 18-19
Ms. Rose Jones (Lasalle Secondary School)	O.A.C. Biology Field Trip	25	Apr 25
Dr. Dolf Harmsen (Queen's - Biology)	High School Enrichment Program	12	May 6
Mr. Mark Millan (Rideau Heights Public School)	Canoe Trip and Station Tour	24	May 29

Organizer	Function	Number of Participants	Duration
Mr. Mark Millan (Rideau Heights Public School)	Canoe Trip and Station Tour	25	June 11
Mr. Colin Gaskell (O.F.N.)	Ottawa Field Naturalists Field Trip and Picnic	31	June 23
Dr. John Smol (Queen's - Biology)	Post-Congress Chrysophyte Excursion	11	Aug 17-20
Mr. Larry Ritchie	4-H Club Field Trip	19	Aug 22
Dr. Ed Kott (Wilfrid Laurier - Biology)	Wilfrid Laurier Senior Undergraduate Field Course	17	Aug 25-Sept 7
Ms. Moira Drummond	Art in Nature Program - Watercolours	8	Sept 9-11
Dr. Paul Horgen (Erindale College)	Centre for Plant Biotechnology Conference and Retreat	27	Sept 14-15
Ms. Rose Jones (Lasalle Secondary School)	Environmental Biology Field Trip (Lake studies)	15	Sept 18
Ms. Adele Mullie (Queen's - Biology)	Bio 202 (General Ecology) Weekend	66	Sept 21-22
Dr. Brian Cummings (Queen's - Biology)	Bio 339 (Limnology) Weekend	24	Sept 28-29
Ms. Adele Mullie (Queen's - Biology)	Bio 202 (General Ecology) Weekend	61	Oct 5-6
Ms. Adele Mullie (Queen's - Biology)	Bio 202 (General Ecology) Weekend	55	Oct 26-27
Ms. Jocelyne Devi-Leyton (Yoga Kingston)	Yoga Group	8	Nov 15-16
Ms. Theresa Gray (C.W.Y.)	Canada World Youth Training Workshop	15	Dec 5-8

QUBS Seminar Schedule 1991

- May 20** Dr. Gordon Bennett - Memorial University, St. John's, Nfld.
"Biting flies: olfactory and visual stimuli"
- June 5** Frances Barry - Department of Biology, Carleton University
"Multiple paternity in a wild population of Northern Watersnakes"
Dr. Bruce Smith and Kit Muma - Ithaca College
"Everglades by video"
- June 12** Dr. Rebecca Irwin - Department of Biology, Carleton University
"Sexual selection in New World blackbirds: A phylogenetic approach"
- June 19** Dr. Bruce Smith - Department of Biology, Ithaca College
"The high and mitey: Why do some individuals carry most of the mites?"
- June 25** Dr. Bernie Crespi - Department of Biology, Cornell University
"Insect reproductive tactics and sociality"
- July 2** Dr. George Eickwort - Visiting Field Scientist
Department of Entomology, Cornell University
"Adaptations of social behaviour at high altitudes and latitudes: the sweat bees"
- July 4** Dr. George Eickwort - Visiting Field Scientist
Department of Entomology, Cornell University
"Evolution of specialized foraging in bees"
- July 10** Dr. Bruce Tufts - Department of Biology, Queen's University
"Physiological aspects of exercise in fish: Implications for catch and release angling"

July 25 Dr. Eugene Daev - Department of Biology, Leningrad State University

"Pheromonal action on genetical processes in mice: Neuroendocrinological and other hypotheses"

Aug. 6 Dr. Michael Clarke - Visiting Field Scientist
Department of Biology, McGill University

"Food storing tactics in chipmunks - a case of parent-offspring conflict?"

Aug. 8 Dr. Michael Clarke - Visiting Field Scientist
Department of Biology, McGill University

"An introduction to Australian birds with particular reference to some cooperative breeders"

Fee Schedule for 1992

55

Board Charges - Meals only

\$410/month/person - no obligation for chores

\$285/month/person - includes obligation for chores on a rotating schedule

Accommodation Charges - Housing only

\$15.75/month/person - Dormitory (White House and Curran Cottage)

\$31.50/month/person - Small Cabin (cabins 1-7, 10 and shaker)

\$63/month/person - Medium Cabin (cabins 12,13,14)

\$84/month/person - Large Cabin (cabins 8,11 and WhiteHouse Apt)

\$115.50/month/person - Cottage (Keast, Earl or Sumac)

Room and Board Rates for Short-Term Visitors

\$170/person - weekly R&B for field courses-includes lab fee

\$21/day/person - 24 hr. room and board

\$4.00 - breakfast or lunch only

\$7.50 - dinner only

\$9.00/person - overnight accommodation - academic purposes

\$18.00/person - overnight accommodation - non-academic purposes

NOTE

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

Boat Rental

\$185/month, \$85/week - includes maintenance from normal use - gas and oil not included

\$39/day - includes gas and oil for one day rental

NOTE - Fees for use of pontoon boats are negotiated directly with the Manager or Director

Bench Fees

\$4.40/day - non-Queen's staff or major researcher (M.Sc. or Ph.D. candidate, project coordinator or PostDoctoral Fellow)

\$1.52/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

Provincial Sales Tax

P.S.T. is applicable to oil used in boats, to photocopies and Fax.

Goods and Services Tax

G.S.T. is applicable to charges for boat rental, direct sales (eg. equipment) and all charges for R&B from casual users.

