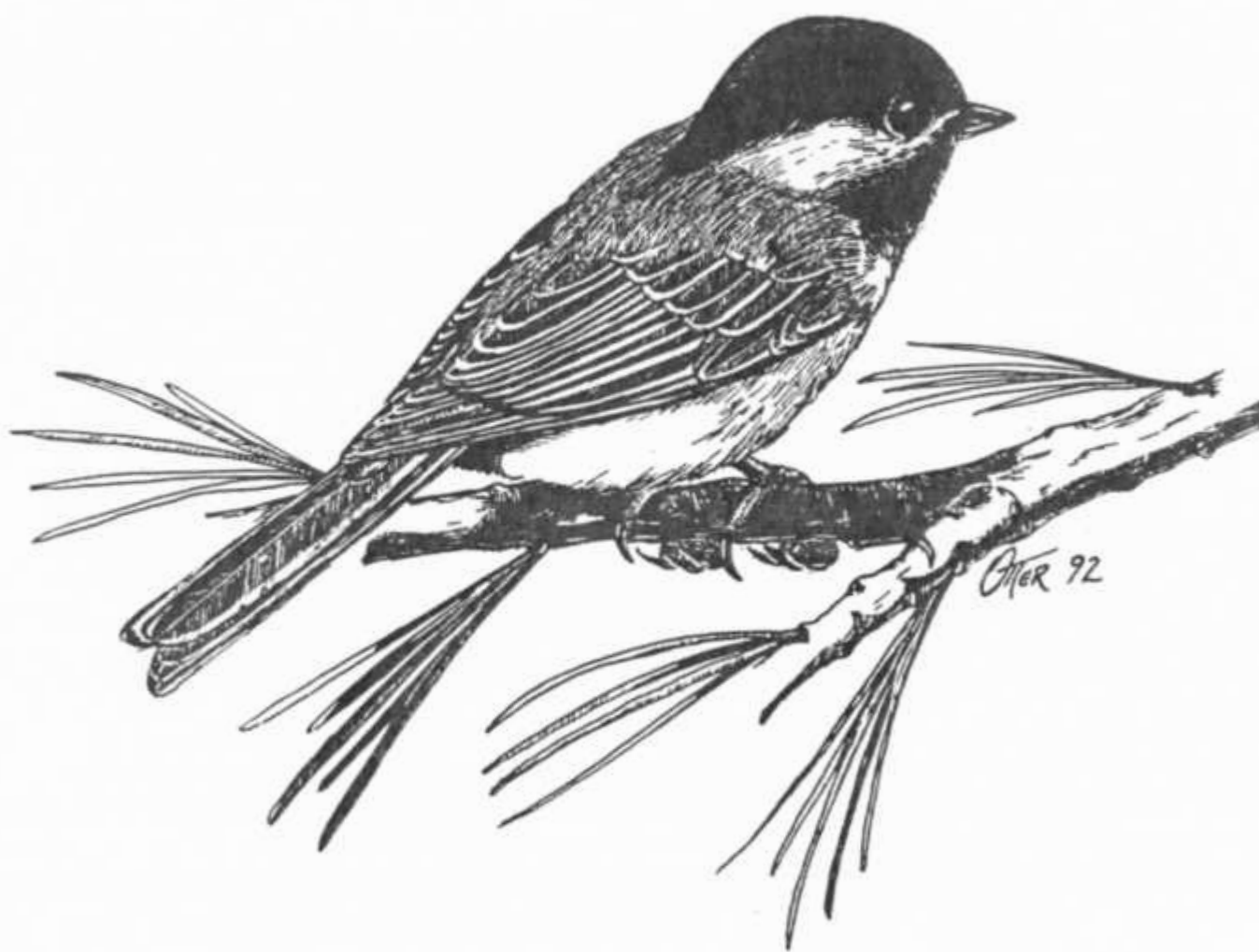


*Queen's University Biological Station
Annual Report and Newsletter*

1992



Director: Dr. Raleigh J. Robertson

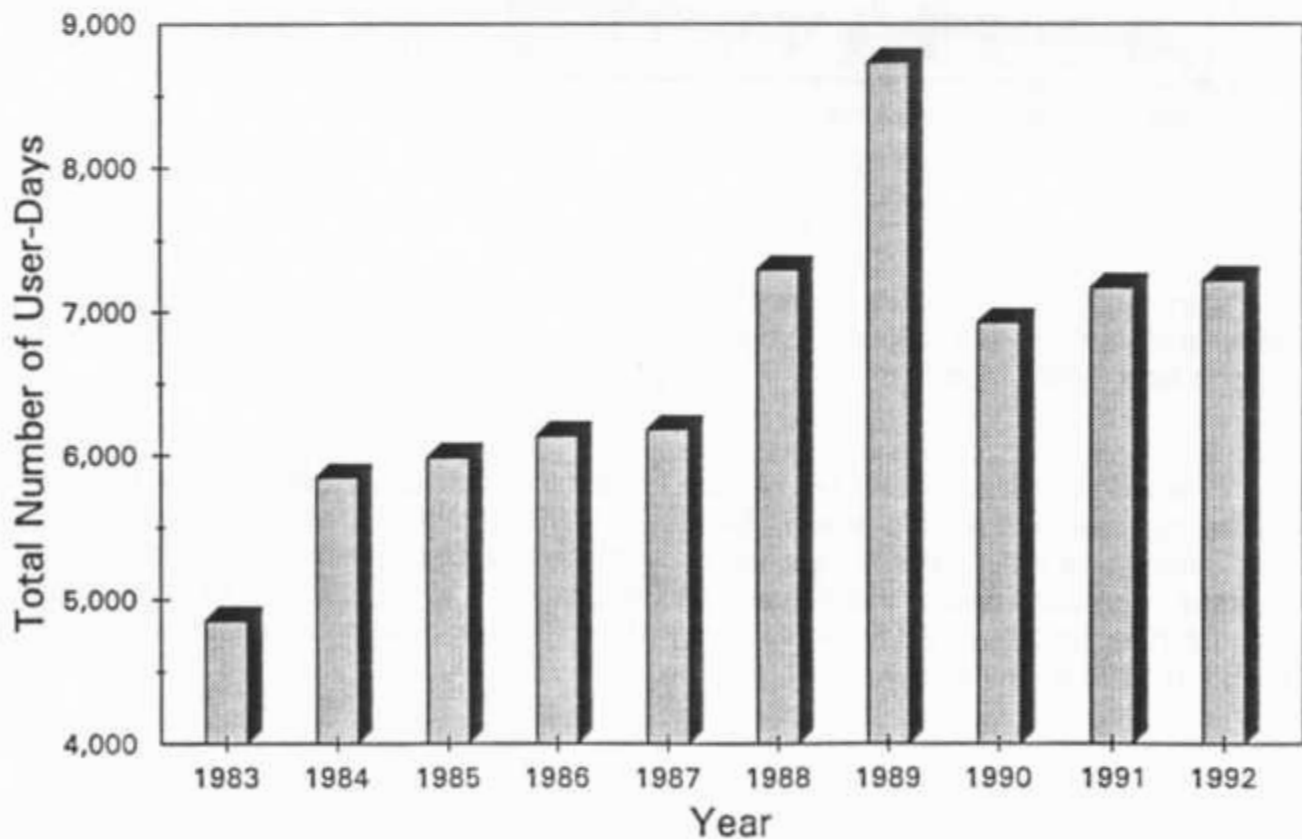
Manager: Frank J.S. Phelan

Introduction

Nineteen ninety-two was another successful and busy year at Queen's University Biological Station. User-days were up slightly from 1991 levels (User-day data are displayed in tabular form later in this report). On average, 32 researchers (professors, graduate students, honours students and assistants) were in residence throughout the summer. Abstracts of research projects and personnel involved are contained in the following pages.

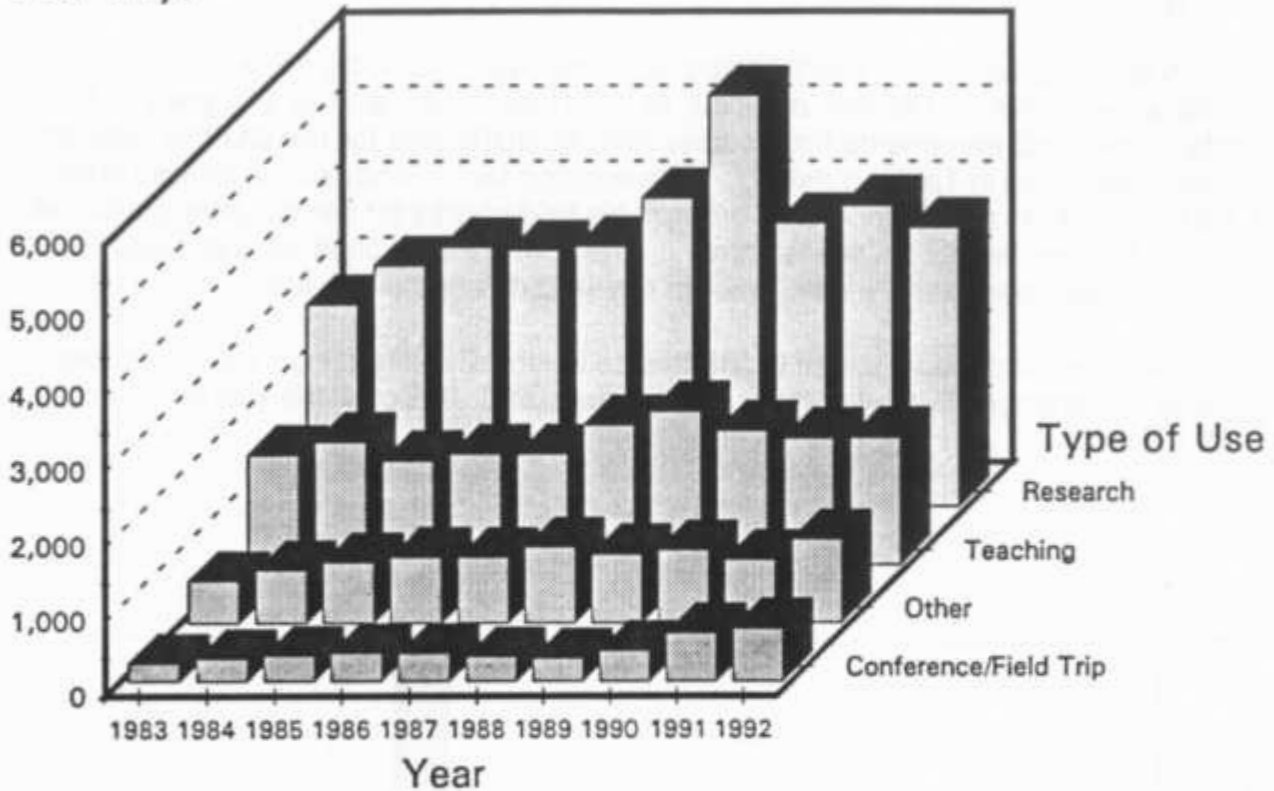
In teaching activities, QUBS hosted eight modules, including seven full-time, and one (Bats and Caves - Fenton) part-time in the Ontario Universities Program in Field Biology. Titles and enrolments for modules held at QUBS and for the OUPFB program in general are found in Tables 1 through 3. In addition 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 fourteenth edition of the Naturalists' Workshop, described in more detail later in this report, was held in May.

Over the last decade, use of QUBS has been steadily increasing. The figure below illustrates the changes in total number of user-days at QUBS over the last ten years.



Comparing 1983 levels with 1992 levels, overall use is up by 49%. All types of use have increased over the ten-year interval, the greatest increase occurring in conference and field trip use (up 188%). Yearly changes in the types of use are illustrated in the figure below. Over the past decade, research use is up by 38% and teaching use by 15%.

User-Days



In 1992, QUBS hosted Dr. Ian McLean (University of Canterbury, New Zealand) under the Visiting Field Scientist Program. Details of his visit are found in a separate section later in this report.

Small conferences and workshops on a variety of topics seem to be making increasing use of the field station facilities. QUBS continues to be an important destination for a variety of field trips, especially those associated with fall and winter term 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 1992 appears later in this report.

Cape-Sauriol Environmental Studies Area

The John M. Cape - Charles Sauriol Environmental Studies Area continues to be an important site for teaching and research in environmental sciences. The value of this property lies mainly in its undeveloped state. As a large, undeveloped block of property with extensive shoreline, its communities, habitats and species serve as comparisons with smaller, fragmented, developed tracts within the Rideau Corridor.

The Purchase of this 315 hectares was made possible by a combination of funds donated for the purpose by the Ontario Heritage Foundation (Natural Heritage Challenge Grant), Canadian National Sportsmen's Shows, John M. Cape, Mrs. John Pangman, Mrs. Dorothy S. Bullen, Mrs. W.E. Burton and the McLean Foundation. The latter four donations, as well as help for some of the others, were arranged through the dedicated efforts of Mr. Charles Sauriol.

In view of the progress of development in the area of QUBS, the decision to purchase and protect this property from development has been vindicated.

Currently, application has been made to the Principal's Development Fund for support of a joint Biology/Geography proposal to prepare a digital base map of resources for all QUBS properties. If funded, this initiative will enable better knowledge of QUBS lands, their features, habitats and species. Over time, comparisons between sites and long-term monitoring will be facilitated. A digital base map could be the first step toward a proper geographical information system for QUBS. Such a system, properly developed, could become a significant teaching and research tool for the environmental sciences.

Initial plans were made in 1992 for the development of a system of trails through the Cape-Sauriol Environmental Studies Area. Perhaps with assistance from the "Friends of Opinicon", this might be accomplished. Reopening of the historical roadways and paths is a first step to improving access by foot to this tract.

Hewlett-Packard Computer Facilities

The computer facilities at QUBS (donated by Hewlett-Packard in 1991) received extensive use by station regulars in 1992. Some workshops and meetings, notably the Willow Workshop (Ontario Field Botanists) and the Geographic Information Systems Workshop, made intensive use of the computer facilities. In the Willow Workshop, the computers were used to provide identification keys to willows. In the Geographic Information Systems Workshop, the computers were used to display GIS maps and data arrays.

1992 Renovations and Additions

In 1992, a number of changes and improvements were made to QUBS facilities. These included: (1) The legs of the new tip-up docks were braced to reduce the wobble apparent while getting in and out of boats. An x-brace was welded up and fitted to each set of dock legs. (2) In Curran cottage, the shower room was repainted and two more bedrooms (#2 and #3) were upgraded. The old windows were replaced, the insulation improved and new drywall installed. Presently, only room #1 remains to be upgraded. Hopefully, this will be done in 1993. (3) The old PCP/CBA lab was altered, becoming a duplex cabin available for accommodation. The old building was gutted, rewired and insulated. A partition wall was added and a new entrance and step at the south side. Each half was panelled, the ceiling tiled and built-in bunks were fabricated. To make this new "Basswood Cabin" functional for 1993, vinyl floor coverings, closets and desks are needed. The quiet location of this cabin should provide improved accommodation space for those whose research is carried on at night. (4) In the lodge, the old pedestal sinks were removed from the women's washroom and replaced with a long counter with inset sinks. This resulted in a much more functional washroom with more storage space and an end to the old plumbing. (5) In late summer, tests of our well water began to show signs of mild contamination. Whether this was the result of a very rainy summer or some subterranean fault could not be determined. It was decided to purchase and install an ultraviolet purification system to ensure a safe drinking water supply. The Biology Department, through Dr. Gerry Morris (Department Head), provided the funds for this installation. In the basement of the White House, next to the pressure tank, a pair of UV treatment units were plumbed into the water system. These units can operate singly (one serving as backup for the other), in tandem or the water supply can be split (half the water delivered passing through each unit). Testing has shown that a single unit is able to treat all of the water at present delivery rates, so the units will operate singly and will alternate monthly. In this fashion, a backup unit is always ready to go. (6) To facilitate use of the workshop, some alterations were needed. Wood storage space was built in tiers under the roof extension on the north side. To keep out wind and snow and to provide a visual barrier, lattice-work was installed along the length of the north side. Provision for tractor parking and storage of seldom-used equipment was also provided under the north side roof extension. Space freed up by this alteration enabled tractor-mounted equipment to be stored under the roof extension on the south side of the shop. Inside, the large fabricating table was provided with wheels and a general clean-up of extraneous and unnecessary equipment and material was undertaken. Overall, access is now possible by both overhead doors and there is much more room available for shop projects. (7) In fall, construction started on a new cottage. This cabin, called (at least for now) Maplewood Cottage, stands north of Sumac Cottage, overlooking Stumpy Bay. The site was cleared, a septic system installed and the shell of the building was up before the weather turned nasty in late fall. With luck, it should be ready for occupancy by late spring. Maplewood Cottage is a scaled-down version of Sumac Cottage, having two bedrooms and a smaller living room/kitchen. It should greatly improve our ability to handle senior researchers and their families. Funds for this project are shared between

QUBS Trust and the Biology Department. (8) This winter, a second bathroom was added to the basement of the Manager's House. As soon as it is fully functional, renovations will start on the main bathroom - replacement of tile in the tub/shower, new vanity, exhaust fan, floor covering and paint. (9) A microscope cupboard was built in the southwest corner of the conference room in the upper Brown Lab. This enables secure and relatively dust-free storage of the station's microscopes and slide projectors and spare parts. Conversion of a couple of old lab cupboards removed from Earl Hall during the never-ending renovations saved a considerable amount on the provision of good storage space. (10) Dr. Harold Good generously donated a quantity of maple flooring which has been installed in the living room/kitchen of the Assistant Manager's House. Surface finishing, stain, varnish and trim are required to finish this project. (11) Demolition of the old sauna was started in late summer. This eyesore will be completely removed this summer. (12) In the White House basement, the lab space at the south end of the house was renovated. The walls and floors were repainted. All unnecessary equipment and extraneous material was removed. This space will become lab space intended for weighing of samples and preparing solutions. It is intended that a basic supply of glassware and lab supplies will be located in this lab. (13) With infrastructure funds, two balances were purchased for installation in the White House lab. An analytical balance - Mettler AE100 (0-109 g range; 0.1 mg precision) and a top-loading Ohaus C305 (0-300 g range; 0.1 g precision) have been purchased. In addition, a Mettler H16 hanging pan balance (0-80 g range; 0.01 g precision) has been obtained, surplus equipment from Earl Hall. From Dr. Ted Brown's old lab, a marble weigh table was obtained and installed. This unit provides a stable base for the analytical balance. It is anticipated that the lab will be fully equipped by summer. (14) Also using infrastructure funds, two Dewar containers were purchased. Given the prevalence of tissue and blood sampling taking place during research at QUBS, proper storage of these samples was seen to be a priority. Two Dewars were purchased, one a 21 litre, the other a 44 litre container. Unfortunately, the first large one leaked and ruined several fish samples. This one was replaced by an XC47-11 in late summer. It is the intention that the small container be used for transportation of samples and for use in the field while the large container be used for longer-term storage within the lab. Wooden storage boxes were built to protect the containers during transportation and storage. These containers are presently stored in the lower Brown Lab. (15) In early summer, a new commercial washing machine was purchased and installed in the utility area at the rear of the lodge. (16) During the summer, many of the window screens on the lodge were replaced. Some of the windows were reputted and painted and all of the trim on the lodge was repainted. This procedure will continue through 1993. (16) Since the railway tie retaining wall on the lake side of the White House was slowly rotting and tending to lean downhill, it was repaired. Of course, rot had proceeded much further than it seemed at first glance, so the entire wall was replaced. In doing so, the lawn was levelled by bringing the new wall higher than the old one. The steps down to the Boathouse path were removed and replaced with proper steps made of cedar. A safety rail along the top of the terrace wall was also added. Addition of a set of low-voltage lights has made this means of access much safer. These lights have been such a boon to night access and safety that more sets will be installed

at critical points around the station in 1993. (17) In late fall, two windstorms played havoc with some of the old trees around the station. Several trees were simply pushed over with all the wind. Some trees snapped off well above the ground and became entangled in the limbs of adjacent trees. Some trees liberally shed upper limbs in a rain of debris. One of these speared through the roof of the White House, necessitating hasty repairs. In the aftermath, a tree removal company was engaged to knock down all of the threatening trees and limbs. Around the White House, some extensive cutting was required. Since heavy snow came very soon on the heels of the cutting operations, much of the debris is still awaiting cleanup during spring thaw. (18) The new FAX machine was a great asset to research and administration. The speed of communications and transmission of data was much appreciated. This was reflected in the use of the machine: to March 1, 1993, some 651 pages had been transmitted and 658 pages had been received. (19) Trundle drawers were built and installed in all rooms in Curran Cottage. These large, under-bed drawers should help to alleviate the chronic storage problems faced by Curran Cottage inhabitants.

Parks Canada - Rideau Canal

In 1992, Parks Canada - Rideau Canal, via Canal Superintendent, Mr. John Bonser, again provided QUBS with free canal passes for both of our pontoon boats. This generosity is greatly appreciated and facilitates our study of a variety of water bodies along the Rideau Canal in both teaching and research initiatives.

Open House

The Open House was held on July 12 in 1992. As usual, there was a good turnout from the area. In all, some 300 visitors toured the displays of current research topics. The regulars deserve the credit for the continued success of this event. The effort that they put into preparing displays and the enthusiasm with which they communicate their research makes for an informative and enjoyable tour. Thank you for your efforts. The 1992 version of the Community Newsletter (twelfth edition) was distributed in early July to 850 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.

Friends of Opinicon

The Biological Station's fledgling organization "Friends of Opinicon" had its first summer of activities in 1992. Growing out of discussions which began in 1991 among Adèle Crowder, Raleigh Robertson, Nasrene MacDonald, and Biological Station staff, its chief purposes are to promote nature education and conservation while encouraging contact and communication with and among neighbours and alumni/alumnae of the Biological Station. With Naz as co-ordinator, the '92 program evolved to include half a

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dozen local nature walks and a cruise on Lake Opinicon on our large barge, the "Rapinicon". Activities were modest in scope, very informal, and usually planned week-to-week based on participants' requests and availability of leaders. Response to the program was gratifying, with several long-time and summer residents of the Lake Opinicon and Chaffey's Lock areas attending most of the sessions and sounding generally very enthusiastic about their content. Tentative plans for '93 include more walks and activities in the local area, some talks, some posters and/or newsletter items advertising the program, and an attempt to organize a workshop/reunion weekend for Biological Station alumnae/alumni. With that in mind, please wish us luck and help us to get correct mailing addresses for as many former Station users as possible!

Hummertime

The "Hummertime" survey of migration and reproduction of ruby-throated hummingbirds continues to grow and thrive. Initiated in the spring of 1990 by Rick Miller of Yale, former supervisor of Raleigh Robertson and Floyd Connor and friend and user of the Biological Station, it relies on data collection by volunteer observers at their own feeders and at nests in their own areas. It is now co-ordinated by Kit Muma and Floyd Connor at QUBS, and by Peggy Latimer at nearby Indian Lake. A grant from the James L. Baillie fund of the Long Point Bird Observatory, awarded in spring of 1992, allowed the survey to maintain and expand its participant list, resulting in the receipt of 76 completed data forms from over 200 participants. Preliminary results from as far away as Saskatchewan, New Brunswick, and Indiana suggest that arrival and departure dates for females, and arrival dates for males, are correlated with latitude (as expected), with males being a few days before females. However, departure dates for males seemed not to be correlated with latitude. The study will continue in 1993, with its scope contingent upon availability of funds.

Seminars

Dr. Raleigh Robertson organized the seminar series at QUBS in 1992. The Visiting Field Scientist seminars are always a highlight of this series. In general, the seminars comprise a very interesting facet of life at the field station, providing a forum for the expression and exchange of ideas on a varied array of biological topics. The list of speakers and topics appears in tabular form later in this report.

Station User Fees

Last year, QUBS fees were unchanged from 1991. The financial squeeze was felt by us all. However, low rates of inflation made it possible to freeze fees for 1992. For 1993, money remains tight and inflation continues at low levels, but some large budget items have continued to increase despite the recessionary climate. Notable among these are salaries, hydro and heat. To keep abreast of these increases, fees for 1993 will rise by 2%. The new fee schedule for 1993 appears on the last page of this report.

Theses and Publications

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

Acknowledgements

Continued successful operation of the field station depends on many things, but foremost among these is the industry and devotion of our staff. Thank you to Floyd Connor (Assistant Manager), Dave Fleming (Maintenance Assistant), Marg Phelan (Food Service Coordinator), Sandra Gentili (for only a short time in early summer) and Kathy and Karen Wetmore (Food Service Staff) and to Mary Elaine Goulah, Ron Vinkle Jr. and Jay Phelan (part-time helpers).

Congratulations

On November 19, 1992 Matthew McKinley Claussen Philipp was born. Congratulations to parents Dr. David Philipp (Illinois Natural History Survey) and Julie Claussen, two of our station regulars.

On January 26, 1993 Sarah Jocelyn Fox, the first child of Dr. Michael Fox (Trent) and Marilyn Chow was born. Congratulations to the proud parents. Mike has been a sometime user of the field station for many years.

Diane Coutts and Dave Warren were married on October 3, 1992. The wedding took place on an outcrop of rock just off the Rideau Trail on a gorgeous fall day. Congratulations on your marriage. Both Dave and Di were past summer staff at the field station and still maintain close contact. Indeed, if everything goes as planned, they will soon be neighbours of QUBS.

The Weather Report

As part of QUBS Annual Reports, a sample of the kinds of weather data compiled and available at the field station is included. In this report, monthly summaries for May through August are displayed. Stevenson screen air temperatures and one meter water temperatures were chosen as being basic to many studies. 1992 will probably be remembered as the year without a real summer. May and June exhibited oscillating temperatures, sometimes significant shifts within very short periods.

Table 1: Summary of course credits in the Ontario Universities Program in Field Biology earned at Queen's University Biological Station in 1992.

Module Topic	Professor & Affiliation	Dates	Credit/ Student	Q	C	Y	B	W	WO	WI	TR	TO	M	O	Total Students/ Module	Total 1/2-course Credits
Bird Behaviour	Robertson (Q)	May 3-16	1/2	6	-	2	-	1	-	-	2	-	1	-	12	12
Ecological Physiology	Tuftis (Q)	May 17-23	1/4	5	-	3	-	-	-	-	-	-	2	-	10	5
Fern Systematics	Pringle (M)	Aug 16-22	1/4	-	-	2	-	-	-	-	-	3	-	-	5	2.5
Plant Sex	Shore (Y)	Aug 16-22	1/4	1	1	4	-	-	-	-	-	1	-	-	7	3.5
Insect Ecology	Danman (C)	Aug 23-29	1/4	3	2	3	1	1	1	-	-	-	1	2	14	7
Plant Evolution	Aarssen (Q)	Aug 23 - Sept 5	1/2	4	-	1	-	-	-	-	1	4	1	1	12	12
Small Mammals	Morris (B)	Aug 30 - Sept 5	1/4	4	-	4	1	-	2	-	-	-	1	-	12	6
<hr/>																
Total Number of Student-weeks				33	3	22	2	3	3	-	6	12	8	4	96	-
Half-course Equivalents				16.5	1.5	11	1	1.5	1.5	-	3	6	4	2	-	48

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

Table 2. Summary of course credits in the Otago University Program as Field Biology started at locations other than OARBS in 1992.

Module Topic	Prerequisite & Admission	Dates	Location	Credit/Student	D	C	V	H	W	MO	MI	TH	TO	SA	S	Total Student/Module	Total 1/2-Square Credits
Tropical Marine Ecology	Duke and Barton (1994)	Apr 18 - May 3	Janetia	1/2	4	-	-	-	1	8	-	-	2	-	-	16	16
Old Growth Forests I	Quay (11)	May 8-24	Pouanaka	1/2	1	1	1	-	1	1	-	4	1	1	1	12	12
Great Lakes Field Biology	Halliday (10)	May 10-23	Woodrow	1/2	2	-	1	-	1	-	10	2	2	2	-	20	20
Marine Develop mental Biology	Bates (2)	May 21 - June 15	Hurstmans	1/2	1	3	1	-	-	-	1	1	-	-	-	7	7
Asian Ecology	Gaston (10)	June 15-29	Queen Charlotte Islands	1/4	-	-	1	-	-	-	-	-	-	-	1	2	1
Field Methods in Plant Ecology	Bailey (11)	June 20-28	Maitland Island	1/4	1	-	5	1	-	-	-	1	2	-	-	9	4.5
Old Growth Forests II	Quay (11)	July 21 - Aug 5	Pouanaka	1/2	2	1	1	-	-	2	-	2	2	1	1	12	12
Marine Mammals	Kennedy (10)	Aug 2-15	Hurstmans	1/2	-	-	-	-	-	13	-	1	3	-	-	17	17
Alpine Plant Ecology and Migration	Cusack (14)	Aug 8-23	Kermadec	1/2	1	-	1	-	-	1	-	1	1	1	2	7	7
Tropical Insect Biodiversity	Lane (2)	Aug 16-29	Principles	1/2	5	2	-	-	1	-	1	1	1	2	-	12	12
Marine Biology	Severin (14)	Aug - Sept	Cook's Bay	1/2	-	-	-	-	1	-	-	1	-	-	-	2	2
Marine Ecology at Birth	Gibbs (14)	Aug 22 - Sept 5	Hurstmans	1/2	3	1	-	-	1	-	-	1	10	-	-	16	16
Freshwater Ecology	Bailey and Tuck (10)	Aug 22-29	McKean	1/4	3	-	2	-	-	-	-	-	-	1	1	7	3.5
Tropical and Freshwater Ecology	Severin (14)	Aug 22 - Sept 5	Dorset	1/2	2	-	-	-	8	-	-	-	-	-	1	11	11
Alpine Ecology	Mann and Leary (10)	Aug 26 - Sept 12	Kermadec	1/2	1	1	-	-	1	1	-	-	14	1	-	19	19
Experimental Marine Biology	Tepper (10)	Aug 26 - Sept 13	Hurstmans	1/2	4	-	1	-	2	5	-	-	-	-	-	12	12
Field Biology	Chapman (11)	Aug 30 - Sept 5	Lauriston	1/4	1	-	6	-	-	1	-	-	1	-	1	10	5
Myxology	Kennedy (10)	Aug 30 - Sept 5	Agnesian	1/2	2	-	2	-	-	6	-	-	2	1	1	14	14

Total Number of Student Weeks

Total course Equivalents

60 148 20 3 40 79 22 20 93 14 46.5 13.5 7.5 10 400 204

Table 3: Overall Summary of the Ontario Universities Program in Field Biology in 1992.

	Q	C	Y	B	W	Wo	Wi	Tr	To	M	O	Total Student Weeks in Modules	Total Half Course Credits
Total Student-weeks not at QUBS	65	18	30	3	40	75	22	28	93	19	15	408	204
Total Student-weeks at QUBS	33	3	22	2	3	3	—	6	12	8	4	96	48
Total Student-weeks in Field Modules	98	21	52	5	43	78	22	34	105	27	19	504	—
Total Half-Course Equivalents in Field Modules	49	10.5	26	2.5	21.5	39	11	17	52.5	13.5	9.5	—	252

19% of credits in entire program earned at QUBS in 1992

(14.1% in 1991; 16.3% in 1990; 29.2% in 1989; 15.6% in 1988; 14.3% in 1987)

33.6% of Queen's credits earned at QUBS in 1992

(15.8% in 1991; 24.0% in 1990; 51.4% in 1989; 22.5% in 1988; 31.4% in 1987)

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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 1992, Dr. Ian McLean from the University of Canterbury in New Zealand was our Visiting Field Scientist. Dr. Mclean was with us for three months. During this time, he pursued some of his own field work on begging calls and enemy recognition in nestling birds. These North American data will be used as part of a comprehensive comparison of bird community structure, nesting habits and nestling behaviours.

With a love of birding, mountain-biking and a keen interest in all aspects of field research, Dr. McLean was a lively, affable addition to the field station. Station regulars benefitted greatly from interaction with him and he delighted in first-hand contact with the variety of researchers and research projects.

During the summer, Dr. McLean offered two seminars, reflecting the scope of his research interests. One of his presentations dealt with the unique status of bird conservation in New Zealand. The second offering dealt more or less directly with his current research on enemy recognition in birds - aspects of behaviour and evolution of behaviours.

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.

Naturalists' Workshop 1992

In 1992, QUBS offered its fourteenth edition of the naturalists' workshop. The week-long workshop was held from May 23 through May 30, with an enrolment of 17. These participants represented a cross-section of people with interest in natural history and environmental topics (one teacher, one student, five amateur naturalists, three staff from the Ontario Ministry of Natural Resources, two staff from Conservation Authorities, two staff from the St. Lawrence Parks Commission, two naturalists sponsored by the Mohawks of the Bay of Quinte and one staff from the Canadian Museum of Nature). In 1992, special themes centred on wetlands, biodiversity and the impacts of mining on local environments.

The McCorquodale Scholarship was awarded to Nancy Doubleday, a Ph.D. student at Queen's. This scholarship adds an extra dimension to the program, enabling attendance of someone who might not otherwise be able to attend because of financial constraints. Thank you to Shannon McCorquodale, whose continuing generosity provides the scholarship named after her. For 1993, a second scholarship will be made available through the S.B. Rutherford Foundation. This scholarship is named for S.B. Rutherford, a former biology teacher at Clarke High School (Orono, Ontario) and a local champion of interest in natural environments. The selection committee for this scholarship is headed by Roy Forrester, a naturalists' workshop alumnus himself. The S.B. Rutherford Foundation plans to make one scholarship available each year.

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 remains successful because of the devotion of time and effort of all our instructors: Floyd Connor (QUBS), Dr. Francis Cook (Senior Collections Specialist - Herpetology - Canadian Museum of Nature), Jennifer Harker (M.M. Dillon Consultants), Dr. Allen Keast (Queen's - Biology), Peter LeBaron (Geologist - Ministry of Northern Development and Mines), Dr. Sandra McBride (Queen's - Geological Sciences), Dr. Ian McLean (University of Canterbury, New Zealand - Biology), Dr. Ted Mosquin (Bioinformation), Mike Newland (Deloro Arsenic Treatment Plant, Ministry of the Environment), Ken Otter (Queen's - Biology), Frank Phelan (QUBS), Jim Ritter (Deloro Project Manager, Ministry of the Environment), Dr. Raleigh Robertson (Queen's - Biology) and Scott Shackleton (Queen's - Biology). A special vote of thanks to all the Biology Station regulars - workshop participants benefit greatly from experiencing an active biological research station and interaction with avid researchers.

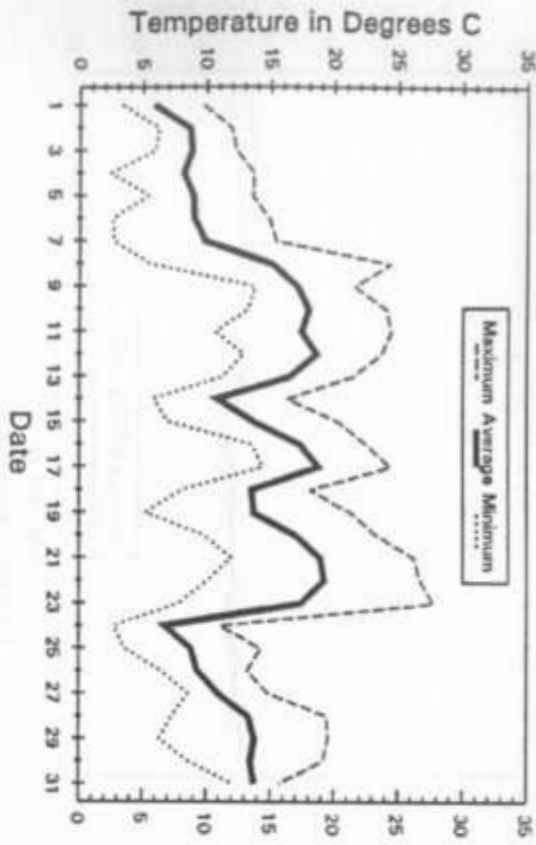
Our day-long road trip on Friday took us to mining sites for a first-hand look at the environmental impacts of resource extraction. During the day, we saw a variety of sites, ranging from the worst cases (severe physical alteration, erosion, siltation, chemical and radioactive contamination) to the best cases (control of surface disturbance, reclamation). For all of us, it was a real eye-opener.

Plans are taking shape for the 1993 edition of the workshop (May 22 to 29). Special topics will include a comparison of Shield and limestone sites and the effect of the Frontenac Axis and a working session on Geographical Information Systems and Global Positioning Systems.

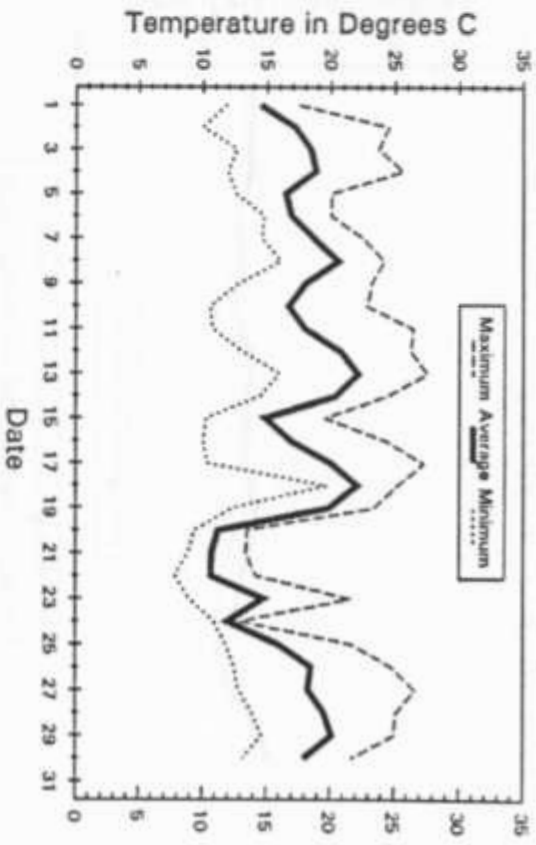
1992 Participants

Sarah Chester	Amherstview Public School, Kingston, Ontario
Ted Rosen	Amateur Naturalist, Toronto, Ontario
Carol Sellers	Amateur Naturalist, Toronto, Ontario
Earl Berry	Management Forester, OMNR, Pembroke, Ontario
Kathleen Kelso	Cooper Marsh Visitor Centre, Raisin Region Conservation Authority, Martintown, Ontario
Astrid LeMaitre	Recreational Programme Officer, St. Lawrence Parks Commission, Morrisburg, Ontario
Sheila Lefebvre	Environmental Programme Officer, St. Lawrence Parks Commission, Morrisburg, Ontario
Bill Hayes	Mohawks of the Bay of Quinte, Deseronto, Ontario
Jonathan Cummings	Mohawks of the Bay of Quinte, Deseronto, Ontario
Lucille Fragomeni	Amateur Naturalist, Carrying Place, Ontario
Gordon Hayes	Amateur Naturalist, Clinton, New York
James Ives	Superintendent, Murphy's Point Provincial Park, Perth, Ontario
Nasrene MacDonald	Amateur Naturalist, Hughson's Island, Chaffey's Lock, Ontario
Tim Deschiffart	Park Naturalist, Murphy's Point Provincial Park, Perth, Ontario
Cheryl McJannet	Botany Division, Canadian Museum of Nature, Ottawa, Ontario
Nancy Doubleday	Graduate Student, Queen's University, Department of Biology, Kingston, Ontario
Jane Watson	Amateur Naturalist and Photographer, Toronto, Ontario

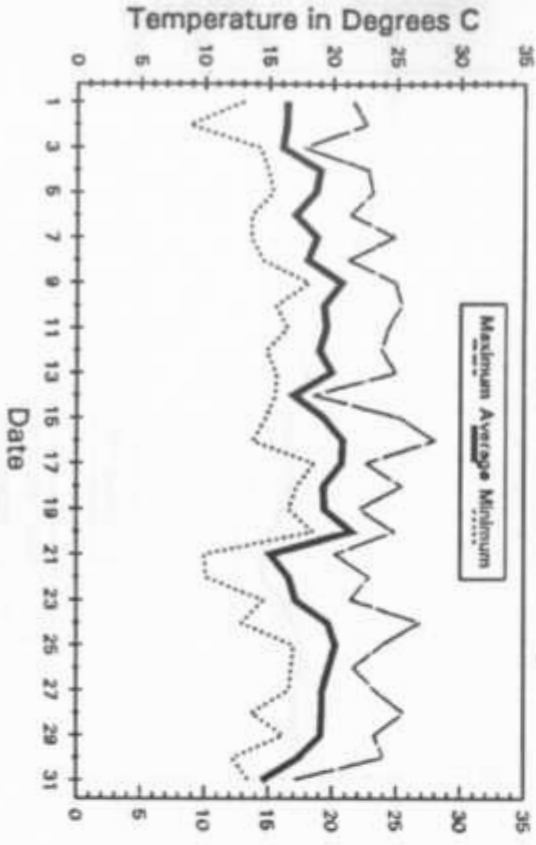
Daily Weather Summaries - 1992
Air Temperatures - May



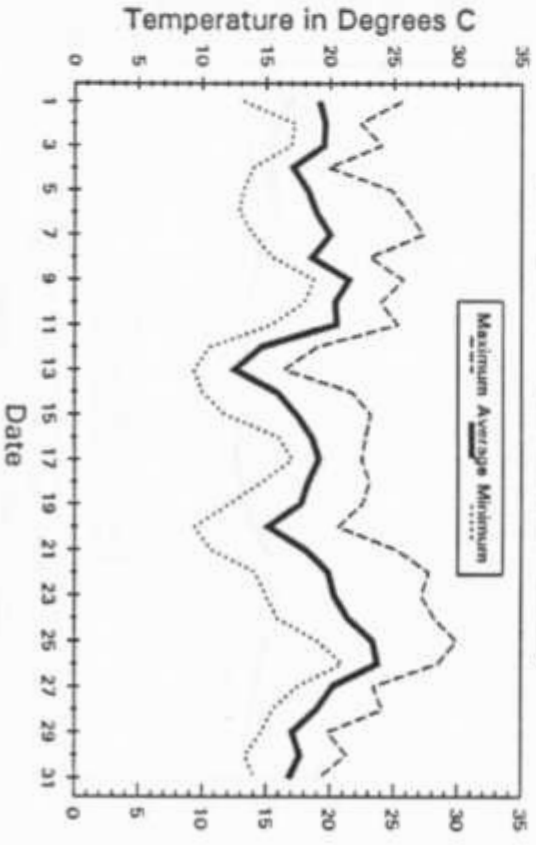
Daily Weather Summaries - 1992
Air Temperatures - June



Daily Weather Summaries - 1992
Air Temperatures - July

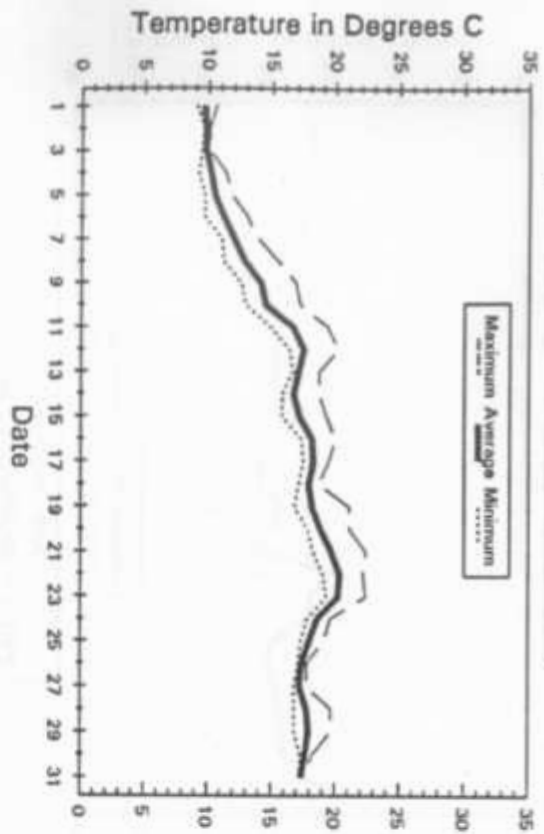


Daily Weather Summaries - 1992
Air Temperatures - August



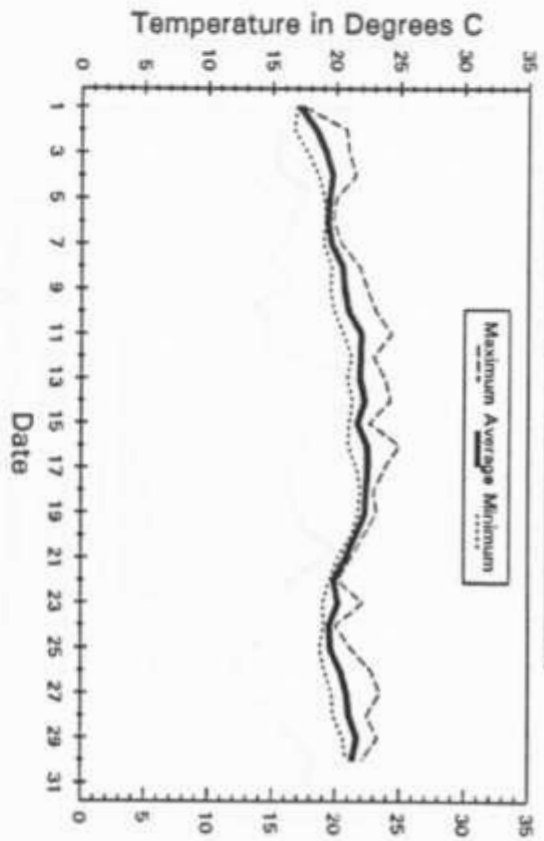
Daily Weather Summaries - 1992

Water Temperatures at 1m - May



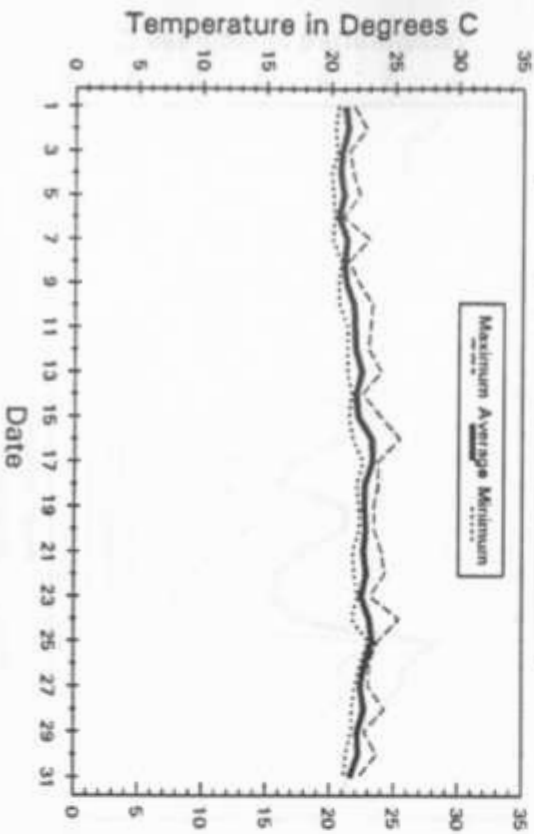
Daily Weather Summaries - 1992

Water Temperatures at 1m - June



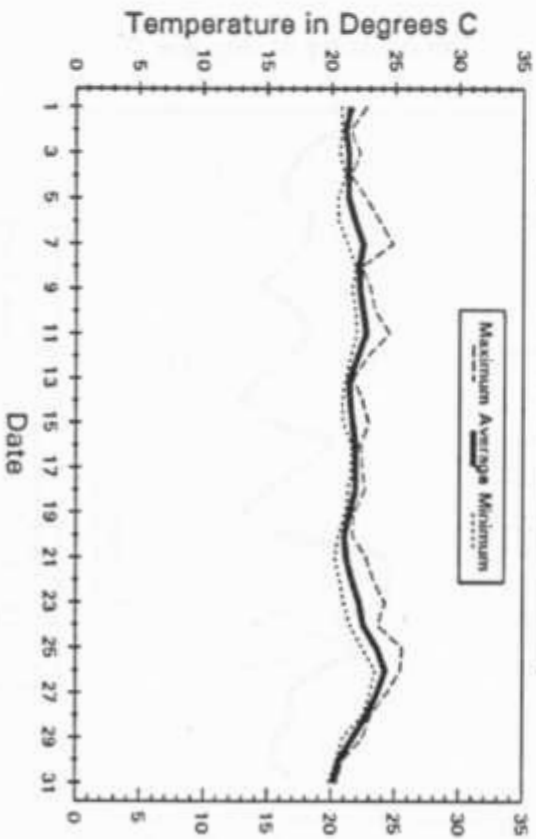
Daily Weather Summaries - 1992

Water Temperatures at 1m - July



Daily Weather Summaries - 1992

Water Temperatures at 1m - August



I: Research by Queen's Students and Staff

Dr. Lonnie W. Aarssen

"Plant Ecology and Evolution"

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 (defended Jan. 1993).

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 P. pratense on Agropyron repens (= Elymus repens) (quackgrass), Bromus inermis (bromegrass) and Danthonia compressa (povertygrass). Results have indicated that the allelopathic pollen in Hieracium is not ecologically significant, however, that of P. pratense is. An experiment in the Wire Fence Field involving local removal of Phleum inflorescences showed that the seed set in Agropyron repens was affected by the proximity of Phleum inflorescences. 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: Sue McLernon

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 "pollination 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 a less-efficient pollinator may have implications for the continued survival of northern populations of spring wildflowers.

Susan McLernon - "Heterospecific pollen transfer in sympatric grassland species" - B.Sc. Thesis

Flowers from nine sympatric species were collected weekly from an old field on the QUBS property, and pollen grains from the stigmas were studied under a light microscope. Heterospecific pollen transfer (HPT) was quantified for each individual as proportion of all grains per stigma that were from another species. All species were found to carry some foreign pollen on some stigmas. There was variation between species in both mean HPT and likelihood of receiving foreign pollen. There was also within-species variation in HPT over time, and this variation was generally not related to the flowering phenology of other species or families. Mean HPT for species was positively related to pollen grain diameter, suggesting that small grains can more easily adhere to stigmatic papillae of foreign species than larger grains. On a species level, mean HPT was negatively related to reproductive success (seed/ovule ratio). This suggests that HPT may act as a form of interference competition in sympatric species, possibly acting through physical occlusion of competitors' stigmas or styles.

Jeremy Lundholm - "Neighbour effects on gender variation in common ragweed" - B.Sc. Thesis

The objective of this study was to determine the effects of shading and proximity to neighbours on gender in common ragweed (Ambrosia artemisiifolia). We predicted that the proportion of female flowers would increase when plants were shorter than their neighbours and growing in the shade. Part of the study was carried out in an experimental plot in the "New Barn" field. The results show that the proportion of female flowers increases with decreasing irradiance and with decreasing height relative to the height of neighbours. Hence, neighbours affect gender expression in ragweed, possibly through shading and/or effects on the spectral quality of light (red/far red balance). This plasticity in gender display may reflect a fitness advantage by maximizing the female function when success as a pollen donor is reduced by the presence of taller neighbours.

Theses:

Irwin, D.L. 1992. The cost and benefit of apical dominance: Growth responses of five herbaceous species to shoot apex removal. M.Sc. Thesis. Dept. of Biology, Queen's University.

Bonser, S.P. 1992. Early growth form variation in sugar maple reflects adaptive responses to light availability. B.Sc. Thesis, Dept. of Biology, Queen's University.

Bosy, J. 1992. The effect of seed orientation on germination in a uniform environment: Differential success without genetic or environmental variation. B.Sc. Thesis, Dept. of Biology, Queen's University.

Publications:

Murphy, S.D. 1992. The determination of the allelopathic potential of pollen and nectar. pp. 333-357 in Linskens, H-F. and Jackson, J.F. (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 polymorphism (white-striped morph and tan-striped morph) and behavioral polymorphism among breeding White-throated sparrows (*Zonotrichia albicollis*) is associated with the presence or absence of a pericentric inversion among the second pair of chromosomes. The occurrence of this inversion is maintained by negative assortative mating among plumage morphs. Thus, the White-throated Sparrow provides an opportunity to examine selective forces that lead to assortative mating and how such selection can influence the genetic composition of populations.

The purpose of this project was to examine why White-throated Sparrows chose mates of opposite rather than similar phenotype. Two principal hypotheses were tested: first, that positive assortative mating is inhibited by behavioural mechanisms (e.g. aggression), second, that positive mating is avoided because such pairings are genetically incompatible (e.g. reduced reproductive success).

We observed the behaviour of 8 white-striped male X tan-striped female pairs (WT) and 8 white-striped male X white-striped female pairs (WW). Among both pair types, male

aggression was negatively correlated, and female aggression positively correlated, with behaviours associated with mating and pair formation. Male aggression was greater toward white-striped females than toward tan-striped females. Tan-striped females were more likely to advertise their sex than were white-striped females. Thus, the inhibition of pair formation among white-striped male X white-striped females could be viewed as resulting from a mutual rejection by both sexes. WW pairs that did nest, did so later in the season than did WT pairs.

In 1992, 57% of the 46 eggs laid were fertile (i.e. showed signs of development). A greater number of fertile eggs occurred among WW pairs (67%) than among WT pairs (50%). However, when only clutches in which at least one egg was fertile were used in the analysis this trend became non-significant (WW = 75%, WT = 70%). Since we expected WW pairs to experience a 25% reduction in fertility (equal to the expected proportion of inversion homozygotes among the young, see Evolution 29: 611-621) these results suggest that there is no genetic disadvantage associated with positive assortative mating White-throated Sparrows.

Assistants: Danielle Deveau, Ellen Dickson

Drs. Dolf Harmsen and Adele Crowder

"Patterns of succession in old field communities"

This is a long term project initiated in 1975. Earlier intense periods of research produced a number of publications on the early, rapid change stages of old field succession, and a few further publications are in preparation. The rate of change is much slower, since the late 1980's, and in 1992 no experimental work was conducted. The project will continue to an estimated termination date of 2001, when a 25 year record will be available for detailed analysis.

Dr. Allen Keast

"Comparative inter-lake studies, fish communities"

Processing of comparative data on the communities of a range of contrasting lake and stream types was continued. The lakes, differing in area, extent of shoreline, depth, degree of macrophyte growth, range of habitats (bottom types) present, total dissolved solids, pH, etc., differ in varying degrees in zoobenthos and zooplankton (i.e. the prey resource base supporting the fish fauna), and in fish species composition. The communities are explored in terms of foods eaten relative to kinds of prey available, growth rates, etc. Besides developing a better understanding of what controls fish species occurrence, a major subject of interest is what controls differences in growth rates in those versatile species that occur

in a range of systems. At the stream level, interest was mainly in the faunal differences between swift-running streams, with areas of exposed shingle and gravel, and of the more sluggish, weedy streams that characterize much of agricultural eastern Ontario today. Focus is on fish species composition, prey resources available, and how these are subdivided between species.

"Long-term studies, fish community of Birch Bay, Lake Opinicon"

The rich inshore community of some 8 species was the subject of a detailed study in 1965-1966, and again in 1974-1975, and has been the subject of periodic attention ever since. Long term studies of animal communities are relatively rare. Hence, it is planned to continue monitoring this system. Recently developed results bring out that the inshore areas have undergone progressive silting (possibly due to the introduced Myriophyllum spicatum impeding water-flow and what was formerly a sandy bay, supporting larger-bodied Bluegill, Pumpkinseed, Yellow Perch, Largemouth Bass etc. is now partly-weeded and has become a major habitat for juvenile fishes.

"Bird community studies"

Work continued on avian habitat use, avian breeding, and allocation of time on the breeding grounds.

Paul Martin, Allen Keast and Laura Pearce

"Numerical abundance and habitat utilization in bird species"

Fifty plots with a radius of 50 m were selected through the broad spectrum of different habitats (mature forest, late stage regrowth, recent regrowth, mature swamp forest, edge, fields with shrubbery, open fields) and population counts made of singing males during 15-minute early morning monitoring periods. Objectives were to relate species occurrence and abundance to habitat types. Whilst there proved to be much consistency between seemingly equivalent plots this did not apply to all species.

A program was instituted of quantifying the major attributes of the different plots (e.g. tree species diversity, foliage height diversity, nature of ground cover, tree density, trunk diameter) to better disentangle factors governing species occurrence. This will be continued during the coming summer.

Allen Keast, Paul Martin and Ian McLean

A comprehensive program of nest-finding was initiated to obtain a precise data base on ovulation and breeding dates of the various Lake Opinicon bird species. Outside of colonial species, data were obtained on some 300 nests of 50 species. An ultimate objective is to understand why some species breed only once and others twice in a summer. The

breeding data are being interpreted relative to a previously gathered data base on fluctuating caterpillar populations, emergence dates of the various kinds of aquatic insects, and changing abundances of flying prey such as dragonflies. It is also, of course, related to time of return from migration, and time on the actual breeding grounds relative to post-breeding wandering.

Dr. Robert Montgomerie

"Sexual selection and parental care in American Robins (with Dr. Pat Weatherhead)"

In 1992 we continued our study of this species (begun in 1986), by attempting to look at the relation between brood order and cuckoldry. Based on our previous work we predicted that males might tend to be cuckolded at a lower level in first broods compared to subsequent broods due to reduced opportunities for mate guarding that would result from the male's involvement in tending broods after they leave the nest. A late spring, high predation rates and apparently low nesting density limited the amount of data collected so further work will be needed to properly address this question.

Assistant: Isabel Mergulhao

Publications:

McRae S., Weatherhead P.J., Montgomerie R. Nestling movement and the distribution of food by robin parents. (submitted to *Behavioural Ecology and Sociobiology* August 1992)

"Adaptive significance of interspecific variation in avian begging calls (with Ian McLean, Univ of Canterbury)"

We recorded the begging calls of 42 species of passerine birds (mainly at QUBS but also in the arctic and in the U.S.) to test the hypothesis that begging intensity is related to the expected level of nest predation (e.g. hole nesters < open nesters, tree nesters < ground nesters, etc.). For selected species we also measured the intensity of begging calls through the nesting cycle to determine how this changes with body mass and expected nutritional requirements. With this large sample of species we hope to be able to control for phylogeny, sound transmission properties of the habitat and brood size in analyzing the relation between predation risk and both the loudness and acoustic structure of nestling begging vocalizations

Dr. Laurene Ratcliffe

"Vocal Behaviour in Black-capped Chickadees"

In 1992 we continued observations and playback experiments on chickadees nesting in the vicinity of QUBS. In addition to the projects described below, we collected ancillary data on the use of song repertoires in intrasexual aggressive signalling, and explored how territorial males perceive pitch change in conspecific song.

Collaborators: Ron Weisman (Psychology, Queen's), Scott Shackleton (Johns Hopkins)

Assistants: Linda Webster, Paul Martin, James Fotheringham

Ken Otter - "Sexual selection and song in the Black-capped Chickadee" - M.Sc. Thesis

"The effect of female removal on the dawn chorus of the black-capped chickadee"

We removed the mate of 10 male black-capped chickadees (*Parus atricapillus*) during the nest building - pre-incubation period to determine the effect of female presence on dawn singing. During the dawn chorus following mate removal, males sang significantly longer, increased movement within their territory, and increased the percentage of their territory covered while singing compared to choruses before the female was removed and after the female was returned. Males did not alter the frequency range or modal frequency of their songs when the mate was removed, nor did they change the degree of frequency shifting in the *fee-bee* song. We conclude that dawn singing in the black-capped chickadee acts, in part, as an inter-sexual signal. However frequency shifts may be directed more towards rival males than potential mates.

Assistants: James Fotheringham, Paul Martin, Linda Webster

"Extra-pair paternity in the black-capped chickadee (*Parus atricapillus*)"

S.M. Smith (1988) observed female black-capped chickadees seeking extra-pair copulations from high quality males, but could not tell whether such EPCs led to fertilizations. We investigated the occurrence of extra-pair paternity in 8 chickadee nests from a banded population at the Queen's Biological Station, Lake Opinicon, Ontario, in June 1992. We collected blood from feeding parents, nestlings and neighbouring males. Using minisatellite probes *per* and *Jeffrey's 33.6* on *Hae III* cut DNA, we produced DNA finger prints to assess paternity of offspring. 3 of 8 nests had young genetically mismatched with their putative father. 17% of all nestlings (9/53) and 47% (9/19) young in nests with mixed paternity were extra-pair young. In two nests where extra-pair paternity could be ascribed to a neighbouring male, interactions between the extra-pair males and cuckolded males during the breeding season and in flocks during winter 1993 suggest that the extra-pair male was dominant. One extra-pair male helped feed the nesting female and nestlings when his own female disappeared. Such cases of polyandry in black-capped chickadees may be an adaptation by the extra-pair male to protect parental investment.

Assistants: James Fotheringham, Paul Martin, Susan Leech, Linda Webster

James Fotheringham - "Signal degradation in transmission of Black-capped Chickadee song" - B.Sc. Thesis.

Black-capped Chickadees (*Parus atricapillus*) sing a two note song termed *fee-bee*. Frequency descends within the *fee*-note and between the *fee*- and *bee*-notes. Within-song frequency ratios are highly invariant while absolute frequency is variable among songs. I conducted transmission experiments April 27 and 28, 1992 at the Queen's University Biological Station at Lake Opinicon, Ontario. I broadcast natural songs at three different absolute frequencies and recorded them over a range of distances in an open field and a dense deciduous forest. There were significant effects of reverberation and amplitude modulation for songs at all three absolute frequencies transmitted over distance through open and forested habitat. The effects of differential frequency attenuation and frequency modulation were not found to be significant. Cross correlation of song spectrographs allowed for a measure of holistic signal degradation, which increased significantly over distance in open and forested habitat. Polynomial regressions for the effects of reverberation, amplitude modulation and general signal degradation revealed consistent trends in open and forested habitat, regardless of absolute frequency. "Far" song stimuli, recorded 60m from source in forested habitat, were played back to colour-banded, territorial males (n=20 birds) along with original "near" songs using a repeated measures experimental design. There was no significant difference between the response of subjects to "near" and "far" song playback stimuli. Perhaps heterogeneity of Black-capped Chickadee habitat prevents the use of signal degradation as a reliable distance cue. We suggest that it may be possible to predict the ability for distance estimation by assessing heterogeneity of habitat.

Publications:

Shackleton, S.A., L. Ratcliffe and D. Weary. 1992. Relative frequency parameters and song recognition in black-capped chickadees. *The Condor* 94: 782-785.

Horn, A.G., M.L. Leonard, L. Ratcliffe, S.A. Shackleton and R. Weisman. 1992. Frequency variation in songs of black-capped chickadees. *The Auk* 109(4):

Webster, L.G. 1992. Speaker location affects individual recognition by song in the black-capped chickadee. Hons B.Sc. thesis, Department of Biology, Queen's University, Kingston, Ontario.

* presented at 1992 Animal Behavior Society meeting, Queen's, June 1992

- 1)*Zanette, L. and L. Ratcliffe. Does social rank influence how conspicuously Black-capped Chickadees (*Parus atricapillus*) behave in the presence of a predator? (spoken paper)
- 2)*Shackleton, S.A. and L. Ratcliffe. Pitch matching during countersinging by Black-capped Chickadees. (spoken paper)
- 3)*Webster, L. and L. Ratcliffe. Speaker location affects individual recognition in Black-

capped Chickadees. (poster)

4) Otter, K.A. and L. Ratcliffe. The effect of female removal on the dawn chorus of the Black-capped Chickadee. NE Regional Anim. Behav. Meeting, Aston, PA, Nov. 1992 (spoken paper)

5) Fotheringham, J. and L. Ratcliffe. Analysis of signal degradation in transmission of black-capped chickadee song and male response to "near" and "far" song playback stimuli. NE Regional Anim. Behav. Meeting, Aston, PA, Nov 1992 (poster)

Dr. Raleigh J. Robertson

"Evolution of breeding and life-history strategies in birds"

Research efforts in 1992 concentrated on continuing studies of Tree Swallows and Eastern Bluebirds, with the main theme being determination of the levels of extra-pair paternity, and the factors related to whether or not a particular female or male had extra-pair offspring in the nest. Other studies focused on nestling growth rates in relation to cavity volume and on determinate versus indeterminate laying patterns in Tree Swallows. These studies used the grids of nest boxes at HU, BG, SP, and NB - four grids on the Hughson Research Tract. In addition, a grid of boxes in the Northeast Sanctuary, one at Crystal Spring Farm, and a trail of boxes from near Perth Road to Forfar, were used for both Tree Swallows and Bluebirds.

Colleen Barber - "Determinants of extra-pair paternity in Tree Swallows" - Pilot study for Ph.D. project

The discovery of high rates of extra-pair paternity (EPP) in species previously considered monogamous has raised many questions about our current interpretations of mate choice, parental care, sexual selection and evolution of mating systems. While certain females within a socially monogamous species adopt a mixed reproductive strategy by engaging in EPCs, others do not. Recent studies suggest that promiscuous females are seeking genetic benefits for their offspring. Tree swallows (*Tachycineta bicolor*) are an ideal species with which to examine these issues since they are accessible, engage in unforced EPCs, and have extremely high rates of EPP that range from 50% of broods with extra-pair young in 1990 to 90% of broods in 1991. The good genes hypothesis is the most likely explanation to account for levels of EPP that although high, do not preclude the occurrence of mate fidelity within a population. It predicts that some females will be monogamous (those mated to "superior" males), while those mated to "inferior" males will engage in EPCs with higher quality males. I will attempt to measure, both through observation and manipulation, several potential cues of male quality: settlement date, morphological features, song rate, and aggressiveness; and compare these variables to the amount of EPP present in the broods. This will be done through DNA fingerprinting analyses. Males that

Jeremy Mitchell - "Determinacy of laying and other studies in Tree Swallows" - Post B.Sc. research

Two experiments were done (with help from RJR) to establish the degree of determinacy, versus flexibility, in laying patterns in Tree Swallows. This study was stimulated by the finding (Rendell and Robertson; 1993) that Tree Swallow clutch size is negatively correlated with cavity volume, and this apparent adjustment in clutch size can occur quite close to the time of laying. We did 2 egg removal, addition and swap manipulations, and found a limited increase in clutch size in response to removal of 2 eggs, but no reduction in clutch size in response to egg additions. We also kept some clutches at 0, 1, and 2 eggs by continuous removals, and found that females kept at 2 eggs laid a normal clutch and incubated, while those kept at 1 or 0 eggs, terminated laying early and laid a replacement clutch. We now have a paper in press describing these results and arguing that traditional dichotomous classification of species as either determinate or indeterminate layers is not appropriate.

My '91 study showed that barriers between two adjacent boxes affected both the male and the female resident's ability to defend a second box, so the level of polygyny was not affected. In '92, in BG, I tried to increase the level of polygyny by handicapping females (clipping 2,4,6, and 8th primary), and then erecting a second box 12 m from the original. Handicapping led to few desertions, but many females abandoned current nesting attempts and began nesting at a new box. Later, many cases of disappearance of one or both residents occurred, which may have been related to hawk predation, since many redwings in BM also disappeared. The handicapping/box addition experiment did not result in greater levels of polygyny.

Laurie Stewart - "Effect of nest box size on nestling growth and survival in the Tree Swallow (*Tachycineta bicolor*)" - B.Sc. Thesis

A positive relationship between clutch size and cavity size has been demonstrated in the Tree Swallow (Rendell and Robertson, 1993), implicating cavity size as an ultimate factor governing clutch size in hole nesting species. Box size may be constraining incubation, and/or nestling growth. However, in the previous study by Rendell and Robertson (1993), differences in reproductive success between box sizes could not be ascertained. Bias in parental quality, however, may have masked such differences. Therefore, the present study was proposed to reexamine the role of cavity size on the reproductive success of the Tree Swallow while controlling for parental quality. Broods were manipulated to 6 at the nestling stage for all nests and nestling growth and survival was compared between large and small nest boxes. In agreement with Rendell and Robertson (1993), clutch size was significantly lower in small boxes. In addition, large and small boxes differed significantly in % hatch and ninth primary measurements; no difference in growth rate was determined. A lower % hatch suggests that smaller boxes are interfering with incubation and/or increasing the risk of egg damage. Overcrowding leading to space constraints as well as the earlier onset of thermoregulation, may have contributed to the

observed lower ninth primary measurements. In general, variance was greater in small boxes, indicating that these nestlings were more stressed than those in large boxes. Whether these differences provide evidence for cavity size as an ultimate constraint of clutch size remains indefinite. Since manipulation of brood size was done after the incubation stage, a difference in % hatch cannot be used as evidence for cavity size as the ultimate determining factor of clutch size. Evidence that lower ninth primary lengths at fledging lead to lower recruitment is difficult to obtain due to very low fledgling return rates. Further study is needed to produce conclusive evidence for cavity size as the ultimate determining factor of clutch size. This study was done in NES.

Publications:

Conrad, K.F. and R.J. Robertson. 1992. Intraseasonal effects of clutch manipulation on parental provisioning and residual reproductive value of eastern phoebes (Sayornis phoebe *Oecologia* 89: 356-364.

Dunn, P.O. and R.J. Robertson. 1992. Geographic variation in the importance of male parental care and mating systems in tree swallows. *Behavioral Ecology* 3: 291-299.

Lifjeld, J.T. and R.J. Robertson. 1992. Female control of extra-pair fertilization in tree swallows. *Behavioral Ecology and Sociobiology* 31: 89-96.

Meek, S.B. and R.J. Robertson. 1992. How do floater male eastern bluebirds benefit by filling vacancies on territories where females already have young? *Behavioral Ecology* 3: 95-101.

Whittingham, L.A., P.D. Taylor, and R.J. Robertson. 1992. Confidence of paternity and male parental care. *American Naturalist* 139: 1115-1125.

Robertson, R.J., B.J. Stutchbury, and R.R. Cohen. 1992. Tree Swallow. In *The birds of North America*, N. 11 (A. Poole, P. Stettenheim, and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union.

Robertson, R.J. 1991. Infanticide or adoption by replacement males: the influence of female behaviour. *Acta XX Congressus Internationalis Ornithologici*: 974-983.

Lifjeld, J.T., P.O. Dunn, R.J. Robertson and P.T. Boag. In press. Extra-pair paternity in monogamous Tree Swallows. *Animal Behaviour*. (accepted 30 Dec. '91).

Dunn, P.O. and R.J. Robertson. In press. Extra-pair paternity in polygynous Tree Swallows. *Animal Behaviour*. (accepted 23 March 1992).

Mather, M.H. and R.J. Robertson. Honest advertisement in the flight display of the bobolink (Dolichonyx oryzivorus). *Auk*. (accepted 31 March 1992).

Whittingham, L.A., P.O. Dunn, and R.J. Robertson. Confidence of paternity and male parental investment in Tree Swallows. *Animal Behaviour*. (accepted 10 May 1992).

Venier, L.A., P.O. Dunn, J.T. Lifjeld and R.J. Robertson. Behavioural patterns of extra-pair copulation in tree swallows. *Animal Behaviour*. (accepted 1 September 1992).

Dunn, P.O., L.A. Whittingham, J.T. Lifjeld, R.J. Robertson, and P.T. Boag. Effects of breeding density, synchrony and experience on extra-pair paternity in Tree Swallows. *Behavioral Ecology*. (accepted 23 September 1992).

Conrad, K.F. and R.J. Robertson. Patterns of parental provisioning by Eastern Phoebe (*Sayornis phoebe*). *Condor*. (accepted 1 November 1992).

Meek, S.B. and R.J. Robertson. The number of nest boxes on a territory affects mate guarding intensity in eastern bluebirds, *Sialia sialis*. *Animal Behaviour*. (accepted 18 November 1992).

Rendell, W.B. and R.J. Robertson. Cavity-entrance orientation and nest-site use by secondary cavity nesting birds. *Journal of Field Ornithology*. (accepted 20 November 1992).

Rendell, W.B. and R.J. Robertson. Cavity size, clutch size and the breeding ecology of Tree Swallows, *Tachycineta bicolor*. *Ibis*. (accepted 20 November 1992).

Mitchell, J.S. and R.J. Robertson. Tree Swallows cannot be classified as determinate or indeterminate layers. *Condor*. (accepted 30 November 1992).

Conrad, K.F. and R.J. Robertson. Clutch size in eastern phoebes (*Sayornis phoebe*). I. The cost of nest building. *Canadian Journal of Zoology*. (accepted 20 December 1992).

Conference Presentations:

Lifjeld, J.T. and R.J. Robertson. Female control of extra-pair fertilization in Tree Swallows. Fourth International Behavioural Ecology Congress.

Whittingham, L.A., P.O. Dunn and R.J. Robertson. Confidence of paternity and male parental care in Tree Swallows. poster. Fourth International Behavioral Ecology Congress.

Meek, S.B. and R.J. Robertson. Paternity assurance versus nest site defense in Eastern Bluebirds. poster. Fourth International Behavioral Ecology Congress.

Dunn, P.O. and R.J. Robertson. Patterns of extra-pair paternity in Tree Swallows. poster. Fourth International Behavioral Ecology Congress.

Conrad, K.F. and R.J. Robertson. Variation in clutch size of the eastern phoebe (*Sayornis phoebe*). poster. Fourth International Behavioral Ecology Congress.

Chek, A.A. and R.J. Robertson. Mate guarding in Tree Swallows: a second look. poster. Fourth International Behavioral Ecology Congress.

Mitchell, J. and R.J. Robertson. Multiple nest site defense in Tree Swallows. Animal Behaviour Society Annual Meeting, Queen's University. 13-18 June 1992.

Rendell, W.B. and R.J. Robertson. Determination of clutch size in birds: cavity size and clutch size in Tree Swallows. poster. Pacific Ecology Conference, Friday Harbor Laboratories, San Juan Island, WA. 6 March 1992.

Rendell, W.B. and R.J. Robertson. Experiments with cavity size in Tree Swallows. poster. SFU-UBC Ecology Retreat, Squamish, B.C. 23 November 1991.

Drs. John Smol and John Kingston

"Limnology"

Michael D. Agbeti - "Internal (autogenic) and external (allogenic) control of plankton succession in two lakes with different morphometry but similar water chemistry" - Ph. D. Thesis

This research is the final year of an ongoing long-term (4-year) intensive research program designed to investigate the relative contribution of internal (autogenic) factors and external (allogenic) factors (in this case wind-induced continuous-mixing) on phytoplankton succession and species composition. Sampling began in February 1989 and continued through 1992.

The study lakes are Lake Opinicon (shallow and continuously-mixed throughout the ice-free seasons) and nearby Upper Rock Lake (much deeper and dimictic). The lakes were sampled twice monthly during the ice-free seasons and once monthly during winter (ice-covered season) for phytoplankton, zooplankton and water chemistry. The zooplankton samples were counted by Christine Watters. In addition, profiles of oxygen, temperature and conductivity, as well as Secchi depth measurements were recorded. Current meters were also deployed to provide us with current measurements in the lakes. Records of air temperature, wind speed and solar radiation were supplied by Queen's University Biological Station (QUBS).

The vertical distribution of phytoplankton community during ice-cover were also examined in the two lakes. Also, sediment traps were deployed in the two lakes to monitor the following: (i) Chrysophyte population dynamics and encystment in natural populations

(ii) the long- and short-term preservation of phytoplankton in lake sediments; (iii) comparison of sediment accumulation (production and resuspension) in a shallow and a dimictic lake; (vi) the onset of heterocyst formation in blue-green algae (Nostocales) and (v) the use of sediment traps in biomonitoring.

Assistants: Members of John Smol's Lab.

Publications

Internal and external control of plankton succession in two lakes with different morphometry but similar water chemistry. *J. Plank. Res.* (submitted)

Chrysophyte population dynamics and encystment in two Canadian lakes. (in preparation).

Winter limnology: a comparison of physical, chemical and biological characteristics in two temperate lakes during ice-cover (in preparation).

Dr. Bruce Tufts, Jim Kieffer, Brian Bagatto, Frank Phelan, Dr. Dave Philipp and Mark Kubacki - Queen's University, Queen's University Biological Station and Illinois Natural History Survey

"The physiological and behavioural responses of nesting male smallmouth bass to acute and prolonged angling stress: implications for catch-and-release"

In this study, we assessed both the physiological and behavioural consequences associated with pre-season angling of nesting male smallmouth bass. The results of this study showed that those fish angled for longer periods of time (i.e. 2 mins) suffered both greater physiological (an increased lactacidosis) and behavioural disturbances (i.e. an increase in the time to return to their nest) compared with fish angled for shorter time periods (i.e. 20 sec). These results clearly show that by reducing the angling duration, anglers can have an important impact on the physiological and behavioural disturbance associated with pre-season angling of bass. Next summer we plan to carry out experiments to examine the influence of temperature on the recovery from angling-induced exercise in bass.

Jim Kieffer

"Foraging behaviour in sunfish"

In 1992, Lake Opinicon was the source of pumpkinseed and bluegill sunfish for my laboratory experiments on the feeding behaviour of fish.

In collaboration with Patrick Colgan (Museum of Nature), we examined the effect of prey and habitat types on the foraging flexibility in sunfish. More specifically, we were interested in whether small sunfish possess the ability to retain learned responses over short periods of time.

Publications:

Kieffer, J.D. and P.W. Colgan. 1992. Differences in learning by foraging juvenile pumpkinseed and bluegill sunfish in a structured habitat. *Env. Biol. Fish.* 33: 359-366.

Kieffer, J.D. and P.W. Colgan. 1992. The role of learning in fish behaviour. *Rev. Fish Biol. and Fisheries* 2: 125-143.

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

Dr. Michael Berrill - Department of Biology, Trent University, Peterborough, Ontario

"Comparative life histories of Ontario Bullfrog populations"

We are comparing life histories of bullfrog populations in south-central and eastern Ontario, including a population inhabiting Lower Dowsley Pond adjacent to Lake Opinicon. We measured growth rates and ages of tadpoles and determined their relative time of metamorphosis. We also weighed and measured the length of all chorusing males in the population. The unusually cool temperatures of the summer of 1992 delayed egg laying in all ponds, but did not affect the duration of the calling season. Chorusing males in Lower Dowsley Pond, and probably at other sites in eastern Ontario, are on average considerably larger than chorusing males at sites in the south-central region. We are currently attempting to understand the reasons for such size differences. There is a possibility that differences in harvesting and hunting pressures may be involved.

Assistants: Susan Bertram & Lise McGillivray

Dr. James Briskie - Department of Animal & Plant Sciences, The University of Sheffield, Sheffield, United Kingdom.

"Sibling relatedness and the evolution of loud begging in nestling birds" (with C.T. Naugler, Queen's University)

In 1992 we initiated a study of begging behaviour of nestling birds. Begging is one of the most conspicuous behaviours of nestling birds and the traditional view is that it evolved as a way for nestlings to communicate nutritional requirements to their parents. However, a number of recent models suggest that the form and intensity of begging may also be adaptations to sibling competition. By comparing the loudness of begging calls across a variety of species, we are testing the hypothesis that louder begging has evolved in conjunction with reduced relatedness among the members of a brood (as determined by previous studies of DNA fingerprinting). That is, species in which siblings are only half-brothers or sisters (due to female promiscuity or brood parasitism) should be more selfish and beg louder than birds in nests where young are full siblings. This project will be completed during the summer of 1993.

Dr. John Eadie - Department of Zoology, Scarborough College, University of Toronto

"The ontogeny of female behaviour in the Basswood Lacebug"

Female lace bugs of the genus *Gargaphia* guard their eggs and offspring from invertebrate predators. Some females do not guard their offspring but instead 'dump' their egg in the clutches of parental females, effectively parasitizing these guarding females. Because the host parental females take care of their offspring, the parasitic or 'egg-dumping' females are released from the cost associated with parental care. We found that the egg-dumping behaviour is facultative and that most parasitic females subsequently guard their second clutch. Parental investment theory would predict that this progression from parasitic to parental behaviour may be mediated by declining reproductive value; hence later in the season a female would be less likely to risk leaving her eggs with a potentially inferior female. However, host availability declines as the season progresses. This suggests that in addition to declining reproductive value, dumper females do not have the opportunity to dump their second clutch because there are few or no hosts. We experimentally manipulated host availability to see if females would dump their second clutch.

David Bell - "Clutch size and brood size in the Basswood Lacebug" - M.Sc. Thesis

The basswood lacebug *Gargaphia tiliae* (Hemiptera: Tingidae) is unusual among insects because it provides care for its progeny. Lone females lay a mean of 82 ± 30 eggs and defend their offspring from predators through five nymphal instars. However there is also a high degree of 'egg dumping' in this species: 55% of all clutches are contributed to

by two or more females which can raise clutch sizes to over 500 eggs ($x = 205 \pm 41$ eggs) and these clutches are tended by only one female. During brood development (15-20 days) most broods become parasitized with larval mites (*Leptus* sp. Acari: Erythraeidae). Females cannot defend against these mites and once a nymph is parasitized it subsequently dies. We found that the number of mites per brood is not correlated with brood size. This results in a negative correlation between the probability of mite parasitism and brood size and hence the per capita survivorship of nymphs increases with the size of a brood. Dumped eggs should therefore increase a female's fitness through this dilution effect. However, field collected survivorship data exhibit no correlation between brood size and survivorship. Moreover, experimental addition of eggs and nymphs to clutches did not result in increased survivorship. We conclude that the dilution benefit of egg dumping to hosts are effectively neutralized by concomitant costs associated with caring for larger broods.

Dr. Spencer Barrett - Department of Botany, University of Toronto

Christopher Eckert - "The evolutionary maintenance of a sexual polymorphism in clonal *Decodon verticillatus* (L.) Ell. (Lythraceae)" - Ph.D. Thesis

Over the last five years, I have been investigating the evolutionary maintenance of the tristylous sexual polymorphism, in a long-lived, clonal wetland plant, *Decodon verticillatus* (L.) Ell. Studies of the morphology, physiology and genetics of tristylous in this species have shown that floral trimorphism is governed by two unlinked, diallelic loci with complete dominance and epistasis. Unlike most heterostylous plants, the floral polymorphism is not associated with a physiological self- and intramorph- incompatibility system. In the absence of incompatibility, mating patterns are generally expected to vary with ecological factors influencing pollen transfer. Outcrossing rates estimated for 6 populations in the QUBS area and 4 populations in Michigan with contrasting ecological characteristics, however, revealed significant levels of self-fertilization (30%) but little variation among populations. Pollen competition experiments with genetic markers revealed significant post-pollination discrimination against self pollen, which could buffer the mating system against ecological variation. Despite moderate selfing, population genetic analyses and formal experiments in both the glasshouse and natural habitats at QUBS indicate that inbreeding depression is strong enough to maintain outcrossing.

Stochastic simulations showed that the life-history, demography and mating parameters of populations interact to affect the pattern of morph-frequency variation. Application of the theoretical results to morph frequencies from 133 populations of *D. verticillatus* and 137 populations of related *Lythrum salicaria* L., indicated that stochastic forces such as genetic drift and founder events strongly influence morph frequencies in both species in spite of frequency-dependent selection. Morph loss was more frequent in more recently colonized areas (*D. verticillatus* - 60% in glaciated areas, 28% in unglaciated areas; *L. salicaria* - 23% in adventive range, 0% in native range), and in clonal, self-compatible *D. verticillatus* than sexual, self-incompatible *L. salicaria*. Deviations from the simple stochastic model of morph loss in *D. verticillatus* involved high frequencies of monomorphic

populations at the northern limit of the range as well as marked deficiencies of the mid-styled morph in New England and Ontario. Studies of clonal diversity in 16 populations using allozyme variation revealed that monomorphism probably results from severe founder effects and exclusive clonal reproduction. Theoretical modelling combined with field and greenhouse experiments involving 30 populations from the QUBS area indicated that deficiencies of the mid-styled morph are probably due to historical accidents during post-glacial colonization rather than natural selection against the mid morph in contemporary populations.

Publications:

Barrett, S.C.H., and C. G. Eckert. 1990. Variation and evolution of mating systems in seed plants, pp. 229-254. In S. Kawano (ed.), *Biological Approaches and Evolutionary Trends in Plants*. Academic Press, Tokyo, Japan.

Eckert, C.G., and S.C.H. Barrett. 1992. Stochastic loss of style morphs from populations of tristylous Lythrum salicaria and Decodon verticillatus (Lythraceae). *Evolution* 46: 1014-1029.

Barrett, S.C.H., C.G. Eckert, and B.C. Husband. 1993. Evolutionary processes in aquatic plants. *Aquatic Bot.*, in press.

Paul Faure - Section of Neurobiology & Behavior, Cornell University, Ithaca, New York

"The auditory inadequacy of tympanate moths to the echolocation calls emitted by gleaning versus aerial insectivorous bats" - Ph.D. Thesis

This study empirically tests the prediction that the echolocation calls of gleaning insectivorous bats are acoustically mismatched to the ears of noctuid moths, and are thus less detectable than the calls emitted by aerial-hawking bats. A textbook example in neuroethology is the avoidance response of tympanate moths to the echolocation calls of insectivorous bats. Moths possess ears sensitive to ultrasound, presumably to detect bat echolocation calls. To date, research on bat-moth interactions has been limited to the auditory or behavioral response of moths in flight, since until recently it was assumed that aerial foraging was a bat's only method of hunting. Few studies have considered other bat foraging strategies (e.g. substrate-gleaning). Gleaning bats typically emit echolocation calls of low intensity, high frequency, and short duration; call characteristics thought to be acoustically mismatched to the auditory receptors of tympanate prey. This allowed us to predict that moths will find gleaning bats difficult to detect, thus leaving moths particularly susceptible to predation. This study examined the auditory response of Catocala moth spp. to the echolocation calls of gleaning Myotis septentrionalis and aerial-hawking Myotis lucifugus. We determined the auditory thresholds of 4 species of underwing moths to

frequencies between 5-125 kHz, and pulse duration mimicking those employed by gleaning (1 ms) and aerial-hawking bats (5 & 10 ms). We tested moths with their ears covered by their wings (to mimic moths resting on vegetation or warming up for flight) *versus* moths with their ears uncovered (wings outstretched to mimic flying moths or moths fluttering on a surface). Our results show that the moth ear is less sensitive to pulse durations used by gleaning bats; a situation worsened when the ear is covered by the wing. Interestingly, moths with their ears covered by their wings maintained their hearing sensitivity in the frequency range used by aerial-hawking bat species, but showed a pronounced deafness in the frequency range employed by gleaning bats. While recording from their auditory nerve we exposed moths to gleaning attacks by M. septentrionalis and aerial calling flights by M. lucifugus. Our results demonstrate that the moth ear responds inconsistently and with fewer action potentials to the echolocation calls of gleaning M. septentrionalis, whereas the echolocation calls of gleaning M. septentrionalis consistently elicited a stronger spiking response. These results support our hypothesis that the echolocation calls used by gleaning bats are acoustically mismatched to the ears of moths (and presumably other nocturnal insects), and suggest that gleaners gain a distinct foraging advantage in this evolutionary game of cat-and-mouse.

Publication:

Faure, P.A., J.H. Fullard and J.W. Dawson. 1993. The gleaning attacks of the northern long-eared bat, Myotis septentrionalis, are relatively inaudible to moths. Journal of Experimental Biology (in press).

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

"Growth, density and other factors affecting reproductive life-history traits in Pumpkinseed Sunfish populations"

The objectives of my study were to explain the high degree of life-history variation exhibited by pumpkinseed (Lepomis gibbosus) populations; to test growth-related predictions of life-history theory; and to determine whether the congeneric bluegill sunfish (Lepomis macrochirus) influences the reproductive patterns of pumpkinseeds. I examined pumpkinseeds from 27 Ontario waterbodies, including Opinicon, Loughborough, Smiths B and Upper Rock Lakes 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).

The fastest growing juveniles within populations matured earliest, but only 24% of the variation in mean age at maturity in females was explained by interpopulation differences in the juvenile:adult growth ratio. Reproductive life-history characteristics were highly correlated with the indicator of life span and adult mortality rate, suggesting that

mortality is more important than growth in the shaping of pumpkinseed life-histories. Pumpkinseed populations that co-occured with bluegills matured significantly later and at a larger size than populations living in waterbodies without bluegills. Pumpkinseed populations in the Rideau-Cataract watershed matured significantly later than those of the Kawartha watershed. Electrophoretic analysis carried out in collaboration with Dr. David Philipp (Illinois Natural History Survey), showed that the genetic characteristics of populations also differed according to the watershed where they are located.

Assistants: Andy Danylchuk, Al Justus

Andy Danylchuk - "Seasonal reproductive patterns of Pumpkinseed populations with varying body size characteristics" - M.Sc. Thesis

The purpose of this study was to determine if differences in body size characteristics at the population level are associated with differences in reproductive activity and reproductive allocation. Pumpkinseed populations in six lakes (including Lake Opinicon) were examined for seasonal nesting patterns and gonad to body weight ratio. Adult body size ranged in these populations from normal for east-central Ontario, to extremely stunted.

The length of the nesting period varied from 5 to 12 weeks in individual lakes. The two stunted populations delayed the initiation of nesting activity and had the longest nesting period. Females from stunted populations allocated more energy to gonadal development than females from populations with normal adult body size. Within populations, smaller females matured later in the season than larger females. These data suggest that high reproductive allocation is associated with small adult body size, and that size-related variation in the timing of reproduction is a consequence of differences in energy reserves between small and large individuals.

Publications:

Keast, A. and M. G. Fox. 1992. Space and resource use patterns in an offshore open-water lake fish community. *Env. Biol. Fish* 34: 159-170.

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

"Insect sensory ecology and neuroethology"

I. Auditory loss in polynesian moths compared to nearctic species - J. Fullard, University of Toronto and D. Thomas, Université de Sherbrooke.

Moths have simple ears to detect the echolocation calls of hunting bats and species that have descended from individuals that migrated to bat-free areas should exhibit signs of auditory degeneration. Noctuid moths from the islands of French Polynesia were sampled and electrophysiologically analysed to test this hypothesis (National Geographic Society Grant #4707-92). Immigrant species and endemic species captured on the Society islands of Moorea and Tahiti, the Marquesan island of Hiva Oa and the Tuamotuan atoll of Rangiroa were brought to the laboratories at the Centre de l'environnement d'Opunohu, Opunohu Bay, Moorea. Frequency sensitivity curves were derived and compared in the two groups of moths. These curves were then compared to audiograms derived from samples of moths at QUBS. On French Polynesia all moths possess neurally responsive ears but endemic moths are significantly deafferented than immigrants at frequencies above 35 kHz and are significantly deafferented than QUBS moths at all frequencies. We conclude that polynesian moths exhibit preliminary stages of auditory loss but there may be selective advantages to retaining partial functionality in their ears considering the extremely low physiological costs of these organs.

II. Isolation and Characterization of the neural circuit controlling sound production in tiger moths (Lepidoptera:Arctiidae) - Jeff W. Dawson, University of Toronto.

The dogbane tiger moth Cycnia tenera and the milkweed tussock moth Euchaetes egle respond to the echolocation calls of an attacking bat by producing ultrasonic clicks from metathoracically paired tymbal organs. I hypothesize this behaviour is under the control of a neural circuit called a central pattern generator (CPG) and my M.Sc. research has focused on isolating and characterizing this neural circuit. When moths are stimulated with electronically generated ultrasonic pulses simulating the echolocation calls of an attacking bat, motor impulses (action potentials) can be recorded from the tymbal nerve which activate the tymbal organs and thus can be used to monitor responses from the moth. To ascertain the location of this neural circuit within the thoracic central nervous system (CNS), connectives between the thoracic ganglia were transected in an effort to identify the minimum amount of CNS necessary for a response. The results from these experiments suggest that the CPG circuitry necessary for tymbal activation is distributed within the pterothoracic and prothoracic ganglia and that an activator and/or maintenance component of the circuit exists within the head. Further studies for my M.Sc. will examine the role the head plays in tymbal activation by direct electrical stimulation of the brain. The distribution of the tymbal CPG within the CNS suggests an evolutionary origin from an acoustic startle response involving leg rather than wing movements. Work during the summer of 1992

involved surveying the Arctiidae found at QUBS to identify candidate species for this study and characterizing the motor impulses which activate the tymbal organs of *E. egle*. Moths were also collected and reared to pupae, then transported back to Erindale College, University of Toronto, for use during the winter months.

III. Neurometamorphosis of the ear in the Gypsy Moth, *Lymantria dispar* (Lymantriidae) - Francine P. Lewis, University of Toronto

Eared moths such as the gypsy moth as adults have simple tympanal organs on their metathoracic segment. The structure that transduces the movement of the eardrum is a chordotonal organ consisting of two auditory neurons. The larva of the gypsy moth do not have ears but through metamorphosis acquires them for the adult stage. My research includes finding and characterizing the precursor organ in the larval stage as well as documenting any changes it may undergo during metamorphosis to the adult stage.

Publications:

Faure, P., J.H. Fullard and J. Dawson. (1993) Auditory inadequacy in noctuid moths against the attacks of the gleaning northern big-eared bat, *Myotis septentrionalis*. J. Exp. Biol. (in press)

Fullard, J.H. and J.E. Yack. (1993) The evolutionary biology of insect hearing. Trends Ecol. Evol. (in press)

Fullard, J.H. (1992) The neuroethology of sound production in tiger moths (Lepidoptera, Arctiidae). I. Rhythmicity and central control. J. Comp. Physiol. A 170:575-588

Lewis, F., J.H. Fullard and S. Morrill. (1993) Auditory influences on the flight behaviour of moths at a Nearctic site. II. Flight height. Can. J. Zool. (in press)

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"

Luca Cargnelli supervised the study of bluegill spawning bouts including dates, colony sites, nest numbers and male reproductive success. These data add to the five-year study by Julie Claussen (1985-89), and the two-year study by James McGuire (1990-91), providing eight years of continuous records in the Fish Reproduction Study Area. Luca was assisted in this work by James, Helen Han and Sylvia Quant. Luca has previously analyzed some of the 1985-1991 data as part of an undergraduate project in my lab.

"Cuckoldry in Bluegill Sunfish"

Luca, James, Sylvia and Helen also studied cuckoldry rates in bluegill sunfish, collecting behavioural data and then fry and adults to determine paternity. John Colbourne is responsible for the paternity analyses and is conducting his work at our Toronto lab. John is using cellulose acetate gels which require minimum protein loading. He is also looking into microsatellite DNA techniques.

Thesis:

Côté, Isabelle M. 1993. The evolution of sociality in fishes with emphasis on the role of parasites. Ph.D. Thesis, Department of Zoology, University of Toronto, Toronto, Ontario.

Assistants: Luca Cargnelli, John Colbourne, Helen Han, James McGuire, Sylvia Quant

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

"Hormonal analysis of male Bluegill during the spawning season"

The main goal of this research is to measure hormone concentrations, particularly 11-keto-testosterone, during bouts of bluegill reproductive activity, and relate them to male characteristics and male reproductive success. Blood samples have been analyzed at the University of Illinois for their hormonal concentrations using a radioimmune assay technique and are being compared to reproductive activities, such as nest construction, nest position within the colony, male body size, clutch size, and reproductive success.

David Philipp, John Epifanio, and Julie Claussen

"Natural hybridization events between Bluegill and Pumpkinseed in Lake Opinicon"

Research on hybridization events between bluegill and pumpkinseed, as well as the behavior of sunfish hybrids, has been going on for a number of years. Research in our lab has shown that small sneaker male bluegill cuckold (steal fertilizations) spawning pairs of pumpkinseed, resulting in hybridization between these two species. We are continuing to study the various costs and benefits of these hybridization events. This year we also focused on using underwater video taping to document the various breeding behaviors of both bluegill and pumpkinseed. In addition, using electroshocking techniques, we are continuing to assess the relative proportions of the two sunfish species and their hybrids in the population.

David Philipp and John Epifanio

"Developmental genetics of Sunfish hybrids in Lake Opinicon"

Our work studies the pattern of gene expression during the various stages of embryonic and larval development of hybrids. Bluegill, pumpkinseed, and their hybrids were collected and gametes from each extracted and used for in vitro fertilizations to make F1 hybrids as well as the backcrosses of each species. Embryos were raised and sampled at various developmental stages. Using molecular techniques, we are determining when certain genes turn on during development.

Assistant: Julie Claussen

Mark Kubacki "Catch-and-release angling of Largemouth and Smallmouth Bass" - M.Sc. Thesis

This was the final year in a two year study looking at the effects of catch-and-release angling on the reproductive success of nesting largemouth and smallmouth bass. Experimental angling was conducted at the St. Lawrence River, Charleston Lake, and Lake Opinicon for both largemouth and smallmouth bass. Data taken from captured-and-released bass such as male size, brood developmental stage, egg score, return time, predation rates etc. will be used to determine how catch-and-release angling impacts the reproductive success of both species.

Assistants: Heather Ferguson, Todd Kassler, James Ludden, and Jeff Stein.

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"

This was the last year in a three year study on largemouth and smallmouth bass reproductive success, supported by the Ontario Ministry of Natural Resources, and the Ontario Federation of Anglers and Hunters. Intensive monitoring of spawning success, the duration of nesting, and parental care behavior in both species continued to be documented at the four study sites: Lake Opinicon, Lake Charleston, the Mississippi River, and St. Lawrence river near Mallorytown. To help with this work, the OFAH again sponsored another undergraduate student from Queen's University to be a part of the research team.

Assistants: Mark Kubacki, Mike Fuhr, Jeff Stein, James Ludden, Heather Ferguson

Dr. Bruce P. Smith - Department of Biology, Ithaca College, Ithaca, NY 14850.

"Water Mite Parasitism of Aquatic Insects"

I. Reproductive tactics and loss of parasitism within Arrenurus spp. mites

In previous research at QUBS I had discovered what appeared to be two species of mites in which some individuals had normal larvae that are ectoparasites of insects, while others had non-feeding larvae that forego parasitism. In 1992 Seth Ettenberg and I more closely examined these species; the first hypothesis was that each species, as currently defined, was actually a pair of sibling species in which one species has parasitic larvae while the other has non-parasitic larvae. We concluded that this was true. Females that produced non-parasitic larvae were slightly but significantly smaller and had significantly larger gonopores (genital apertures) than females that produced parasitic larvae. Each female was found to consistently produce only one type of larva, and all female offspring had characteristics consistent with their maternal parent. Male offspring of females that produced non-parasitic larvae were slightly but significantly smaller than male offspring of females that produced parasitic larvae.

We also hypothesized that there would be an evident reproductive trade-off between egg size and egg number between sibling species and within each species. There were evident differences between sibling species: females of species that produce non-parasitic larvae produced smaller numbers of larger eggs than females that produce parasitic larvae. However, there was no comparable trade-off within each species. In one species, larger clutches were positively correlated with larger egg size. We suggest that this could indicate differences in condition: individuals with more available energy may increase both clutch size and egg size if both tactics would increase fitness. Female volume did positively

correlate with reproductive volume, and within all four species the larger females produced larger clutches.

II. Influence of wing-morph and parasitism on mate-selection in the water strider Gerris comatus

From observing populations in nature during previous summers, there was apparent assortative mating among Gerris comatus based on wing-morph and intensity of parasitism. Short-winged males carried fewer mites and were apparently more successful obtaining mates than were long-winged males. However, long-winged water striders of mid-summer are individuals that have overwintered, while short-winged individuals are their offspring and are less than 6 weeks old. Intensity of infestation by mites is also age-related, as the mites accumulate with time. Hypothetically, the assortative mating may be an age-related phenomenon, with older individuals being less competitive than younger individuals. If this hypothesis is correct, intensity of parasitism and wing-length would only be correlations with age-effects and would not directly influence competitiveness for mates.

In 1992, Nolan Pickens and I attempted to test the influence of age, wing-morph, and parasitism on mating success of water striders. Under experimental conditions, the three factors could be isolated and tested separately. We encountered problems because only a small proportion of water striders would mate in the experimental conditions provided, and we discovered that the time elapsed until mating was correlated with air temperature, which could not be controlled.

Assistants: Seth Ettenberg, Nolan Pickens

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

"Mate Choice in Red-winged Blackbirds"

Collaborator: Dr. Peter Boag (Queen's)

The goal of this long-term project is to test several mate-choice hypotheses using red-winged blackbirds, and by repeating this research over a long period (7 years) using a marked population, to determine lifetime mating strategies and lifetime reproductive success of known individuals. The importance of this project is that mating behaviour is being determined using DNA fingerprinting, so a true measure of individual reproductive success will be obtained. This year marked the end of data collection for this phase of the project. Fingerprinting analysis is progressing well and should be completed in 1993.

Assistant: Kit Muma

"Sexual Selection in Northern Water Snakes"

Collaborator: Dr. Mark Forbes (Postdoctoral Fellow, Carleton)

During the mating season, receptive female northern water snakes are often courted by several males simultaneously. In most animals, competition among males for access to females is associated with the evolution of sexual size dimorphism, where males are larger than females. However, female northern water snakes grow much larger than males, suggesting that attributes other than large size contribute to male mating success in this species. Previous work by Frances Barry suggested that intermediate-sized males may be more competitive because their energy reserves relative to their body size are greater. This year we began to study the relationship between male size, condition, locomotory performance, haematocrit infections, and mating performance. This research will be continued in 1993.

Assistant: Frances Barry

"Correlates of Dominance in Male Brown-headed Cowbirds"

Collaborator: Dr. Kevin Teather (Postdoctoral Fellow, Carleton)

We investigated the effect of associating with a female, male age and infection with blood parasites on the dominance relationship between pairs of captive male cowbirds. Pairs of males housed with a female invariably established a clear dominance relationship, with the dominant male associating exclusively with the female. When males differed in age, older males usually dominated younger males. When the subordinate male was allowed exclusive access to the female for two days, 30% became dominant when rehoused with the dominant male. These dominance reversals were not associated with the relative ages, morphology or parasite status of the two males. However, subordinate males that displayed more when alone with the female were more likely to become dominant. The failure of parasites to affect dominance in competition for mates contrasts with an earlier study in which we found that parasites affected dominance in competition for food, suggesting that the value of the resource being competed for may influence how birds respond behaviourally to parasitic infections. The success of some young males at dominating older males as a result of associating with a female may explain why young males appear to compete successfully for mates in some field studies of this species.

**Kevin Dufour - "Heritability of reproductive performance in male Red-winged Blackbirds"-
Ph.D.thesis**

On-going research on the reproductive behaviour of red-winged blackbirds has revealed that breeding males vary widely in the degree to which they achieve reproductive success. Theory suggests that there may be a genetic component to this variation, but evaluating this

possibility has proved difficult in the past. This summer, an unprecedented number of males that had been banded as nestlings in previous years returned to their natal area to breed, thus providing a unique opportunity to assess the relation between the reproductive behaviour and performance of individual males and that of their sons (i.e., heritability). To this end, we monitored the reproductive performance of all individuals breeding in marshes comprising PJW's long-term study population. This included sampling blood from all breeding adults and associated nestlings for subsequent genetic analysis to determine true parentage.

Assistant: Kit Muma

Drs. Mark Forbes¹ and Kevin Teather² - "The ecology of female-limited polymorphism in two species of damselflies" 1- NSERC Postdoctoral Research Fellow

2 - Postdoctoral Research Fellow, Carleton University

Female-limited polymorphism is found in several species of insects from two orders (Lepidoptera and Odonata). In coenagrionid damselflies, one female morph is often coloured or patterned like the conspecific male, whereas the other morph is coloured or patterned unlike the male. We investigated responses of conspecific males to females of either morph for two species of Enallagma damselflies to test several predictions of recent hypotheses for morph coexistence. In one species (E. boreale), male-like females were by far the most numerous type of female, whereas in the other species (E. ebrium) male-like females were rarely found (ca. 5 % of all females). We show that male responses to females of either morph depends on the species and several other factors including time of day, whether or not the female is presented with another female or a conspecific male, and possibly the number of previous male-male interactions prior to the presentation of female morphs. We suggest that differential male responses to female morphs may result in differential selection on morphs as measured over the short term, although this supposition needs to be corroborated.

Kent Prior - "Conservation biology of black rat snakes" - Ph. D. Thesis

The black rat snake is a rare species in Ontario. They persist in three or four geographically isolated, relict populations, the largest of which occurs in the Rideau Lakes Region. My research is aimed at providing a variety of ecological data critical to their conservation. Continuous monitoring of seven hibernacula across the Rideau Lakes Region during the spring of 1992 allowed me to collect data on emergence patterns, hibernacula demographics, habitat use and to sample blood from individuals for genetic analyses. Preliminary results suggest that spring emergence can be quite prolonged (i.e., 3-4 weeks) and that there are no apparent sex- or age-specific trends associated with the timing of emergence. The majority of snakes captured were mature adults with males and females equally represented, and captures ranged from 20 to 29 animals per hibernaculum.

Following emergence, many of the snakes were found basking in the vicinity of the hibernaculum prior to dispersal. Trees having dead and hollow limbs or trunks appear to be preferred sites for basking. Preliminary analyses of the genetic structure and diversity found within the Rideau Lakes population(s) have been made using randomly amplified polymorphic DNA (RAPD). Comparisons will be made between this population and those sampled from southern Ontario, Ohio, and Maryland in order to assess the role that population size and bottleneck severity may play in determining genetic variation. Genetic analyses are being done in collaboration with Dr. H. Lisle Gibbs (McMaster).

Assistant: Frances Barry

Stephen Yezerinac - "Sexual selection via extra-pair matings in yellow warblers?" - Ph.D. Thesis

Previous research on yellow warblers - conducted at QUBS - has shown that males vary in the extent of development of breast plumage streaking, and that males' territorial behaviour and parental effort covaries with this secondary sexual character. Current theory suggests that this plumage variation and corresponding differential allocation of reproductive effort may either be maintained via the achievement of equal reproductive success by males employing alternative tactics, or that this variation may reflect fundamental differences in male quality and hence translate into differences in reproductive success. The main aim of my research is to test these alternative hypotheses by monitoring males' apparent and true reproductive success (as revealed by DNA Fingerprinting) in relation to their plumage phenotype. Initial results indicate that although yellow warblers are socially monogamous, the genetic mating system is not exclusively so. The extent of extra-pair parentage, as well as its relationship with male phenotype, nesting date, and the sexes' relative contributions to nestling care should be revealed by 1992's data. Work will continue on this project in 1993 and 1994 with a comparison being made between the QUBS population and one at Delta Marsh, Manitoba.

Assistant: Terri Taylor

Publications:

Barry, F.E., P.J. Weatherhead and D. P. Philipp. 1992. Multiple paternity in a wild population of northern water snakes (*Nerodia sipedon*). Behav. Ecol. Sociobiol. 30: 193-199.

Dufour, K.W. and P.J. Weatherhead. 1991. A test of the condition bias hypothesis using brown-headed cowbirds trapped during the breeding season. Can. J. Zool. 69: 2686-2692.

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. Molecul. Biol. Evol. 8: 433-446.

Hoysak, D.J. and P.J. Weatherhead. 1991. Sampling blood from birds: a technique and an assessment of its effect. *Condor* 93: 746-752.

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. Sociobiol.* 28: 23-27.

Metz, K.J. and P.J. Weatherhead. 1992. Seeing red: uncovering coverable badges in red-winged blackbirds. *Anim. Behav.* 43: 223-229.

Metz, K.J. and P.J. Weatherhead. 1993. An experimental test of the contrasting-color hypothesis of red-band effects in red-winged blackbirds. *Condor*, in press.

Muma, K.E. and P.J. Weatherhead. 1991. Plumage variation and dominance in captive female red-winged blackbirds. *Can. J. Zool.* 69: 49-54.

Robertson, I.C. and P.J. Weatherhead. 1992. The role of temperature on microhabitat selection by northern water snakes (*Nerodia sipedon*). *Can. J. Zool.* 70: 417-422.

Scott, D.M., P.J. Weatherhead and C.D. Ankney. 1992. Egg-eating by female brown-headed cowbirds. *Condor* 94: 579-584.

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. Sociobiol.* 28: 235-241.

Shutler, D. and P.J. Weatherhead. 1992. Surplus territory contenders in red-winged blackbirds: where are the desperados? *Behav. Ecol. Sociobiol.* 31: 97-106.

Weatherhead, P.J. and G.F. Bennett. 1991. Ecology of red-winged blackbird parasitism by haematozoa. *Can. J. Zool.* 69: 2352-2359.

Weatherhead, P.J. and G.F. Bennett. 1992. Ecology of haematozoa parasitism in brown-headed cowbirds. 1992. *Can. J. Zool.* 70: 1-7.

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* 93: 1013-1016.

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

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

Weatherhead, P.J. and I.C. Robertson. 1992. Thermal constraints on swimming speed and escape response of northern water snakes. *Can. J. Zool.* 70: 94-98.

Weatherhead, P.J. and K.L. Teather. 1991. Are skewed fledgling sex ratios in sexually dimorphic birds adaptive? *Am. Nat.* 138: 1159-1172.

Documentation of Research Use of QUBS in 1992 - User-Days

User	Supervisor	Post-Doc	Graduate Student	Assistant	Total
INTERNAL (QUEEN'S)					
Aarssen	16	0	60	112	188
Briskie	0	0	0	33	33
Cooke	0	110	0	32	142
Crowder	6	0	0	0	6
Harmsen (on sabbatical leave)	0	0	0	0	0
Keast	82	0	0	158	240
Montgomerie	14	0	5	65	84
Phelan	n/a	0	0	119	119
Ratcliffe	8	0	101	83	192
Robertson	99	0	202	317	618
Smol/Kingston	0	0	3	3	6
Tufts	1	0	2	3	6
Total Internal	226	110	373	925	1634
EXTERNAL					
University of Toronto					
Baker (Erindale)	0	0	10	0	10
Eadie (Scarborough)	2	0	114	4	120
Eckert	5	0	0	4	9
Fullard (Erindale)	62	0	273	2	337
Gross	4	0	58	154	216
Carleton University					
Weatherhead	87	158	220	183	648
Illinois Natural History Survey					
Philipp	45	52	77	177	351
Ithaca College					
Smith	94	0	0	145	239
Trent University					
Berrill	3	0	0	3	6
Fox	3	0	3	0	6
University of Canterbury N.Z.					
McLean	90	0	0	0	90

Rideau Lakes Fisheries Assessment Unit - Smith	4	0	0	7	11
Cornell University Faure	0	0	24	0	24
Total External	399	210	779	679	2067
TOTAL RESEARCH USER-DAYS	665	320	1152	1604	3701
% Queen's	34	34	32	58	44
% Non - Queen's	66	66	68	42	56

USER-DAYS IN TEACHING ACTIVITIES 1691

CONFERENCE AND FIELD TRIP USE 708

OTHER* 1121

Grand Total User-Days in 1992 7221

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

Summary of Conference, Meeting and Field Trip Use of QUBS in 1992

Organizer	Function	Number of Participants	Duration
Julie Duke (Queen's - German)	German Language Immersion Weekend	8	Jan. 10-12
Frances Barry (Carleton - Biology)	Reunion Weekend	18	Jan. 17-19
James Fotheringham (Queen's - Biology)	Italian Club - Language Immersion Weekend	12	Jan. 24-26
Mrs. Bark (Queen's - Spanish)	Spanish Club - Language Immersion Weekend	10	Jan. 31 - Feb. 2
Dr. Kristen Day (University of Toronto)	NorthEastern North American Chapter of Society of Environmental Toxicology and Chemistry Meetings	39	April 24-26
Mark Milian (Lancaster Drive Public School)	Canoe Trip and Station Tour	22	June 2
Peter Good (Kingston Field Naturalists)	Bat Workshop - Mammal Atlas	35	June 4
Deb Metzgar (Botany - Royal Ontario Museum)	Ontario Field Botanists Willow Workshop	14	June 6-7
Mark Milian (Lancaster Drive Public School)	Canoe Trip and Station Tour	24	June 11
Dr. Laurene Ratcliffe (Queen's - Biology)	Animal Behaviour Society Post-Congress Excursion	61	June 16
Malcolm Griffin (Queen's - Mathematics)	Math Department Workshop	9	June 22
Steve Blakely (Queen's - Biology)	Plant Physiology Workshop	8	August 11
Phyllis Connell (Elgin W.I.)	Elgin Women's Institute Station Tour	10	August 27
Dr. Ed Kott (Wilfrid Laurier - Biology)	Wilfrid Laurier Senior Undergraduate Field Course	16	August 30-Sept. 12
Adele Mullie (Queen's - Biology)	Biology 302 (General Ecology) Weekend	69	Sept. 26-27
Dr. Bruce Tufts (Queen's - Biology)	Catch and Release Workshop	26	Sept. 27-28
Dr. John Smol (Queen's - Biology)	Biology 335 (Limnology) Weekend	46	Oct. 3-4
Mike Plancke (South Crosby Public School)	Grades 7 and 8 Pond Study Field Trip	50	October 8
Dr. Ed. Kott (Wilfrid Laurier - Biology)	Fish Ecology Weekend	17	Oct. 9-11

Adele Mullie (Queen's - Biology)	Biology 302 (General Ecology) Weekend	53	Oct. 17-18
Adele Mullie (Queen's - Biology)	Biology 302 (General Ecology) Weekend	70	Oct. 24-25
Dr. Rollie Tinline (Queen's - Geography)	Geographic Information Systems Workshop	22	Nov. 3-4
Anne Robertson (Kingston Field Naturalists)	Junior Kingston Field Naturalists Field Trip	12	Nov. 21

QUBS Seminar Schedule 1992

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|---------|--|
| May 7 | Dr. Ian McLean - University of Canterbury, New Zealand
"Conservation biology and New Zealand birds" |
| June 3 | Dr. Allen Keast - Department of Biology, Queen's University
"Birds of Lake Opinicon: seasonality" |
| June 11 | Dave Rosen - Department of Biology, Memorial University
"Eat more and lose weight: the Nutri-seal diet" |
| | Grant Brown - Department of Biology, Memorial University
"Do kin really make better neighbours?: salmon and trout" |
| June 24 | Mike Runtz - Department of Biology, Carleton University
"Antlers in the trees: natural history of Algonquin Park" |
| July 13 | Dr. Ian McLean - University of Canterbury, New Zealand
"Enemy recognition in birds" |
| July 22 | Kevin Dufour - Department of Biology, Carleton University
"Sampling waterfowl populations: condition bias revisited" |
| July 24 | Kerri-Anne Edge - Department of Biology, University of Otago, New Zealand
"Brood reduction in the endangered yellow-eyed penguin" |
| | Cathy Shave - Department of Biology, University of Otago, New Zealand
"A test of the sensory exploitation hypothesis with a New Zealand species of freshwater fish" |
| July 26 | Dr. Ian Jamieson - Department of Biology, University of Otago, New Zealand
"Certainty of paternity and parental investment in the polyandrous pukeko" |
| | Colleen St. Clair - Department of Biology, Queen's University
"MacQuarrie Island: Penguins and seals in Southern Oceans" |

Fee Schedule for 1993

Board Charges - Meals only

\$418/month/person	-no obligation for chores
\$290/month/person	-includes obligation for chores on a rotating schedule

Accommodation Charges - Housing only

\$16/month/person	-dormitory (White House or Curran Cottage)
\$32/month/person	-small cabin (Cabins 1-7, 10, shaker and Basswood Cabin)
\$64/month/person	-medium cabin (Cabins 12, 13, 14)
\$86/month/person	-large cabin (Cabins 8, 11 and White House Apartment)
\$118/month/person	-Cottage (Keast, Earl, Sumac or Maplewood)

Room and Board Rates for Short-term Visitors

\$175/person	-weekly R&B for field courses - includes a lab fee
\$21.50/day/person	-24 hr. room and board
\$4.00	-breakfast or lunch only
\$7.50	-dinner only
\$9.00/person	-overnight accommodation - academic purposes
\$18.50/person	-overnight accommodation - non-academic purposes

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

Boat Rental

\$190/month, \$87.50/week - includes maintenance from normal use - gas and oil not included

\$40/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

\$4.50/day - non-Queen's staff or major researcher (M.Sc. or Ph.D. candidate, project coordinator or Post-Doctoral Fellow)

\$1.55/day - each non-Queen's assistant

NOTE - If sufficient 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 (e.g. equipment) and all charges for room and board from casual users.