

CALENDAR DESCRIPTION

SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE OUTLINE

AQUATIC SURVEYS

Course Title:

FOR 328-4

Code No.:

FISH & WILDLIFE/WATER RESOURCES

Program:

V

III

Semester:

AUGUST, 1988

Date:

V. WALKER

Author:

New: _____

Revision: _____

X

APPROVED:

V. Walker
Chairperson

Aug 16/88
Date

CALENDAR DESCRIPTION

AQUATIC SURVEYS FOR 328-4

Course Name

Course Number

PHILOSOPHY/GOALS:

A field course designed to provide a practical evaluation of physical, chemical and biological parameters of lake and stream ecosystems.

Students will produce a depth contour map based on echo sounding conducted in the field, a physical features map and a gradient profile map.

Gill nets, trap nets and electroshockers will be utilized to assess fish species present.

Proper handling and processing of fish will be practiced, as well as various forms of fish tagging and marking.

The purpose, procedure and data analysis for a creel census will be considered and an effort will be made to conduct a creel census at the St. Mary's Rapids.

A freshwater invertebrate collection is required.

METHOD OF ASSESSMENT (GRADING METHOD):

90%+	A+
89 - 89%	A
70 - 79%	B
60 - 69%	C
less than 60%	I

TEXTBOOK(S):

Dodge, D.P. et al, 1986. Manual of Instructions, Aquatic Habitat Inventory Surveys. Fish Br., Ont. Min. of Nat. Res. pp. 159.

OPTIONAL TEXTBOOKS:

Lehmkuhl, Dennis M., 1979, How to Know the Aquatic Insects. Wm. C. Brown Co. Publishing, Dubuque, Iowa.

McClane, A. J., 19-- , Field Guide to Freshwater Fishes of North America.

REFERENCE LIST FOR COLLECTION IDENTIFICATION

Edmunds, G. R. - Mayflies of North and Central America. Minneapolis, University of Mineapolis Press, 330 p.

Needham, P. R. and Heedham, J. G., 1969 - Guide of the Study of Fresh Water Biology. San Francisco, Holden-Day Inc., 108 p.

*Needham, J. S., J. R. Traver and Y. -C. HSU. 1972 - The Biology of Mayflies. Hampton, E. W. Classey. 759 p.

*Pennak, R. W., 1953 - Fresh Water Invertebrates of the United States, New York. The Ronald Press Company. 769 p.

*Merritt, R. W. and K. W. Cummins, 1978. An Introduction to the Aquatic Insects of North America. Dubuque, Kendal/Hunt. 441 p.

*Wiggins, G. B. 1977 - Larvae of the North American caddisfly genera (Trichoptera). Toronto, University of Toronto Press. 401 p.

*These references will be particularly useful.

FOR 328-4

AQUATIC SURVEYS

LABORATORY OUTLINE

- Lab 1
- Introduction to course
 - Aquatic Surveys Gear, QUIZ
 - Purpose of Aquatic Surveys, Field Map Enlargement, Pre-Field Work
- 2
- Review Aquatic Surveys Gear, Pre-Field Work (cont.)
 - Fish Anatomy - QUIZ
 - Field Notes/Field Exercise Review
 - Fish Handling, Vital Statistics
 - Video (Practical Aspects of a Lake Survey)
 - Fish Disease/Parasites - Field Identification
- 3
- Lake Survey
- 4
- 5
- 6
- 7
- Contour Map Construction
 - Contour Map Construction and Volume Calculation QUIZ
 - Pre-Field Work for Stream Survey
- 8
- Stream Survey
- 9
- 10
- Gradient Profile Construction
 - TERM TEST #1
- 11
- Game Fish ID*, Toxicants, Tags,
 - Aquatic Plant & Invert ID (slide presentation)
 - QUIZ* (Invert ID)

Lab 15

- TERM TEST #2

* Water Resources Only

N.B. Schedule subject to change

N.B. Field Exercises

Unless alternative arrangements have been previously made with the instructor for students with extenuating circumstances, all students are expected to use college transportation provided to and from the study areas.

AQUATIC SURVEYS

STUDENT EVALUATION

A. Term Tests

Term tests will be written based on practical field work, laboratory exercises and lecture material for a total value of 30 marks.

B. Quizzes

Several quizzes will be written during the laboratory sessions. A pass mark is 60% for each quiz, however 80% of Ontario's game fish must be correctly identified.*

Students receiving less than 60% for any quiz, other than for Game Fish Identification, will be required to rewrite that quiz for a passing grade of 60%.

Quizzes are valued at 10% of the course.

* Water Resources Only

C. Assignments

An aquatic invertebrate collection is required by each student for a value of 15 marks.

Lake and stream survey forms and maps will be submitted at specified times for a total value of 60 marks (see summary of student evaluation p.8)

Students receiving an "I" grade for any assignment are required to resubmit that assignment one week after receiving an "I" grade with corrections made. The grade received for that assignment will not be upgraded to 60%.

D. Discretionary

A total of 10 marks will be allotted at the instructor's discretion. Students will be evaluated on the basis of attitude, attendance, general participation and interest.

A pass mark for the course is 60%. Attendance during field trips and labs is **MANDATORY.** Students missing these without documented reason will risk repeating the course.

NOTE:

This course has a large field component and many of the assignments are based on data collection in the field. The quality of the assignment (maps, notes, forms etc.) are perceived to be a direct reflection of the quality of the field work. For this reason, students receiving a final grade of less than 60% will not have the opportunity to rewrite.

AQUATIC SURVEYS

SUMMARY OF STUDENT EVALUATION

	<u>VALUE</u>
Aquatic Collection	15
Quiz	
Contour Map Test & Field Notes	5
Lake Contour Map and Data Collection Sheet (Volume Calculation)	15
Physical Feature Map/Remaining Lake Survey Forms	15
Gradient Profile/Stream Survey Forms/Discharge Calculations	15
Creel Census Interview Forms and Calculations	15
Term Tests	30
Quizzes (Fish Anatomy, Gear, Contour Map/Volume, Invert, Game Fish*)	20
Discretionary	10
Total	<u>135</u>

* WRT only

NOTE: Deadline dates to be announced.

Late Assignments:

Ten percent (10%) will be deducted from the total value of the assignment for every week late.

FIELD ACTIVITIES - ANDERSON BAY

GROUP 1	GROUP 2	GROUP 3	GROUP 4
DAY 1			
1. echo sound	1. trap nets*	1. gill nets*	1. seine
L	U	N C	H
2. shore cruise	2. chem sta.*	2. seine	2. gill nets*

DAY 2			
1. seine	1. gill nets*	1. chem sta.*	1. echo sound
L	U	N C	H
2. chem sta.*	2. seine	2. trap nets*	2. shore cruise

DAY 3			
1. gill nets*	1. echo sound	1. shore cruise	1. trap nets*
L	U	N C	H
2. trap nets*	2. shore cruise	2. echo sound	2. chem sta*

* LARGE BOAT

LAKE SURVEYEQUIPMENT

NB. SEPT 15 -- OPENING DAY OF DUCK SEASON (BEV)

1. at least 1 Manual of Instructions per group (Blue Binder)
2. FIELD NOTE BOOK & FIELD MAPS/COMPASS
3. clipboard, paper, pencil, small ruler
4. dissection kit
5. rain gear
6. warm clothes
7. work boots
8. LUNCH
9. LIFEJACKET MUST BE WORN IN BOATS

ACTIVITIES

A. TRAPNETTING

- 2 trap nets; 6 floats; 6 anchors; rope for floats
- RED kit; large boat; one plastic tub

B. SHORE CRUISE

- READ MANUAL CAREFULLY, light brown kit
- measure fluctuation; check bench mark & measure
- check all inlets (See Lake Survey Summary Sheet)

C. GILL NETS

- 2 gill nets; 4 floats with rope; 4 anchors (bricks)
- 2 lead lines; RED kit; extra plastic tub

D. CHEM STATION

- kemmerer bottle, oxygen meter, conductivity bridge
- HACK kit, secchi disc
- plankton net; wash bottle & formalin
- sample bottles; pails' Eckman dredge
- meter stick; light brown kit
- 2-15 lb ANCHORS and rope (use both anchors for stability)

E. SEINE

- dip nets; seine net; minnow traps (use bread)
- meter sticks; hip waders; pails (2)
- electroshocker & gloves (if available)
- Formalin; sample bottles; light brown kit
- do flow determination on inlet (see manual)
- collect inverts for your collection

F. ECHO SOUNDING

- clip board; pencil; small ruler
- echo sounder & transducer

NOTE: A record must be filled out for each field collection, even if no fish were caught.

Gill Net

1. Gill Net Catch Record (copies in course outline)
2. Field Collection Form (copies in course outline)

Trap Net

1. Field Collection Form

Minnow Trap

1. Field Collection Form

Seine

1. Field Collection Form

Information and collection location, as required on each Field Collection Form, should be documented in field book, then transferred to Field Collection Form.

LAB 1. Introduction (slide presentation)
Aquatic Surveys Gear
Pre Field Activities

Aquatic Surveys Gear

On display in the lab will be various instruments and gear typically used in aquatic surveys. (see list as follows)

Familiarize yourself with each apparatus by reviewing the instructions for operation or by observing the demonstration. Water chemistry gear may be best understood by retrieving a tap water sample and performing some analysis.

It is essential that each student be experienced at the correct operation of each apparatus and instrument prior to undertaking the field exercises.

Random quizzing on the purpose of and operation of various gear will be conducted during this lab period.

Students are also advised to consult with the Manual of Instructions, Aquatic Habitat Inventory Surveys, for the purpose and operation of standard equipment.

AQUATIC SURVEYS GEAR (on display)

1. Kemmerer Bottle
2. HACH kit
3. Dissolved Oxygen Meter
4. Conductivity Meter
5. Secchi Disc
6. Wisconsin Plankton Net
7. Juday Plankton Trap
8. Ekman Dredge (Grab)
9. Echo Sounder
10. Electroshocker

LAB 1 (con't)

Pre-Field Activities

A. THE STUDY AREA

The study area consists of a bay off the St. Joseph Channel, immediately west of Kensington Point in the district of Algoma. The area is locally referred to as Anderson Bay, although it is unnamed in the FRI Base Map as well as on the respective topographical map.

Due to the fact that Anderson Bay is not enclosed, as is a lake, theoretical boundaries will be established at the mouth of the bay to delineate the study area (see Fig 1). Note also that Sucker Creek and its associated perimeter and area are NOT considered in the various calculations required for the study area.

Fig 1. Anderson Bay Study Area

B. MAP OUTLINE

Four enlarged map outlines will be required from the FRI map (4" = 1 mile) using a pantograph.

To begin:

1. Use FRI Base Map for all enlargements.

Include all streams, islands, access roads, township boundaries. Be sure to extend the shoreline to the east to include Holder's Marina (our access point) as well as a portion of Kensington Road (refer to MNR manual p. 18).

Include north designation

2. Use the FRI Base Map
 - i) all four map enlargements
 - ii) area determination
 - iii) lake perimeter, island perimeters

3. For map enlargements
 - i) select an appropriate enlargement factor (300X is probably best)
 - ii) refer to pantograph instructions
 - iii) affix FRI Base Map to bench top and proceed to make four enlargements using the dull side of 2 sheets of bristle board. Label one bristle board enlargement "CONTOUR MAP", the second "PHYSICAL FEATURES MAP". The next two enlargements will be on a sheet of tracing paper. Label each "FIELD COPY". One is for rough Physical Features map, the other for transect lines. Bristle board maps will eventually be submitted for evaluation. These are your good copies which remain at school. The two "Field Copy" maps will be used in the field as a rough transect map and shoreline cruise map.

C. ADDITIONAL INFORMATION REQUIRED ON ALL ENLARGEMENTS

Determine Gazetteer name, Latitude, Longitude, Watershed Code, Township, District, etc. from appropriate maps and references (MNR manual pp. 14-17).

Enter this information on Lake Survey Summary Form using block letters and Indian ink or Leroy lettering set.

D. AREA/CORRECTION/CONVERSION FACTOR (A.C.F)

Determine area (ha) from enlargement map entitled "Contour Map". This area will be used with the area calculated from the FRI Base Map to determine the A.C.F.

E. SDF

The Calculation of the Shoreline Development Factor (S.D.F.) is not applicable to a bay, such as the study area, because it is not an enclosed area. For an enclosed lake, the lake shoreline is equivalent to the perimeter of the area and is used in the formula outlined in the manual.

LAB 2. Fish processing, Vital Statistics, Field Notes
Fish Anatomy
Video

Processing

Obtain a fish specimen and a scale sample envelope. Observe the demonstration on processing fish samples, completion of scale sample envelopes and fin removal. A demonstration of tag attachment may also be included.

Perform the same operations on your fish sample, complete the scale sample envelope and submit to instructor.

Field Notes

A brief presentation will be given on the necessity for complete and accurate field notes.

Field notes are to be completed by each student (not group) in the field. [Rough notes taken in the field and then transferred to the field book are NOT acceptable].

Students will be advised that keen observations and immediate documentation of those observations result in a superior field book.

Field notes should include information on:

Weather

Access

Time of Initiation & Completion of all Field Activities

Summary of Fish catches (ie. for gill, trap nets)

Chemical/Physical Summary of Water Analysis

Bench mark Description/Fluctuation

No. Resorts/Cottages

Description of Inlets/Outlets

Description & Location of Aquatic Vegetation

Description & Location of Spawning Shoals

Wildlife sightings/Sensitive Areas

LAB 2 - (con't)

Fish Anatomy

Retain your fish sample for a review of basic anatomy. Use manuals and aids provided.

A. Superficial Anatomy

Make a good sized outline drawing of your specimen. Show the distribution of the lateral line system. Locate the main lateral line. Is it decurved or straight?

On the outline draw and name the following structures:

- dorsal fin (indicate spiny and soft parts)
- adipose fin (if present)
- caudal fin (homocercal or heterocercal?)
- anal fin (indicate spines)
- pelvic fins and pelvic axillary process
- pectoral fins
- standard length, fork length, total length
- caudal peduncle
- scales in diagonal row above/below the lateral line
- predorsal length
- body length
- anus
- isthmus
- operculum, preoperculum and suboperculum
- maxillary and maxillary barbel
- premaxillary
- branchiostegals and isthmus
- nostrils, forehead and suborbitals
- pupil and orbit

* Take a careful look at the difference in size and attachment of maxillary and premaxillary in the two fishes.

The digestive system begins at the mouth which leads into the pharynx (from which the gill slits lead to the exterior) from which the esophagus leads to the tubular stomach). A pyloric valve separates the stomach from the small intestine which continues caudally to the large intestine. The pyloric caeca (absent in some freshwater fishes) are blind tubes entering into the fore part of the small intestine. Note the location of the liver, gall bladder, and spleen.

The urogenital system consists of a long mesonephric kidney which lies ventral to the vertebral column and dorsal to the swim bladder. Caudally the kidneys drain into a small urinary bladder which discharges into the urogenital sinus. The testes of the male lie just beneath the swim bladder and extend through a greater length of the abdominal cavity. Each is continued posteriorly into a duct which opens into the urogenital sinus. The ovaries of the female are in a similar position and contain numerous ova but lack oviducts. Mature eggs pass to the exterior through the urogenital sinus.

The air bladder lies above the viscera and in physostomous fish opens the esophagus by means of the pneumatic duct. Examine the air bladder of the perch, it has no pneumatic duct. Examine the inner surface of the air bladder in the perch. Look for area of vascularization on inside, lower, anterior surface of swim bladder. The "oval", a gas absorption area, on the top of the swim bladder may not be visible.

The respiratory system includes 4 pairs of gills, each with a double row of filaments. The 5th gill arch bears no filaments. A hyoidean pseudobranch is present on each side anteriorly under the operculum. Each filament is composed of numerous lamellae. Remove a section of gill arch. Identify again the afferent and efferent branchial arteries. Identify gill lamellae and gill rakers.

Endoskeleton: the vertebral column supports the body axially and is made up of 2 kinds of vertebrae. A typical trunk vertebra consists of a neural spine, neural arch, centrum, zygapophyses, and parapophyses bearing ribs. Caudal vertebra have also a hemal spine, and a hemal arch (a ventral extension of the parapophyses). The last vertebrae have their centra deflected dorsally. Neural and hemal spines of the posterior caudal vertebrae are directed caudally, are broadened and flattened, lie close to one another, and support the caudal fin rays. Note trunk muscles arranged in zig-zag myomeres. The skull is very complex and composed of bone and cartilage. Its parts are the cranium, hyoid apparatus, jaws and suspensorium, opercular apparatus, and branchial arches.

LABS 3, 4, 5 (6 OPTIONAL) FIELD ACTIVITIES

The class will arbitrarily be divided into groups consisting of 3-4 persons. Each group will have at least one individual experienced in the operation of an outboard motor.

Each student will be given a schedule outlining each group's field activities on a daily basis.

It is critical that each individual is completely familiar with that day's field exercises prior to entering the field. (Spot checking will be initiated on a regular basis by instructor).

It is the group's responsibility to ensure that at least one MNR manual is available to the group during each field day for reference purposes.

Basic boat safety must be regarded at all times. **LIFE JACKETS MUST BE WORN!**

* TO BE BOAT OPERATORS: Keep in mind that you are in unfamiliar waters. Utmost caution must be used in conducting transects and shoreline cruises. Keep boat speeds down to a level where persons at the bow can watch for hazards. There are several shoals and isolated boulders in Anderson Bay.

Fish Collection

Students are asked to be conservation-minded in the collection of fish from the various netting gear. Only those fish severely damaged or unidentifiable will be retained for further studies.

NOTE: Do not guess on the identification of fish species. If there is doubt, retain 1 or 2 of each unknown species for later identification in the lab. Be sure this information is recorded. All other fish will be processed and returned alive to the bay.

LABS 3, 4, 5 (6) FIELD ACTIVITIES (con't)

MISCELLANEOUS EQUIPMENT

1. TRAP NETS

Nearly all of the equipment we will use is described in the Aquatic Surveys Manual (MNR). However, trap nets will be employed for fish sampling, although they are not routinely used in standard lake surveys as outlined by MNR.

Trap nets are most often used in mark-recapture (tagging) studies, spawntaking operations or whenever fish are to be processed and then released unharmed.

Trap nets are heavier and more difficult to set than gill nets. The components and layout are illustrated in Figures 1 and 2.

Trap nets are best set off points of land or islands where there is a gentle slope. The depth at which trap nets are set is dependent on the size of the trap net.

2. INVERTEBRATE SAMPLING

Sampling of invertebrate bottom fauna (benthos) and plankton is not usually included in a standard lake survey.

An Ekman dredge will be employed for sampling benthos in deeper water.

Plankton samples will be taken using a Wisconsin Plankton Net and a Juday Plankton Trap.

LAKE SURVEY SUBMISSIONS

All submissions of assignments are to be placed in a folder clearly displaying the student's name as well as group members.

NOTE: Ten percent (10%) deducted from total value for every week late.

1. LAKE CONTOUR AND DATA CALCULATION SHEET

a) Lake Contour Map

- bristle board with contours and information as outlined in manual, black ink, block lettering or lettering set.

b) Field Copy of Study Area

- with transect lines in pencil.

c) Data Calculation Sheet

- black ink, block lettering stapled to bristle board

2. REMAINING LAKE SURVEY FORMS/MAP

a) Physical Features Map

- bristle board with information as outlined in manual, black ink, block lettered.

b) Lake Survey Summary Form

- complete, black ink, block letters.

c) Field Collection Records

- complete for each collection attempted, using gill nets, trap nets, dipnets, seine, minnow traps etc. (complete a form even if "No Catch"), black ink, block letters

d) Gill Net Catch Records (for each gill net set)

- in black ink, block letters

e) Scale Sample Envelopes

- all completed scale sample envelopes (in pencil only) to be submitted as a package by one member of the group (use elastic band to keep envelopes together).
- all whirl pac bags with completed Field Collection Labels (in pencil only) to be submitted as a package by one member of the group

Minimum Features Required on Maps

	Outline Map	Transect Map	Contour Map	Physical Feature Map
Gazetteer Name	x	x	x	x
Local Name	x	x	x	x
M.N.R. Distric No.	x	x	x	x
Township	x	x	x	x
Lat. & Long.	x	x	x	x
A.C.F.	x	x	x	x
North Sign	x	x	x	x
Bar Scale	x	x	x	x
Access Roads	x	x	x	x
Area	x	x	x	x
Survey Date		x	x	x
Sounding Transects		x		
Railways	x		x	x
Power Lines	x		x	x
Dams, Rapids, etc.	x		x	x
Direction of flow (streams)			x	x
Chemical Stations			x	x
Bench Mark			x	x
Depth Contours --				
1 m, 2 m, 4 m etc.			x	
Campsites			x	x
Cottages, resorts			x	x
Gill Net Locations				x
Small Fish Stations				x

Minimum Features Required on Maps...continued

	Outline Map	Transect Map	Contour Map	Physical Feature Map
Surrounding Terrain, Slopes				x
Aquatic Vegetation				x
Point of Maximum Depth			x	x

LABS 7 and 8 Stream Survey
Bellevue Creek

A. Study Area

The study area is Bellevue Creek located primarily in Van Koughnet Township north of the city of Sault Ste. Marie.

Biological, chemical and physical parameters will be evaluated for four (4) stream stations which have been previously selected. (see Figure 1)

B. Field Activities

Field activities will be performed at each stream station in the following order:

1. Water Chemistry
Equipment: HACK kit, DO meter
2. Invertebrate Collections
Equipment: Serber samplers (see demonstration & MNR manual)
Hester-Dendy artificial substrates
Rock balls
Nets, Trays, Whirl-pak bags, formalin, labels
3. Fish Collections
Equipment: Electroshocker
Dip nets, whirl-pak bags, formalin, labels

Note: The electroshocker for collecting fish is somewhat different than that described in the MNR manual. On our unit, both the anode and cathode are hand held probes. A switch on the cathode handle allows a switch from AC to DC current. Fish will be drawn to the anode and stunned. A second person will collect the fish specimens with a dip net.

4. Discharge

Equipment: tape measurer
meter sticks
off meter (current meter)

Note: Conversion factor for current meter used in discharge calculations: if $n < 1.25$;

$$V = .7354 n + 0.157$$

if $n \geq 1.25$

$$V = 0.8479 n + 0.016$$

where V = velocity (m/sec)

n = no. of revolutions of prop per sec

5. Physical Data

Equipment: tape measurer
meter stick
stream summary forms

FOR ALL FIELD ACTIVITIES CONSULT WITH MNR MANUAL FOR DETAILS

Field activities will be performed by student groups at designated times and stations according to the following schedule.

Note that not all activities will be performed at each station by each group. As a result, there will be a pooling of information by all groups in the classroom at the end of each field session (enumeration and classification of invertebrates to Family will be pooled at a later date).

Stream Survey Submissions

Each student is responsible for the submission of a stream survey package containing the following:

1. stream gradient profile/summary
 - completed on graph paper in black ink as per MNR manual guidelines
2. stream survey summary forms
 - completed in black ink
3. example calculation (showing all work) of discharge (floatation method AND current meter) for one stream station
4. list of invertebrates FAMILIES and numbers for each stream station
5. biotic and diversity indices (including calculations) for each stream station

**STREAM SUMMARY SCHEDULE
BELLEVUE CREEK**

DAY 1/LAB 7				
	GRP 1	GRP 1	GRP 3	GRP 4
AM	Sta 1 - P.D. - W.C.	Sta 3 - P.D. - F.C.	Sta 2 - P.D. - I.C.	Sta 4 - P.D. - Dis
	L	U	N C	H
PM	Sta 2 - P.D. - I.C.	Sta 4 - P.D. - Dis	Sta 3 - P.D. - W.C.	Sta 1 - P.D. - F.C.

DAY 2/LAB 8				
	GRP 1	GRP 2	GRP 3	GRP 4
AM	Sta 3 - P.D. - Dis	Sta 1 - P.D. - I.C.	Sta 4 - P.D. - F.C.	Sta 2 - P.D. - W.C.
	L	U	N C	H
PM	Sta 4 - P.D. - F.C.	Sta 2 - P.D. - W.C.	Sta 1 - P.D. - Dis	Sta 3 - P.D. - I.C.

P.D. - Physical Data
F.C. - Fish Collection

Dis - Discharge
W.C. - Water Chemistry
I.C. - Insect Collection

AQUATIC SURVEYS (FOR 328-4)
BIOLOGICAL COLLECTION REQUIREMENTS

GENERAL

A collection of 25 different species of macroscopic aquatic freshwater invertebrates is required for presentation. Collection will be worth no less than 10% of the final grade. Deadline for submission is September 30.

COLLECTION

Students are urged to start collecting specimens this summer. Some equipment may be loaned to students by the Department for collection in the fall. Students are required to purchase specimen bottles and preservative.

PRESERVATION

An alcohol preservative is recommended. Preferably a 70-80% ethyl alcohol and water solution. Ethyl alcohol is available at most drug stores.

PRESENTATION

Specimens are individually preserved in vials* or screw capped jars of suitable size. Specimen jars are numbered to correspond with a separate species list with classification and pertinent information.

1. date of capture
2. location
3. depth and temperature of water
4. habitat description (substrate type, veg.)

CLASSIFICATION

For each specimen, give a reduced hierarchical classification as follows:

- Phylum
- Class
- Order
- Family (a passing grade for collections ID'd correctly to Family)
- Genus (full marks awarded to collections ID'd correctly to Genus)

Use a bifurcating identification key. DO NOT CLASSIFY ON THE BASIS OF SUPERFICIAL RESEMBLANCE TO LINE DRAWINGS IN SIMPLIFIED FIELD GUIDES.

*Vials available at College Bookstore or any drugstore.

REFERENCE LIST FOR COLLECTION IDENTIFICATION

Edmunds, G.R. - Mayflies of North and Central America. Minneapolis, University of Minneapolis Press, 330 p.

Needham, P.R. and Needham, J.G. 1969 - Guide of the Study of Fresh Water Biology. San Francisco, Holden-Day, Inc., 108 p.

*Needham, J. S., J. R. Traver and Y. -C. HSU. 1972 - The Biology of Mayflies. Hampton, E.W. Classey. 759 p.

*Pennak, R. W. 1953. - Freshwater Invertebrates of the United States, New York. The Ronald Press Company. 769 p.

*Merritt, R. W. and K. W. Cummins, 1978. An Introduction to the Aquatic Insects of North America. Dubuque, Kendal/Hunt. 441 p.

*Wiggins, G. B. 1977. - Larvae of the North American caddisfly genera (Trichoptera). Toronto, University of Toronto Press. 401 p.

*Usinger, R. L. (ed.). 1973. Aquatic Insects of California. University of California Press. Berkeley, California. 508 p.

*THESE REFERENCES WILL BE PARTICULARLY USEFUL