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THE USE OF COMPUTERIZED INFORMATION RETRIEVAL IN MOSQUITO CONTROL

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ABSTRACT. A computerized information retrieval system was designed for Marion County, IN. Working on a data base of 4 years of site inspection records, the Mosquito Information Retrieval System identifies those sites which have a historical record of producing mosquitoes under conditions similar to the present. The system is designed to run on an interactive timesharing computer system available through most state universities or from commercial computer firms.

In August of 1978, the Division of Public Health-Mosquito Control of Marion County in Indianapolis, Indiana, began using the computerized Mosquito Information Retrieval System (MIRS). With MIRS, the control personnel will now be able to retrieve breeding site information easily, to predict potential breeding sites throughout the control season using past site histories, and to summarize the activities of the program.

Computerized information retrieval is not new to entomology. Foote and Zidar (1975) listed many pre-1970 projects where the computer had come to the aid of the entomologist. Information retrieval has even had a significant effect upon mosquito biology. Crovello (1972) described the Mosquito Data Bank at the University of Notre Dame (MOD-ABUND) and White and Grodhaus (1972) described an off-line information retrieval system for California mosquito collection records. To our knowledge this is the first attempt to utilize computerized information retrieval in an ongoing mosquito control program. This paper will explain the reasons for developing a system such as MIRS, the concept of MIRS, and how MIRS operates.

THE PROBLEM

Across the United States there are areas which use the most sophisticated control techniques and equipment, and there are areas which have no mosquito control program at all. Between these extremes there is a range in sophistication.

The basic procedure begins with a mosquito control operator inspecting a circuit of potential breeding sites. Each circuit may take from 1 to 4 weeks to complete depending upon the number of operators that are employed by the mosquito control program. Each site is inspected for the presence of some stage of mosquito. If mosquitoes are found, a lar-

vicide or adulticide is then applied. De-
scriptive information concerning the site
is also recorded by the operator. This re-
corded information may include the fol-
lowing items—site identification, date in-
spected, habitat description, size of the
site, species found, relative density of
each species, quantity and type of insec-
ticide applied, or mode of insecticide ap-
plication.

If descriptive information for each site
is accumulated over a period of several
years, this recorded information can con-
stitute a reliable mosquito-breeding his-
tory for a site. However, the value of such
a history lies mainly in the ability to re-
trieve the information easily and effi-
ciently. Many mosquito control programs
store site information on paper or cards
in file cabinets or notebooks. Therefore,
in order to determine a complete breed-
ing history for a particular site, a person
would have to search through various
cabinets and volumes of site reports. The
accumulated site records serve as an ex-
cellent index of the productivity of the
control program but can be simply useless
due to the difficult of retrieving site in-
formation.

THE SOLUTION

A system was needed that enabled the
control personnel to retrieve the informa-
tion easily, to be able to predict potential
breeding at sites each season using past
site-breeding histories, and to be able to
summarize certain aspects of the control
activities of the program. With these re-
quirements in mind, MIRS was developed
for the Marion County Mosquito Control
Program.

MIRS is a package of interactive Cobol
computer programs designed to operate
on the DEC system-10 Timesharing Sys-
tem at Indiana University-Purdue Uni-
versity at Indianapolis (IUPUI). An
acoustic coupler connected to a DEC
writer terminal allows the control per-
sonnel to operate MIRS from the comfort
of their offices.

THE DATA BASE

The site information collected by a con-
trol operator on the Larval Survey-
Treatment Report (Figure 1) is entered
into the computer via the terminal as a
"record." A record is a line 165 characters
long that contains a single site report.
Each record is divided into 11 parts or
fields—of 15 characters each—which con-
tain a specific piece of information. Rec-
ord composition is shown in Table 1.
Table 2 contains the species codes that are
recorded in field 10. Sample records are
shown in Table 3 as they would appear
after the information from Figure 1 is
entered into the computer.

Table 1. Record construction for the data
base of the Mosquito Information Retrieval
System.

Field	Contents
1	6-digit unique serial number auto- matically assigned to each record when it is entered into the computer
2	2-digit zone number and a 3-digit site number
3	Date of site inspection
4	Operator's name
5	Habitat description— Ditch, catch basin, tire, trash, con- tainer, woodland, pool, grassy swale, waste lagoon, swamp, borrow pit, bog, pond, lake, creek, temporary pool
6	Size information—length/width/depth
7	Stage of mosquito present or condi- tion of site if mosquitoes not present—larvae, pupae, adult, wet, dry
8	Insecticide applied
9	Quantity of insecticide
10	Relative density code and species code
11	Comments (Used for site address or other special site characteristics, e.g. beware of dog)

THE MIRS PACKAGE

There are 3 main programs or modules
which constitute MIRS: INPUTT,
MAINT, and MIRS. The user operates
each program by issuing semi-English

DIVISION OF PUBLIC HEALTH
MOSQUITO CONTROL
LARVAL SURVEY-TREATMENT REPORT

ZONE __13__ NAME __SMITH__   DATE: YR. __78__ MO. __8__ DAY __14__ TRUCK NO. __3__ PAGE __1__

Site #: 146 Time: 10:48	Site #: 147 Time: 11:10	Site#: 150 Time: 11:20
Address __600 MAIN RD.__	Address __5100 EPLER AVE__	Address __5700 EPLER AVE__
*Description: __DITCH__	*Description: __CREEK & TRASH__	*Description: __DITCH__
Observations: Wet _X_ Dry___ Larvae/Dip __5__	Observations: Wet _X_ Dry___ Larvae/Dip __6__	Observations: Wet _X_ Dry___ Larvae/Dip __15__
Larvae _X_ Pupae___ Adult___ Pot. ___	Larvae___ Pupae___ Adult___ Pot. _X_	Larvae _X_ Pupae___ Adult___ Pot. ___
Sample: Yes _X_ No___	Sample: Yes___ No _X_	Sample: Yes _X_ No___
Size: (feet) Length __75'__ Width __3'__ Depth __5"__	Size: (feet) Length __150'__ Width __5'__ Depth __10"__	Size: (feet) Length __50'__ Width __1'__ Depth __4"__
Treatment: Type: __FLIT__ Quantity: (ounces) __30__	Treatment: Type: __NONE__ Quantity: (ounces) __—__	Treatment: Type: __FLIT__ Quantity: (ounces) __20__
I.D. (Lab only) __31__	I.D. (Lab only)	I.D. (Lab only) __35__

DESCR. Roadside ditch, tires, trash, container, tree hole, woodland pool, temporary   Finish Mileage __1246__
pool, grassy swale, waste lagoon, swamp, borrow pit, bog, railroad ditch,   Start Mileage __1164__
pond, lake, creek, swim pool, catch basin   Total Miles __82__

COMMENTS: _____

676-MC-2rev.

Fig. 1. Larval Survey-Treatment Report.

commands in response to the questions asked by the program.

The INPUTT module of MIRS allows the mosquito control personnel to delete out-of-date records, to modify existing records, or to add new records. The records are organized into data files according to larviciding zones and are then stored on magnetic tape to prevent the files from being lost or destroyed.

The MAINT module of MIRS is used to update periodically the data base by compressing and renumbering the records in the data files following deletions or additions.

The MIRS module is the backbone of the MIRS package. With the MIRS module, a user can search the data base for a particular numeric quantity or alphabetic word or phrase. When the specified information is found in any of the records within the data base, the record containing that information is printed at the user's terminal. This type of search is called a "question." The MIRS module is also capable of performing another type of search called a "question and operation." As with a question, the MIRS module searches for a numeric quantity or alphabetic word or phrase specified by the user. But, when the specified information is found within a record using this type of search, an operation—sum, average, count, alphabetic or numeric sort—is performed on a particular field indicated previously by the user.

THE CAPABILITIES OF THE MIRS MODULE

A question asked using the MIRS module may consist of up to 5 parts or parameters (but, not every question must have 5 parameters)—each parameter consists of a field, a target, and a conjunction. The field indicates the area within the record that is to be searched; the target is the numeric quantity or alphabetic word or

phrase for which the field is searched; and the conjunction serves as a connector (an "and" or "or") within a question consisting of more than one parameter. In addition, three comparators—">", "<", and "*"—allow the user to ask "greater-than," "less-than," and "not" questions, respectively.

Table 2. Species code to be entered into Field 10 of the data base of MIRS.

Code	Density
01	less than 1 larvae/dip
02	1–10 larvae/dip
03	>10 larvae/dip
Code	Species
11	*Aedes* species
12	*Ae. aurifier*
13	*Ae. canadensis*
14	*Ae. cinereus*
15	*Ae. excrucians*
16	*Ae. fitchii*
17	*Ae. hendersoni*
18	*Ae. sticticus*
19	*Ae. stimulans*
20	*Ae. triseriatus*
21	*Ae. trivittatus*
22	*Ae. vexans*
23	*Anopheles* species
24	*An. barbari*
25	*An. punctipennis*
26	*An. quadrimaculatus*
27	*An. walkeri*
28	*Culex* species
29	*Cx. erraticus*
30	*Cx. peccator*
31	*Cx. pipiens*
32	*Cx. restuans*
33	*Cx. salinarius*
34	*Cx. tarsalis*
35	*Cx. territans*
36	*Culiseta* species
37	*Cs. inornata*
38	*Cs. melanura*
39	*Cs. morsitans*
40	*Cs. silvestris*
41	*Orthopodomyia alba*
42	*Or. signifera*
43	*Psorophora ciliata*
44	*Ps. confinnis*
45	*Ps. ferox*
46	*Coquillettidia perturbans*
47	*Uranotaenia sapphirina*
48	*Wyeomyia smithii*
49	Aquatic Diptera

Suppose, for example, that early in July tests for St. Louis encephalitis in a sentinel flock in Indianapolis have shown an increase in the percentage of birds with antibodies for SLE. To prevent an outbreak of SLE in the human population, the mosquito control personnel wish to treat those sites which have a history of breeding *Culex pipiens* or *Cx. salinarius* during the month of July. The question is a 4-parameter question: the computer will search for records with *Cx. pipiens* (parameter 1) *or* *Cx. salinarius* (parameter 2) *and* with dates larger than June 30 (parameter 3) *and* less than August 1 (parameter 4). The resulting output from MIRS would be a list of all sites that have a history of breeding *Cx. pipiens* or *Cx. salinarius* in the month of July. This list could be given directly to mosquito control operators who would first inspect those sites on the list before inspecting other sites in their zone. Table 4 contains a few of the records obtained when the above question was asked using the MIRS module.

Weekly, monthly, or yearly statistics can be easily obtained using the "question and operation" option of MIRS. Suppose that control personnel wished to determine the total amount of insecticide used in the month of June, 1977. This would be a 2-parameter question: the computer would search for records with a date greater than May 31, 1977 (parameter 1) and less than July 1, 1977 (parameter 2). Field 9, the field containing the quantity of insecticide, of the records with the correct date would then be summed to obtain the total amount of insecticide used in July, 1977. Figure 2 contains the sample output for the question and operation.

FUTURE DEVELOPMENTS

The MIRS package can serve as a basis for future expansion. Several possibilities are particularly well-suited for mosquito control work. One possibility, for instance, could be a computer-drawn map of potential breeding sites in addition to the listing of sites that is now obtained

Table 3. Records obtained from data in Figure 1—Larval Survey—Treatment Report.

000964	13–146	78–8–14	Smith	Ditch
075/003/00.3	Larvae	Flit	30	02 31
6100 Mann Rd.				
000965	13–147	78–8–14	Smith	Creek
130/003/00.8	Wet			
5100 Epler Ave.				
000966	13–150	78–8–14	Smith	Ditch
050/001/00.3	Larvae	Flit	20	03 33
5100 Elper Ave.				

Figure 2. Sample execution of MIRS program using question and operation option to obtain the total amount of insecticide used in June, 1977. (Bold face characters are the response typed by the user.)

```
Mosquito Information Retrieval System
Please enter desired activity:
   1=question
   2=question and operation
   3=terminate
2
   Enter the # of parameters you wish to con-
   sider (0–5)
2
   Parameter 1
      Enter Field
3
   Enter Target
>77–5–31
   Enter Conjunction
1
   Parameter 2
      Enter Field
3
   Enter Target
<77–7–01
Which type of operation do you wish to per-
   form?
   1=sum
   2=average
   3=count
   4=alphabetic or numeric sort
1
   Upon which field is the operation to be per-
   formed?
9
   In records conforming to question:
      3,>77–5–31,1
      3,<77–7–01
   The sum of field 9 is 8,778.
```

from MIRS. The map could then be given directly to a control operator. Another possibility may involve the incorporation of a weather algorithm into MIRS. This weather algorithm would draw upon past rainfall and temperature data and the past site histories to predict which sites could have a hatch of mosquitoes for a particular set of temperature and rainfall conditions. A feature could also be added that would provide a printout listing the optimal deployment of mosquito control operators and resources.

SUMMARY

With approximately 15,000+ site inspection records generated by the control operators per year, it is impossible for any mosquito control district to make efficient use of this historical data. Computerized information retrieval shows the greatest potential for utilizing this deluge of valuable site information. The MIRS package has the ability to increase the efficiency of mosquito control operations by directing personnel to breeding sites which have the highest probability of producing mosquitoes. The 1979 control season will offer the first full evaluation of the use of computers in mosquito control.

ACKNOWLEDGMENTS

Table 4. Sample output from MIRS module searching for all sites that have a history of breeding *Culex pipiens* (31) or *Culex salinarius* (33) in the month of July.

000060	07–107	76–7–27	Jackson	Ditch
150/001/00.5	Larvae	Flit	20	01 53
10th & Rural				
000688	07–006	77–7–01	Turner	Creek
180/003/00.9	Larvae	Flit	256	03 31
W. 10th St.				
000848	07–071	78–7–06	Smith	Ditch
500/003/00.3	Larvae	Flit	384	03 31
E. 38th St.				
000898	07–215	78–7–10	Smith	Creek
200/004/00.7	Larvae	Flit	256	03 33
6022 Winston				

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