# ARTICLES

## SOURCE REDUCTION AS AN ECONOMICAL APPROACH TO MOSQUITO MANAGEMENT[1]

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ABSTRACT. The method of comparing 2 methods of mosquito control over a long term basis is described. The method is utilized on 4 possible upland water management projects to assess the economic feasibility of implementing water management methods as compared to the continued chemical control measures.

Integrated Pest Management (IPM) is a philosophy directed towards a holistic approach to management of a pest species (Axtell 1979, Olson 1979). Axtell (1979) further states that IPM is based on ecological principles and integrates multidisciplinary methodologies in developing ecosystem management strategies that are practical, effective, economical and protective of both public health and the environment. In order for an integrated program to be effective and economical, it is necessary to periodically evaluate all aspects of the control program. This evaluation is especially important because of the restrictions, environmental problems and regulations confronting mosquito control agencies. One of the questions we must always consider is, "Is the method of control being utilized an economical choice for mosquito control?"

The efficacy of the method is fairly simple to judge by continuously sampling mosquito populations as affected by various control procedures. However the economy of a control method is more difficult to assess since the economics of control may be evaluated in several ways. One need for IPM at the operational level is the development of methods to evaluate various methods of control in order that these organizations can utilize them in their present programs of mosquito control. This economic feasibility of implementing individual approaches to suppress mosquito populations has been one of the objects of the Mosquito Management Methodology Task (Olson 1979). But actual publications concerned with the comparison of costs of various methods of control are absent from the literature and this aspect of an IPM program needs more attention (Rupp 1978). Comparative costs of physical and chemical control for coastal areas have been reported elsewhere (DeBord et al. 1975, Hansen et al. 1976, Provost 1977, Shisler et al. 1979). The objective of this paper is to compare the costs of physical and chemical control approaches in upland habitats.

Our cost comparison between physical and chemical control is based on several projects that have been identified and evaluated to determine if they would be

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economically feasible as physical control projects. These areas are located in similar upland habitats and have produced a variety of mosquito species for the last 3 years (Table 1). The individual areas have been inspected and the best physical control methods have been selected and their associated costs determined (Table 2).

larval sampling locate individual breeding areas and identifies the mosquito species in the area. Adulticiding data are more generalized and define an impact area that mosquito populations affect from a given breeding site or sites.

The chemical control program in the proposed project area has been larviciding; therefore exact breeding areas and acreage have been identified. An inspector inspects the areas weekly and collects mosquito larvae which are brought back to the laboratory for identification. After identification of the larvae as a pest and/or possible vector species, a larviciding treatment by helicopter is scheduled for the individual areas. The

Table 1. Number of larvicide treatments for the individual project areas for a three year period and the mosquito species treated.

| | Number of larval treatments | | | | Mosquito species | |
|---|---|---|---|---|---|---|
| Project | 1977 | 1978 | 1979 | 3 yr. mean | Treated | Not treated |
| A | 9 | 9 | 6 | 8.0 | *Ae. vexans*<br>*Ae. canadensis*<br>*An. crucians*<br>*Ps. ferox*<br>*Cx. pipiens*<br>*Cx. restuans* | *Cx. territans*<br>*Ur. sapphirina* |
| B | 4 | 9 | 11 | 8.0 | *Ae. canadensis*<br>*Ae. vexans*<br>*An. punctipennis*<br>*Cx. pipiens* | *Cx. territans* |
| C | 4 | 5 | 5 | 4.7 | *Ae. vexans*<br>*Ps. ferox*<br>*Cx. restuans* | |
| D | 3 | 1 | 8 | 4.0 | *Ae. vexans*<br>*An. punctipennis*<br>*Cx. pipiens*<br>*Cx. restuans*<br>*Ps. ciliata* | |

Table 2. Summary of the four water management projects in the woodland swamp habitat.

| Project | Size (ha) | Length (m) | Equipment | Time | Costs |
|---|---|---|---|---|---|
| A | 202 | 30,000<br>1,500 | Dragline<br>Backhoe | 1 year | $69,050. |
| B | 2 | 600 | Backhoe | 1 month | 5,500. |
| C | 20 | 100 | Dragline | 4 months | 25,000. |
| D | 70 | 1,200 | Dragline | 2 months | 6,000. |

## CHEMICAL CONTROL COSTS

A chemical control program documents areas that have a history of producing problem mosquito populations. The utilization of these data is important in evaluating alternative methods of control. Larviciding data (i.e. acreage treated, number of treatments and pesticide) and cost of chemical treatment is expensive (Table 3) and the application of chemicals to control a mosquito species that does not affect man is needless and could be considered pollution. After treatment, the area is reinspected to assess the effectiveness of the treatment. Utilizing accumulated larviciding data for the last three years, the individual project areas were judged for mosquito species and the number of larvicidings (Table 1).

The costs involved in the larviciding program with commission-owned helicopter and Abate 5G averaged to approximately $9.27/ha in 1978. These larviciding costs are lower than reported by Hansen et al. in 1976 ($9.52/ha) and Shisler et al. in 1979 ($16.70/ha), because the helicopters in those evaluated programs were rented on a seasonal basis. No adulticiding program is utilized by this county in their upland program, so these costs were not considered in the cost of chemical control.

## PHYSICAL CONTROL COSTS

PROJECT DESCRIPTIONS:

*Project A.*—A hardwood woodland swamp was created by elimination of maintenance by farmers in existing streams for over the last 30 years. The stream has become clogged with fallen trees and erosion from the fields causing the adjacent 200 ha flood plain to be inundated after rain. It is estimated that the project will require approximately 30,000 m of stream realignment with a dragline and 1,500 m of backhoe work to eliminate peripheral mosquito breeding sites. The spoil will be graded and seeded along the banks of the stream. The project will require an estimated year to complete at a cost of $69,050.

*Project B.*—A relatively small area (2 ha) created by the interruption of normal drainage patterns by a landfill operation. The project requires construction of a 600 m ditch with a backhoe and the placement of 15 m of 1 m diameter reinforced concrete pipe under a macadam road. The total project would cost approximately $5,500 and would require a month to complete.

*Project C.*—A 20 ha woodland habitat was created by the interruption of natural drainage patterns by a dredge material disposal site on one side and a landfill operation on the other. The project would require the excavation of a ditch approximately 3 m in depth and 100 m long with the placement of 1 m diameter reinforced concrete pipe through the landfill. This would allow a grade through which natural drainage could occur. The project would take approximately 4 months at a cost of $25,000.

*Project D.*—A typical upland mosquito breeding area created by the clogging of a drainage ditch through a woodland area. The cleaning of approximately 1200 m of ditch with a dragline would take 2 months and eliminate mosquito breeding in the 28 ha area for a cost of $6,000.

## COMPARISON OF COSTS

One of the important components in

Table 3. Comparison of several water management projects evaluating the cost effectiveness of the project with larval control.

| Project | Size (ha) | Cost of project (C) | Mean. no. treatments/yr. | Larviciding costs Per yr.[a] | Larviciding costs 10 yrs.[b](B) | B/C | Years to recovery |
|---|---|---|---|---|---|---|---|
| A | 202 | $69,050.00 | 8.0 | $14,980.32 | $238,741.36 | 3.46 | 4 |
| B | 2 | 5,500.00 | 8.0 | 148.32 | 2,363.77 | 0.43 | 17 |
| C | 20 | 25,000.00 | 4.7 | 871.38 | 13,887.18 | 0.55 | 15 |
| D | 28 | 6,000.00 | 4.0 | 1,038.24 | 16,546.43 | 2.75 | 6 |

[a] Using $9.27/ha treatment
[b] Assuming a 10% inflation rate per year, see Table 4.

the evaluation of the costs associated with control methods is the life of the application of the method. In chemical control the life of the application is relatively short (several hours, days or up to a week) with certain chemicals; while source reduction (water management) can be effective for years with little maintenance (Hansen et al. 1976, Provost 1977, Shisler et al. 1979). In the upland situations identified here we are assuming the project will have no maintenance costs for a period of 10 years after completion of the project (Table 2). The 10-year life span is an arbitrary time period which could vary because of differing physical conditions in the project areas.

In assessing the larviciding costs we first determined the cost per year based on the mean number of larviciding applications for the last 3 years (Table 1), times the costs per ha ($9.27/ha), times the size of the individual project area. Prorating the larviciding costs over a period of 10 years, we have added on a yearly 10% inflation rate. Table 4 is a summary of factors from Grant and Ireson (1970) showing with inflation percentages and the period of time through which a uniform cost is projected. For example, we estimated that larviciding would cost $14,980.32/year for Project A. Multiplying this larviciding cost by a factor of 15.94 from Table 4 (10% inflation for 10 years) yields $238,741.36 or the total cost of larviciding Project A until 1989. These estimated 10-year costs of larviciding the individual projects can now be compared with the cost of the water management work for the individual projects.

Table 3 presents a cost/benefit ratio derived by dividing the 10-year estimated costs for larviciding (B) by the cost of the water management project (C). The ratio would be 1.00 if the costs of larviciding and water management were equal for the allotted period. The higher the ratio the more economical the water management project becomes; recognition of this potential economy allows an agency to set priorities for the maximum utilization of both chemical and physical control equipment. For example, the cost of approximately $70,000 for a water management project (A) might seem astronomical in comparison with the $5,500 (Project B, Table 3). The comparison of both the cost/benefit ratio and years to recover the investment shows that Project A will recover its investment in only 4 years while Project B will require 17 years.

The continuous evaluation of mosquito control methods allows a control agency to develop an effective IPM program. In this evaluation many factors must be considered in the selection of one method over another and in establishing priority of the project. One important factor is the number of people who will benefit from the project. This number includes the immediate area surrounding the project and adjacent areas affected by the individual mosquito species' flight range. In summary, we have presented a simple method of evaluating different methods of control to determine whether they are economically feasible over a period of time.

Table 4. Compound amount factors for uniform series at fixed interest rates versus time (see Grant and Ireson 1970).

| Years | Percent 8 | 10 | 12 | 15 | 20 |
|---|---|---|---|---|---|
| 5 | 5.87 | 6.10 | 6.35 | 6.74 | 7.44 |
| 10 | 14.19 | 15.94 | 17.55 | 20.30 | 25.96 |
| 15 | 27.15 | 31.77 | 37.28 | 47.58 | 72.03 |
| 20 | 45.76 | 57.28 | 72.05 | 102.44 | 186.69 |
| 25 | 73.11 | 98.35 | 133.33 | 212.79 | 471.98 |
| 30 | 113.28 | 164.49 | 241.33 | 434.74 | 1181.88 |

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