PROCEEDINGS OF THE
FOURTEENTH ANNUAL MEETING

OF THE

UTAH MOSQUITO ABATEMENT ASSOCIATION

held at the

Davis County Court House

Farmington, Utah

March 17 and 18, 1961

edited by

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Fourteenth Annual Meeting

THE FOLLOWING PAPERS WERE GIVEN BUT MANUSCRIPTS WERE NOT SUBMITTED FOR PUBLICATION

PROCEEDINGS OF THE FOURTEENTH ANNUAL MEETING UTAH MOSQUITO ABATEMENT ASSOCIATION

The opening session of the Fourteenth Utah Mosquito Abatement Association convened at the Davis County Court House, Farmington, Utah, and was called to order at 9:30 a.m. by Vice-President Jay Linam, presiding. Welcoming addresses were given by Wayne Winegar, Davis County Commissioner and Delore Nicols, Mayor of Farmington, Utah. Response for the Utah Mosquito Abatement Association was given by Dr. Lewis T. Nielsen of the University of Utah.

PANEL: WATER UTILIZATION RELATED TO MOSQUITO CONTROL PROBLEMS

MODERATOR; JACK BERRYMAN, Extension, Wildlife Specialist, Utah State University, Logan, Utah

MOSQUITO ABATEMENT AND THE NEW SPIRIT OF COOPERATION[1]

Jack H. Berryman[2]

Mosquito abatement touches upon the activities and lives of many people—namely the sensitive skins of backyard suburbanites and outdoor enthusiasts. Less facetiously, control has become increasingly important as it has become necessary for an expanding population to move into new and previously unoccupied lands. Health and comfort have become prime reasons for control.

As control has become more important, so also has it become more complicated in terms of administration and potential conflict wih other interests—with wildlife, agriculture, recreation and others.

It is the purpose of this panel to discuss several of the problems of mosquito abatement as related to water utilization, with each of several speakers touching on a different phase. My purpose is to discuss the attitude with which we face our problems.

It is indeed gratifying that the approach is a cooperative one, in keeping with the leadership long displayed by organized mosquito abatement efforts in Utah.

We approach these discussions and subsequent action programs in a new and invigorating climate of cooperation. In his Special Message on Natural Resources, presented to the Congress on February 23, 1961, President Kennedy pointed out conflicting resource policies and competing and wasted efforts. He stressed the need for reducing conflicts and for engaging in long range planning, and urged the Federal Government to take leadership in developing local, state and federal cooperative programs. He concluded that the task is large but that it will be done. A mandate has thus been given to the federal agencies and the weight and spirit of the presidency thrown behind a renewed cooperative effort.

The climate is favorable; the need is great. The task now is to translate the spirit of cooperation into effective working relationships. It is obvious from a sudy of the program for this annual meeting that this will be the case—that necessary mosquito abatement can and will be conducted with due consideration for other interests and related resources.

We shall then open the first panel discussion on a note of optimism and in a spirit of renewed cooperation.

1. Introductory remarks made at a panel: Water Utilization Related to Mosquito Control Problems at the Fourteenth Annual Meeting, Utah Mosquito Abatement Association, Farmington, Utah, March 17, 1961.
2. Wildlife Specialist, Extension Services, Utah State University, Logan, Utah.

CONSERVATION AND THE MOSQUITO PROBLEM[1]

John W. Metcalf[2]

Most people would expect to find little relationship between conservation and mosquitoes. Certainly we aren't interested in conserving mosquitoes. This discussion concerns soil and water conservation and the place of conservation practices in mosquito abatement.

Those of us who can remember the old rain barrel can also remember the hundreds of mosquito wrigglers that used it for a temporary home. This, and the recurrent campaings to clean up empty cans, to drain or fill in puddles, etc., lead people to think that most mosquitoes are hatched in long-standing stagnant water. In irrigated areas, this is not true. Studies conducted by the U. S. Public Health Service in Montana[1] showed that over 70 percent of the mosquitoes were actually raised on the irrigated fields and that over 90 percent of the mosquitoes produced were associated with irrigation water. This is not to imply that mosquitoes do not hatch in ponds or other permanent bodies of water. Those hatched in this environment are controlled to some extent by natural predators, and more recently, by mosquito abatement activities.

Mosquito-producing water sources can be divided roughly into two categories. The first includes natural lakes, ponds, and drainageways which are not associated with irrigation and irrigation water. The second category consists of man-made storage and conveyance structures, irrigated fields, and waste water disposal facilities. It is in the management of water in this

1. Prepared for presentation at Utah Mosquito Abatement Association, Farmington, Utah, March 17, 1961.
2. State Soil Conservationist, Utah State Office, Soil Conservation Service, USDA.

second category of water sources that conservation agriculture can accomplish the most in reduction of the mosquito problem.

Much has been written about seepage from irrigation water storage or conveyance systems which results in mosquito-producing areas. Some of these situations are caused by poor design, faulty construction, or poor site conditions. Improved design and construction can take care of this problem in future projects. Remedial measures can be taken, in existing structures, by lining the leaky sections or putting in drainage systems to remove the water. The latter is the well-known procedure of "locking the barn after the horse is stolen," in that the seepage water is lost or at least diverted from its intended use. Ignoring the mosquito problem, for the moment, it may be that such remedial measures are not now considered to be economical if based solely on the value of the lost water. However, consideration of the over-all problems caused by seepage reveals other values. In addition to the loss of water, there are other problems such as the development of salt and alkali spots and a lowering of production not only immediately below the canal or ditch, but sometimes for hundreds of feet on down the slope.

There are many other structural-type problems associated with irrigation, such as undrained depressions, borrow pits, turnouts, stilling basins, high or blocked culverts, that contribute to the mosquito problem. Using the Public Health Service study in Montana[1] as a base, mosquito-breeding places associated with such structures contribute less than 20 percent of the mosquitoes that are raised in water associated with irrigation. The irrigated fields alone produce seventy percent of the mosquitoes. The latter are the mosquitoes that can largely be eliminated by proper irrigation water management.

In the history of irrigation, a super-abundance of water and of mosquitoes have occurred together With the increasing need for more efficient use of our dwindling water supply, it may be that public pressure and economics eventually will require more careful irrigation water management. Meanwhile, it is necessary that conservation agencies such as the Soil Conservation Service be able to show irrigators the value of water management.

Not many people are aware of the relationship between high-producing crops and low-mosquito production.[2] Of the major agricultural crops, rice is the only one that thrives under conditions favorable for mosquito production. None of the crops grown in Utah produce their highest yields if flooded for more than a few hours at a time—and this includes native hay and pasture.

How does soil and water conservation fit into the problem of mosquito control? The answer lies in good irrigation water management. The Soil Conservation Service, working through the local Soil Conservation District and in cooperation with the and Agricultural Research Service has developed techniques and methods of irrigation water management that are summarized in irrigation guides. These irrigation guides are based on consideration of the kind of soil and its ability to take in and store water; the slope of the land to be irrigated; the size of irrigation stream available; the kind of crop to be irrigated; the length of time between irrigations; and many other factors.

Many of these characteristics cannot be measured exactly. Others may vary from one irrigation to the next. In order to arrive at what is an efficient irrigation, it is necessary to evaluate the conditions existing at the time. The summation of these conditions gives the irrigator a guide as to the amount of water he needs to apply and the length of time it will take to apply it.

The object of irrigation is to get water into the soil reservoir for use by the crops. Each kind of soil has its own limited reservoir capacity for the important air and water needed in the root zone of the crops.[3]

Each kind of crop has its own water need which changes as the growing season progresses from spring to fall. Each crop also has a pattern of root growth which changes with the season. This is particularly true of annual crops or of newly-seeded perennial crops such as alfalfa or pasture. In the seedling stage, these crops do not use the amounts of water that they do as mature plants.

The soil reservoir should be filled to its moisture-holding capacity by a late fall or early spring irrigation. Each irrigation thereafter is done only to replace the water taken out by the crop.

The amount of water actually used by the crop —that is, the amount that is pumped out of the soil into the air—is a direct and necessary cost of crop production. On the other hand, the amount of water lost by deep percolation or by surface waste is an overhead cost. This wasted water is that which produces the mosquito habitat.

Dr. Sterling Davis, Irrigation Engineer, Agricultural Research Service, in his paper, "Mosquito Reduction by Good Agricultural Practice,"[4] states that, "The pest mosquitoes lay their eggs on damp soil, and when the area is flooded the eggs hatch into adults in about 5 days in hot summer weather. The disease-carrying mosquitoes lay their eggs on the water and need a week or more to become adults."

Therefore, a period of 5 to 7 days of water standing on a field is sufficient to bring forth a horde of mosquitoes.

McCulloch and Criddle[5] in Agriculture Bulletin Number 8, define proper irrigation water management as conservation irrigation. Their definition reads, "Conservation irrigation is simply using irrigated soils and irrigation water in a way that will insure high production without the waste of either water or soil. It means using cropping, irrigation, and cultural practices that will maintain the land in permanent agriculture."

In order to accomplish conservation irrigation, a number of mechanical helps are available. Land leveling to permit uniform water application; installing of sprinkler systems or graded contour ditches as alternatives to leveling; putting in checks, headgates, turnouts, etc., to give better water control, and using siphon tubes or gated pipe to regulate stream size all help to get conservation irrigation. Cost-sharing through the Agricultural Conservation Program is available to assist the irrigator in installing these aids.

Using all of the helps available, the attainment of conservation irrigation finally depends on the irrigator. "Even with the most efficient and modern irrigation system delivering water to perfectly leveled fields, the irrigator has final control on how much, how long, and how often water is applied to the crop."[6]

Each irrigator needs to study the soils on his farm to determine the water intake and water holding characteristics of the land he is irrigating. He needs to know the crop requirements and how their water use varies by age, rooting habits, and season of the year. A shovel or spade, and a soil auger are invaluable aids to the irrigator. Using these tools, he can check the soil moisture before irrigating, and the depth of water penetration during and after irrigating.

After the irrigation water is shut off and it has all soaked into the surface, there is still downward movement of water in the soil. As an example, in loam soils such as are found on some of the lake terraces along the Wasatch Front, this downward movement is considerable. Suppose that a test with the auger or moisture probe shows that the water has penetrated to 12 inches at the time the water is taken off. Twenty-four hours later, the water will have drained down another 12 inches. Knowing this will help the irrigator avoid putting on excess water which results in deep percolation, and seepage farther down the slope. The extent of this additional water movement depends on a number of soil characteristics such as texture, organic matter, structure or granulation, and others. Each soil has its variations and the good irrigator will study and learn these if he wants to manage his water properly.

The irrigation guides, mentioned earlier, take into account these soil characteristics as well as the others listed. An irrigator can combine his experience and knowledge of his land with the technical knowledge of an experienced technician. By using their combined knowledge, and the irrigation guide, they can arrive at method and length of run. Size of stream and hours allowed on each irrigation set must be adjusted to meet the needs of the crop and soil. Such water management will avoid excessive runoff, ponding both on and off the field, and will result in a reduction of mosquito population by restricting the area of their habitat.

Irrigation farmers in Utah are making substantial progress toward conservation irrigation. To date, they have lined, or put into pipelines over 450 miles of canals and ditches. Nearly 600 miles of drain have improved 75,000 acres of land. Improved irrigation water management is in effect on 450,000 acres, partly as a result of leveling 250,000 acres and partly through the installation of 300 sprinkler systems. Roughly 60 percent of this conservation work has been applied in the Wasatch Front area. These conservation farmers are making a major contribution to the alleviation of the mosquito problem.

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PARTICIPATION IN MOSQUITO CONTROL BY THE DEPARTMENT OF FISH & GAME

by Donald A. Smith, Supervisor of Waterfowl
Utah State Department of Fish and Game

From reviewing contributions of the Department of Fish and Game to your previous Association meetings it is apparent the effects of various types of mosquito control on wildlife have received considerable attention. I would, therefore, like to give some of the present views of the Department concerning our participation in a mosquito abatement program, and to express some general thoughts for your consideration.

To fully understand the importance of our waterfowl resource and wetland habitat it seems advisable to briefly review our local situation. Utah has some 600,000 acres of wetland habitat of variable value to wildlife. The Department owns and operates approximately 60,000 acres of marshland and the U. S. Fish and Wildlife Service some 83,000 acres. The remaining 400,000 acres are in private ownership either as managed clubs or as unmanaged, natural wetlands.

Waterfowl and other wildlife produced on these marshlands are important recreational and economic assets to the State. Approximately 31,000 persons hunt waterfowl in Utah annually. They average about 5 hunting trips per season and spend $26.31 per trip. Thus, during an average year, waterfowl hunters will spend in excess of $4,000,000.00 in Utah pursuing this form of recreation. These data alone place a pretty high price on the heads of ducks and geese.

What is the value of the knowledge and appreciation of nature received from these resources by students, teachers, and others who use our marshes to study and observe? Obviously, you cannot place a dollars and cents value on this activity, but I believe all of you appreciate its importance in our fast moving world. Guided tours and lectures are daily routine on our public marshes during the spring and summer months.

Utah trappers take some 100,000 muskrats from the State's water areas annually. Although this species is no longer considered a game species by the Department, it is a fur bearing animal from which revenues are derived.

Let us also consider the importance of Utah's waterfowl to other areas. Ducks and geese banded on our marshes have been recovered in 38 states and 3 foreign countries. It is apparent then that our marshes are of more than local significance.

Management of waterfowl is one of many responsibilites with which the Department is charged by State Statute. Our attempts to mitigate wetland losses, to develop new and additional marshes, and to just meet the everyday demands of our growing populus are obligations we must meet.

Your various District Boards are authorized by law to take steps necessary in the extermination of mosquitos. Superficial comparison of the responsibilities of our respective offices indicates conflict between our obligations. To an extent this observation is correct; however, the conflicts can be minimized through an understanding of and coordination between each others programs. We are now attempting to learn more about mosquitoes, their requirements and control. We hope you are acquainting yourselves with the demands for and requirements of wetland wildlife.

A modern waterfowl management program, which I believe we have, is broad in scope. It is so because of the number of activities with which we operate rather than the complexity and detail of those activities. Marsh development and management are but two of these activities, but they are probably the most important. A productive marsh is more than a puddle of water. It is a variety of deep and shallow water, submerged and emergent aquatic vegetation, and dry upland areas well interspersed with one another.

In our effort to attain our goals in waterfowl and marsh management we sometimes develop conditions conducive to mosquito production. These conditions may or may not be beneficial to waterfowl. Generally, they are not. We attempt, as rapidly as possible, to alter or correct these situations to gain the maximum in waterfowl productivity.

Your work is much the same since in your efforts to fulfill your legal obligations you sometimes reduce, either in value or in extent, our waterfowl production and hunting habitat. This action likewise may or may not accomplish your basic aim — that of mosquito control.

To be of maximum value our programs must be coordinated. As definded by Webster, coordination is "To bring into common action . . ." The word "action" implies something beyond discussion. So far it seems both of us have just given lip service to our mutual problems.

In what form should cooperation be between our agencies? Probably the most pertinent action should be an exchange of principles and objectives concerning our respective operations. I do not understand mosquitoes, and I am sure by conversation with many of you, that you do not understand waterfowl management. This points out a basic oversight on both fronts.

It has been suggested we should contribute financial support to the various Districts. Our contention is that this is not our responsibility, nor was such support intended by those formulating your code of operation. State Law provides that your program will be financed by specific taxation of not to exceed a 1 mill levy on real property within each District. I believe the average levy for the 6 organized Districts is presently about .5 mill. This amounts to some $300,000.00 annually in 4 counties. Our annual, state-wide waterfowl budget is only about $350,000.00.

To us it is no more realistic to assess a fish and game license buyer for mosquito abatement on public lands than it is to charge a farmer, industrialist, political subdivision or private individual for mosquitoes being produced on their properties. This is not to say that good water use practices should be ignored. It is intended to point out there are necessary and desirable uses of water from which we all benefit that are going to produce mosquitoes even under the best of circumstances.

Possibility of the Department participating in aerial spraying operations has been discussed. Here again we do not recognize such an obligation and contend that aerial spraying is an art which involves a certain element of danger to both human life and to an expensive piece of equipment. People involved in spraying recognize the dangers and accept them. For us to become involved in the aerial application of pesticides would require organizations of a specialized division whose services could not contribute to any significant degree to the rest of our operation. It would involve new policy, new personnel, new equipment and added responsibility. This hardly seems feasible.

As I pointed out previously the fish and game license buying public finances our waterfowl management program. They, however, are not the only ones to enjoy the benefits therefrom. Other persons, non-contributors insofar as financial support of our program is considered, rely heavily on our marshes for educational and aesthetic purposes. Although they receive the benefits, they would not be supporting any mosquito control operation by the Department. This circumstance further demonstrates the inequities of direct financial aid to your program by our Department.

We recognize our areas produce a certain number of mosquitoes and we also recognize mosquitoes are being produced elsewhere. We believe we can demonstrate our program of marsh management is far superior to the conditions which would exist if we were not situated where we could reasonably control the fluctuating waters eminating from the numerous streams and drains entering the Great Salt Lake. On this basis we feel our contributions to your operation are, or should be in the form of (1) cooperative planning of future marsh development projects, (2) cooperation with abatement personnel in activities on our properties — not just accepting or approving the proposals of abatement, but in actually participating in the planning of abatement activities on specific areas, (3) conducting basic research concerning vegetation manipulation, (4) combining efforts with the Districts to reduce organic and chemical pollution which may be adverse to both our programs, (5) control of water supplies and levels to the greatest extent feasible, and (6) aid to the Districts in gaining the understanding and cooperation of private marsh owners in mosquito control and waterfowl management practices.

I believe these are the more important areas in which the Department can work with you people to improve both our operations from a mosquito control standpoint. Of course there is the other side to this cooperative effort and I believe a brief resume of what we expect from you is in order.

We would appreciate knowing in advance of any surface water drainage or diversion planned by your Districts. We should be notified of chronic trouble spots on our developments and of your plans to alleviate mosquito production on these areas. Aerial spraying of our marshes should be closely coordinated with the respective area manager to prevent unnecessary disturbance of nesting waterfowl. We believe it is your responsibility to conduct or sponsor research to (1) provide information relative to mosquito productivity in various types of vegetation and under various water conditions, and (2) to determine the extent and frequency of mosquito movements from our marshes to populated areas. Some of these data have been presented to us in a general way through conversation, but I believe some definite and specific information should be reported.

By recognizing each others programs and obligations and by proceeding along the lines just described, I believe we can considerably improve our respective operations and our interdepartmental relationship.

WATER UTILIZATION ON IRRIGATED FARMS IN RELATION TO THE MOSQUITO CONTROL PROGRAM [1]

Joseph F. Parrish

I appreciate being invited to appear on the panel of Water Utilization relative to mosquito control problems. My report, I believe should continue on with phases of water conservation and educational work which county agents and others are doing with farmers in relation to mosquito abatement through improved use, management and application of irrigation water on farms.

As we discuss the use of irrigation water on farms, I was surprised and interested to learn from the report of John W. Metcalf, State Soil Conservationist of the Soil Conservation Service, when he quoted from the U. S. Public Health Service Manual, published in Montana, which showed that over 70% of the mosquitoes are actually raised on irrigated fields and that over 90% of the mosquitoes, produced on farms, are associated with irrigation water.

We realize that our task is to assist or help educate farmers with management and better use of irrigation water on the farm. We are told that it takes large quantities of water to supply the needs of crops. An example, near 500 tons of water is taken from the soil for each ton of alfalfa hay produced. We must also become acquainted with the fact of where in the soil available water comes from? How much water will different soils hold and the amount of water available for plant needs?

We are also trying to learn what we should accomplish when we apply water to the land for plant needs. We know that plants or crops obtain water from the soil reservoir through their roots. The amount of water that is available in the soil for crop use, depends on the type of soil and the depth of the rooting of plants. The reservoir for crop needs and use, reaches to the bottom of the crop root zone and hence, varies in size for different crops.

We have learned through studies that clay soils hold more water than do sandy soils. Fine textured soils (not always) hold more available water than coarse soils. Also, from research, we have learned that the amount of available water in fine, medium and coarse soils, available for plant needs and other uses, following irrigation, is usually as follows:

Type of soil or texture	*Inches of water per foot of soil*
Fine (clay loams, clays)	2 or more
Medium (loams)	1¼ - 2½
Coarse (sandy, sandy loams)	½ - 1½

Crops with deep rooted systems have a larger root zone and consequently have more water available in the soil reservoir. These crops can go longer between irrigations than the crops with shallow root systems. This is the kind of information and guidance which we are passing on to farmers as we study soils in relation to irrigation water and crop needs.

The question is often asked "In what portion of the soil is the majority of the roots of crops?" Most crops rooting systems will extend from three to six, or even ten feet in depth. However, a large portion of crop roots are found in the surface foot of soil. Crop roots extend into subsequent feet of soil depth where they obtain water and plant nutrients. The approximate rooting depth of three representative crops, grown on deep well drained soil is as follows:

Crop	*Depth of rooting*	*Spread of roots-diameter*
Alfalfa	6 - 10 feet	1 -2 feet
Small Grains	3 - 5 feet	2 - 3 feet
Corn	5 - 6 feet	7 - 8 feet

Root development is altered or restricted, subject to soil conditions such as hardpans, plow soles, water tables and unevenness of land surfaces. It is from these problems in soil management that we find problems of irrigation water control and possible homes for mosquitoes which are found on many farms.

How much water should we apply to fill the soil reservoir for crops?

This is a problem to all farmers. Our advice to farmers is to wet the soil to the depth of rooting of the crops for we are aware that plant roots will not grow or thrive in dry soil. We suggest to farmers that they irrigate to satisfy crop needs, plus water losses by improper management. By this we mean that the amount of irrigation water applied to the soil at each irrigation, must meet the crop needs, plus the water lost from different methods of application and other causes.

Often farmers apply irrigation water to leach excess salts from the soil, and water is also lost through deep percolation or due to uneven wetting of the soil and excessive runoff from farm-land. These are problems in management of irrigation water and control of excess water.

1. Prepared for presentation at the Utah Mosquito Abatement Association, Farmington, Utah, March 17, 1961.
2. County Agricultural Agent, Salt Lake County, Utah State University.

Crop use of irrigation water varies with the weather, along with many other management factors.

Our understanding of crop use of water refers to (1) water taken up by and transpired from plants and (2) water evaporated from the soil under the plants. Crop use of water varies widely, depending upon temperature, relative humidity, length of day, length of growing season and the amount of sunshine and other factors. Higher water use is associated with high temperatures, low humidity, long sunny days and long growing season.

The approximate monthly and seasonal use of irrigation water, let us refer to alfalfa hay needs in Salt Lake valley - alfalfa hay requires approximately thirty inches of accumulated water for a growing season with high water use during June, July and August, and with lesser amounts during the eariler and later months of the growing season. This water includes water taken up and transpired by the alfalfa crop and water evaporation from the soil under the crop. Alfalfa requirements for water are as high or higher than most other crops grown by farmers.

In irrigation water application to lands, we advise farmers that they do not guess on the amount of water applied. We suggest they examine the soil, using a spade, shovel or soil auger and a thorough examination be made of each foot of the root zone. We suggest that farmers learn to feel the soil by hand to see whether it is coarse, medium or fine texture, and the amount of available water in the soil for plants. Persons learning this method of soil and moisture relationship, soon become very apt at it.

We work with farmers to assist them in determining the hours needed for irrigating, to meet the needs of crops on certain soils, and this is done according to the crop needs of irrigation water and the size of the stream available.

The length of time farmers need to irrigate is determined by:

1. The amount of water needed to fill soil reservoir.
2. The size of the irrigation stream.
3. The acres to be irrigated at each irrigation turn or setting of the water.
4. How efficient the farmer is in irrigating.

A stream of 1 cubic foot per second, running 1 hour, will deliver 1 inch of water covering 1 acre. This is if the water is spread evenly over the acre. This is good information for farmers to know as most farmers do not irrigate as efficiently as they should. Many factors affect irrigation, and to overcome this inefficiency, an additional length of time of irrigation water application to soils must be increased in irrigating to take care of water losses and inefficiencies. It is some of these practices of inefficiency and management of irrigation water, where much of the trouble and problems arise to farmers in applying irrigation water to farmland and crops, and lend towards some of our mosquito problems by excess water accumulating on farms.

In summarizing this report, may I suggest the following practices:

1. Crops grown on farms obtain water from soil through their roots.
2. The volume of soil, occupied by the roots, is the reservoir which can supply water to the crop.
3. Farmers irrigate to fill the soil reservoir.
4. The amount of irrigation water applied at each irrigation depends upon —
   (a) How much water the soil will hold in the root zone.
   (b) The amount of water in the soil at time of irrigation.
   (c) The farmers efficiency in irrigating.
5. The water holding capacity of soil in the root zone is largely determined by the soil texture and the depth of soil occupied by the roots.
6. Farmers must apply excess water to take care of unavoidable and necessary losses but should not permit water to accumulate or stand on the surface of soils.
7. Farmers cannot half-wet the soil and raise normal crops. Light irrigation simply wets less soil and is soon lost through evaporation or by other means.
8. Farmers should manage their soil and irrigation water so that there is no misue of water to accumulate in areas which will permit a home for mosquitoes or mosquito larva.

A LOOK AT THE PROBLEM OF SEWAGE LAGOONS

Grant K. Borg

Department of Civil Engineering, University of Utah

In the past 10 years, principally due to one sided publicity, officials of many communities, and some engineers, have begun to assume that the raw sewage lagoon is the quick, cheap, and complete answer for all waste disposal. And while one cannot quarrel with the facts of biological stabilization, there seem to be many more problems involved.

The movement for lagooning of sewage will present new problems in Public Health, principally with respect to

1. Ground water pollution.
2. Mosquito breeding.
3. Infection of and transmission of disease by water fowl.
4. Contact by domestic animals.
5. Contact by rodents.
6. Direct human contact.
7. Creation of nuisance and odors.
8. Aerosols.

A lagoon is an open pond of sewage, and certainly should be constructed, operated, and maintained with this in mind. There are many hazards inherent in this kind of an operation because we are concentrating and storing tremendous volumes of waste which are continuously being re-innoculated with incoming fresh wastes.

It is the aim, in operating a lagoon, to keep the liquid in an aerobic state. Algae growing in the lagoon furnishes the oxygen necessary for aerobic bacteriological action, and in the aerobic state, few odors are produced and stabilization of the sewage wastes proceeds very well.

If, however, for some reason, usually temperature change, the algae is killed, then anerobic conditions will develop within a matter of hours with the resulting disagreeable odors and nuisance associated with these conditions. The dead algae bloom imposes a further B.O.D. in the lagoon.

Winter time operation creates some difficult problems. Ice cover and low temperatures prevent algae growth and lagoons operate under anerobic conditions. Turnover in the spring and the occurance of unusual climatic conditions will cause the lagoon to produce offensive odors while operating under anerobic conditions.

Lagoons are essentially of two types:

1. Overflow
2. Non-overflow

The individual ponds of the system may be operated singly, in parallel, or in tandem. Pond sizes vary from an acre or so as a minimum to about 40 acres as a maximum, with depths varying from 3 to 5 feet. Each individual pond is surrounded with a dike providing at least a 3 foot free board, and wide enough on top for vehicular travel. The side slopes must be gentle enough to prevent erosion. The bottom of the lagoon should be level and impervious. The inlet and outlet system should be designed to prevent shortcircuiting.

The non-overflow lagoon should be designed large enough to continuously contain the entire sewage flow. The overflow lagoons are usually designed for 90 to 120 days retention. B.O.D. loadings vary from 10 to 5 pounds of 5-day B.O.D. per acre per day. Above all, the system must be capable of flexible operation.

Maintenance is very important, principally in prevention of dike erosion, control of aquatic or long rooted growth at the water's edge, rodent control, and mosquito control.

Of course, one of the pressing problems confronting those in mosquito abatement, will be the creation of many acres of open ponds of relatively quiet and possibly stagnant water located within mosquito flight range of a populated area. There are many reports of extensive mosquito breeding in sewage lagoons, particularly those that are not well maintained and where the water surface remains calm and at a constant elevation. Most prevalent in the reports are *Culex tarsalis* and *Culex pipiens*.

The area required for a sewage lagoon at this latitude and under our conditions of climate will be about 1 acre for each 100 persons served. Thus, for a city of 200,000 population, some 2,000 acres of lagoons will be required. The actual required area could be more or less than this figure depending on per capita water consumption, rainfall, evaporation, seepage, population growth predicated, and strength of the sewage.

There are many problems with respect to lagoons confronting the sanitary engineer. A few of these are:

1. How to produce a clear effluent in overflow lagoons.
2. What is the true sanitary quality of lagoon effluent or lagoon content since it is con-

tinuously being innoculated with fresh sewage.

3. What is the potential for propagation of disease vectors—including mosquitoes.

4. Significance of ground water pollution.

5. Infection of, or transmission of, disease by waterfowl.

6. Build-up of nutrients in non-overflow lagoons.

Possibly, as one investigator summed up the lagoon situation, "Our lagoons would be perfect if it were not for:

1. Inadequate preliminary study.
2. Inadequate and improper design.
3. Faulty construction.
4. Lack of operation"

One might add, "and if we knew the health hazard potential, and if we knew how this potential could be minimized." Certainly, the potential for the propagation of insects and other possible disease vectors is greater in lagoons than at conventional treatment works.

How can we completely evaluate this potential hazard? Possibly it could best be studied by allowing a city to build a lagoon close to a populated area, then conduct a careful long-term epidemilogical study on the people there. This was our approach with malaria and yellow fever. Are there some here who want to volunteer to play guinea pig?

WATER MANAGEMENT REQUIREMENTS FOR MOSQUITO ABATEMENT

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The purpose in arranging this panel discussion on water utilization related to mosquito control is a continuation of the efforts of the Utah Mosquito Abatement Association to obtain a better understanding and greater cooperation among those concerned with water management and direct these combined efforts towards more effective source reduction of the mosquitoes in the state.

We have repeatedly discussed water management in previous meetings of this association and are aware that considerable progress has been made in solving the mosquito abatement problem in Utah through your support which has been solicited and obtained during these meetings.

I need not remind any of you that in this semiarid land proper water management and complete utilization of this precious natural resource is a problem with which every person in this state is concerned. With our rapidly growing human population and our diminishing per capita water supply, we must properly manage the use and re-use of every drop of available water allowing none of it to be unnecessarily squandered or lost before it has been subjected to maximum beneficial use by all potential users.

This means in effect, that as citizens of this state, we are all concerned with beneficial water management practices. Our present economy and future development depends on how well we understand the water requirements of the various interests concerned and assist in providing these needs. When many different interests are involved in procuring, treating, and using water, or in disposing of water not in use, conflicts of interests naturally occur. It is impossible in some instances to use water solely for one purpose without creating some injurious effects for others who may or may not be, directly engaged in the problems of water management. The problem of water management is nothing more than water conservation, as conservation has been defined as the use of a resource for "the greatest good for the greatest number of people."

The true principle of water conservation may make it necessary to curtail the development of some water use programs and develop others and in so doing balance and harmonize as much as possible the more beneficial aspects of all programs. This can only be accomplished by a better understanding of the objectives of these various programs and the water requirements for maximum returns through its use, by each of the users. We hope through discussions of this kind this information can be obtained, correctly evaluated and accepted for cooperative action.

In order to clarify water management problems as they pertain to mosquito abatement let us review the following facts about mosquito production.

1. All immature stages of mosquitoes live and develop only in stagnant or slow moving water. However, all water in ponds, lakes and other water impoundments are not mosquito producers; 2. In urban areas mosquitoes are produced in ornamental pools, roadside ditches, barrow pits, gutters, catch

basins or in any kind of a receptacle containing exposed stagnant water; 3. In rural areas mosquitoes may be produced in the above named situations but the large broods are generally produced in freshly flooded areas such as pastures and other vegetated depressions in which shallow water remains longer than four days between each successive flooding, as it requires a minimum of four days for adult mosquitoes to emerge from these newly flooded areas.

The problem of mosquito abatement, therefore, is basically a problem of proper water management directed at preventing the creation of suitable water habitats in which mosquitoes can be produced. It has been ascertained that approximately 75% of the mosquitoes produced in the cultivated areas of the state come from man-made water habitats. It is also evident that most of these mosquito producing situations can be prevented without interfering in any way with the multipurpose beneficial use of this water. In other words it is the mismanagement or lack of management of water that makes it necessary to establish mosquito abatement districts in this state. It is obvious mosquito abatement interests are not in competition with you or any other water users for the available water supply. We also want to make it clear that we do not have plans or designs to remove water that can be put to beneficial use under proper management by responsible agencies or individuals. As water users we are asking you to contribute to mosquito abatement by including mosquito prevention measures in your water management practices. This we are confident can be done very effectively and at the same time not greatly interfere with your own program of water use, in fact, the adoption of mosquito abatement measures in many instances will be an improvement to your program and interests.

To acquaint water users with procedures necessary for the prevention of mosquito production is a problem of education for which the mosquito abatement workers are largely responsible and to date rather negligent. We cannot expect those engaged in water management to include mosquito prevention measures in their programs if they are not aware of what these measures should consist.

As previosuly mentioned, the problem of mosquito source reduction by water management has two major aspects: one, the problem of eliminating or treating mosquito producing water in the cities and towns; and second, the prevention of unnecessary periodical flooding and retention of water in previously dry areas and the fluctuation of water levels in impounded bodies of water in the rural areas. These are the principal mosquito producing problems in this state and both can be largely solved by proper water management.

In solving the problem in the cities and towns greater effort should be made to acquaint the public with the kinds of situations that may exist on their premises or in their neighborhood in which mosquitoes are produced and request their support in removing or treating this water to prevent mosquito production. If they are unable to handle the problem then urge them to report the problem to employees of the mosquito abatement district.

This kind of an educational program can be carried on most successfully in the public schools and through civic clubs and organizations particularly those containing women membership.

The second phase of mosquito prevention in the rural areas by proper water management practices is a matter of determining; first, who owns or assumes ownership of the water through use; and second, by planning a program of water use with these individuals or agencies that will include maximum mosquito prevention measures. Unfortunately much of the water that is producing mosquitoes on our marshes is so-called waste water to which legal ownership has not been established. It is frequently found that in practice the management and use of this water is everybody's business, yet, nobody's business when responsibility for mismanagement is to be established.

Much of the problem of mosquito production would be eliminated on these marshes if impounded water was maintained at a constant level and was not permitted to flood into the grassy margins where mosquitoes can develop. It is also essential that water on newly flooded vegetated area should not remain longer than five days. When water remains longer than five days chemical treatment is usually necessary to destroy the developing larvae, chemical control is an expensive-method and rarely completely effective when used on large areas. Chemical control of mosquito larvae and adults is at best a curative measure in mosquito abaement and should only be used when mosquito prevention by proper water management has not been applied.

There is nothing proposed in the above program of water management that could not be readily adopted by most water users and in some programs these measures would be decidedly beneficial to the program. We request your support in incorporating into your program all of these water management practices for mosquito abatement that are applicable. In so doing you would greatly assist in our mutual problem of mosquito control. We pledge our support to assist you in your efforts to use and re-use all available water for the greatest good for the greatest number of people.

WATER UTILIZATION RELATED TO MOSQUITO CONTROL PROBLEMS PANEL

Summary Statement - Jack H. Berryman

We began this panel in a spirit of cooperation and on a note of confidence. To say simply that this has been experienced would be a gross understatement.

There is a thread of similarity running through the talks by each speaker. As emphasized by Dr. Rees, it is the mis-management of water that results in mosquito production—proper water management is compatable with organized mosquito control.

Mr. Metcalf explained that good agricultural practices, specifically proper and efficient irrigation, reduces mosquito production.

Mr. Smith stressed the importance of Utah's waterfowl resource, but explained that conflicts can be minimized—that proper marsh management reduces mosquito production. His definition that coordination means "common action" was especially significant, particularly since this was followed by recommendations for a positive program of exchanging information and plans.

Mr. Parrish's comments on education and teaching are significant. A gap exists between the development of recommended practices and their application to the land. The Extension Services, through the County Agents, can be helpful in making these recommenadtions known.

Professor Borg treaded on an entirely different area—the relationship between sewage lagoons, mosquitoes and public health, emphasizing the complexity of mosquito control and water management. Like other speakers, he too concluded that properly treated sewage is not a problem in creating ideal mosquito conditions; conversely, improperly treated sewage, particularly in a lagoon system, constitutes a health hazard.

Dr. Ree's paper was in effect a summary, presenting broad views and guidelines. He stressed the increasing need for intensive water management and the fact that it is mismanagement that results in mosquito production, all of which points to the need for improved cooperation and improved education, specifically through the school system and civic groups. He suggested that women's clubs can be very effective in stimulating interest in mosquito control problems.

The Utah Mosquito Abatement Association is to be complimented for developing programs that result in concrete coordination and cooperation. It is evident from the panellists that mosquito control can be practiced effectively, but that closer working relationships need to be developed and that the emphasis on public education must be increased. The willingness of affected groups to work together is most significant and encouraging.

OBSERVATIONS ON CONTROL DEVELOPMENTS IN CALIFORNIA'S URBAN AREAS

C. Donald Grant, Manager-Entomologist

San Mateo County Mosquito Abatement District

In spite of the preponderance of papers and discussions given in the past years on the tremendous scope of mosquito problems resulting from California's extensive irrigated agricultural areas, a very large percentage of mosquito abatement agencies as well as a percentage of work effort are largely concerned with control in urban and suburban areas. It is only in comparatively recent times that many of these agencies have felt the delayed impact of such expansion in their control work and have commenced to recognize its potential problems and technical demands that are presaged for the next few decades in California.

The approaches to mosquito, and often other types of vector control, in urban areas are necessarily quite distinct and infinitely varied from the comparatively efficient methods employed in agricultural or rural areas such as once comprised the principal control efforts in this State. The basic principles of source reduction and prevention are still valid, with emphasis needed on prevention; but the methods, costs, equipment and manpower needs involve an entirely different basis of evaluation. When a manager from our Central Valley speaks of the cost problem of insecticides due to failures with parathion which have been effecting kills at 12½c per acre and fear is expressed that the next feasible insecticide may double such cost per acre, then the managers of urban districts may sympathize with the effects on the other district's budget but also smile inwardly at the cost differential on an acreage basis between the two areas.

Insecticide usage in urban areas is especially specialized. It is surprising that nearly every district varies in its selection of materials for larviciding and show many preferred techniques for a variety of reasons. Often the personnel, storage methods, equipment modifications and purchasing procedures may govern the selection as much as do the types of sources for treatment and the mosquito species therein. Often what appears impractical to one manager is justifiably the most expeditious procedure in a neighboring district. Still the fact remains that the development of more efficient larvicides for polluted water and urban use, as well as a reliable evaluation and use index for such larvicidial practices is not only far below the currently needed level of attainment, but is still in its infancy compared to modern potentials. We are beginning to afford recognition to these needs, but the research and development processes will lag many years behind.

Suburban sources are not constituted of significant acreages, but are manifested by tens of thousands of small but significant sources of often intermittent or slow flowing highly polluted water which becomes worse over a period of several years. A good percentage of these may be ephemeral or in a transition stage with little predictability as to their mosquito production at a given time, whereas a great number of the rest are constant potentials and require retreatment as every six days for much of the year under normal circumstances. The manpower needed in merely traveling the treatment routes on such a routine may be enormous and such desired scheduling is seldom attained, which consequently leads to a constant low-grade mosquito prevalence from a certain percentage of such sources producing adults between visits. The status of drainage provisions, the amount of accumulating organic material introduced, and the stage of evolution in the local urban development will considerably affect these mosquito potentials in such sources and influence the treatment schedules. But it is becoming increasingly common to find that most districts are having to continually speed up such schedules for a variety of reasons. In such situations, chemical costs are almost negligible compared to manpower and transportation costs and thus provide a favorably high cost margin for selecting an efficient material on such sources as catch basins, permanent drains and sewerage impoundments wherever such insecticidial material will serve to reduce the frequency of treatment. This District has been happy to achieve source elimination in such foul water areas at a cost in excess of $1,000 per acre, but unfortunately the majority of such sources do not lend themselves to such correction or else represent a kinetic body of sources with correction expected "in the coming year."

An extensive treatise is merited on the effectiveness of insecticides and their physical forms in various foul water sources, and although many of the synthetic organic insecticides may be used to effect an immediate kill on the majority of locations, they leave much to be desired. Many such materials are rapidly inactivated by physical and chemical actions in such polluted waters, as by adsorption, absorption, oxidation and chemical actions which may be as effective against other portions of the formulation as to the active insecticide. Incidentally, the work by Jim Gahan a couple of years ago in measuring the loss of active material from acetone solutions in distilled water in various containers used for running bioassay levels is an interesting observation, yet this loss is negligible compared to the inactivation potentials of a majority of our polluted sources. Thus, such materials do little to alleviate the problem of frequent treatment schedules.

For individual situations, a variety of innovations have been employed, such as drip cans, residual spraying of the surrounding environment, special plaster of paris blocks impregnated for slow toxic release, of active material, screening or mechanical baffles — yet all of these, when measured for efficiency in meeting the bulk of tens of thousands of sources, constitute little more than a losing battle with time. Cost factors of five to ten dollars an acre for such spot work in actual material cost on a repetitive basis are common. In this range a great many types of material may be feasibly employed, permitting application rates of 50 or a 100 parts per million of substances like special detergent formulations, quartenary ammonium compounds, specially prepared oil fractions and additives; and many of these help to meet the current local problems and provide increased residual effectiveness, but none so far may be deemed efficient or feasible for very extensive work.

It should be mentioned that in many areas of California the chlorinated hydrocarbons, as DDT and DDD are still effective and are still used against certain mosquito species and in certain environments. Those *Aedes* species with a restricted number of generations per year through their biology or the environmental factors such as temperature and periods of inundation, such as *A. sierrenis, increpitus*, and salt marsh *dorsalis*, etc., have not yet demonstrated a resistance to such materials in most of the State. However, the choice of applying such insecticides is goverened principally by the potential hazards to other organisms or agricultural restrictions.

With resistance to the chlorinated hydrocarbons appearing to an advanced degree in our urban areas for *Culex pipiens* (165X), and to variable but widespread extent in *C. tarsalis* and *peus* throughout the state, there has been a general shift to the use of malathion in urban areas for *Culex* control. It is highly probable that malathion may enjoy but a short period of effectiveness in many local areas.

The major hope of stemming the tide in the rate of creation of new thousands of these local sources in many districts lies in the development of a significant program of public relations and education. This is designed not alone for our school classes, but more purposefully toward civic bodies, planners and engineers, to emphasize the needs in removal of organic wastes in our waterways and of efficiency in low level drainage with specific recommendations in planning and drainage installations to minimize these multiple mosquito sources. This is not easy; it is not quickly effected; and it demands constant effort. Thus far it has been demonstrated that awareness by the public bodies, coupled with efficient operations by the district and recognized by such bodies, provides a considerable incentive towards their correction and prevention of mosquito sources on public lands (where a large portion of the urban problem exists), as well as serving to indirectly place a greater pressure on the individual developers and landholders to recognize such drainage needs and to cooperate in the correction or prevention upon request.

To implement the program of public awareness and resultant conformance to an acceptable level of source prevention by public pressure, this district and several others have extended their program into special aspects of publications and illustrative materials. In urban areas, where there is such competition for the attention of the public awareness by commercial, social and civic groups, a successful bid in this aspect demands first rate material on a competitive level with the deluge from other outlets.

A second and important aspect of developments within the spreading suburbs lies with the demand for control of other public nuisance insects, such as biting gnats, midges and flies. Involvement to varying extents in domestic fly control has already overtaken some districts and is imminently facing several more. It is a major challenge of the near future, but will not be discussed here. However, this district has engaged in research studies and some control work for several years on both Biting Black Gnats (*Leptoconops torrens*) and on Chironomid midges.

L. torrens is very similar in appearance to the black gnat occurring locally here in Utah, *L. kerteszi*, but is a distinct species with significant differences in its biology and habitat. Both species occur in many portions of California, but *torrens* larvae are restricted to cracked clay soils of specific drainage factors and occur normally at depths of one and a half to three feet below the surface of the soil, and they may occur as far down as four feet. Development from egg to adult apparently takes two years, but the larvae may undergo prolonged diapause in which case pupation and emergence may be delayed a few more years, hence the life span from egg to adult may entail five or more years. The adult life span is short, felt to average two or three days, but refrigerated specimens have survived for up to five days.

The district has received a state research grant through the State Department of Public Health for the last three years to supplement these studies on gnats and on midges to limited degree. A primary objective of the gnat program has been in the determination of positive larval sources in correlation with specific soil types and their limiting factors so that treatment may be directed at such sources with some degree of reliability and facility. An extensive program of emergence trapping via modified Dow traps in various areas and soils of the State in correlation with soil coring and analysis has been a major project. Experimenal plot treatment with chemicals and test projects entailing environmental modification as a means of permanent elimination of the gnats has also been under way for four years. Several problems and methods need further work before a cost feasible program of control can be recommended. It is obvious that the provision of water can eliminate the gnat problem — and change it to a mosquito problem. Continued soil cultivation or disking over a period of several years will also eliminate the gnats by inhibiting oviposition. A major problem lies in providing control at a feasible cost during the long period of land development in these gnat areas, since the many thousands of acres of such adobe soils throughout the state are only marginally productive for agriculure and will be only spottily obliviated by building development.

The gnat is readily susceptible to most of the available insecticides, apparently as low as one pound of DDT per acre, under proper exposure. The big problem has been one of mechanical distribution in applying such insecticides so that they will endure for six weeks if applied at the beginning of the emergence season and reside in the microhabitat where the resting and emerging adults will make adequate contact with such material long enough to provide a lethal dose. Or one could merely recommend a blanket coverage with an overdose of toxic material; but that isn't the answer we are looking for and have in mind.

The second research project undertaken by the district has been on the midges, as mentioned. Here again, the rapid increase of such Chironomid populations may be directly attributable to our rapid population growth and resulting increase of organic wastes. Although a district of varied terrain may have as many as 150 different midge species represented therein, only a few of these tend to occur in such numbers as to become a public nuisance. It has been repeatedy observed that a few years following rapid suburban developments the lower portions of drainage systems from such areas, or impoundments receiving waste waters therefrom, will develop a high potential for such midge development; i.e. for certain species of midges, which may have been relatively scarce previously in spite of heavy organic oozes accumulated over time in the natural impoundments from non-domestic sources. Many studies have been made throughout the world on the relationships of midge productivity with organic content, low dissolved oxygen, etc. and part of our work is involved with source analysis and the application of other studies to the evolution of our mounting midge problems in California. The study and development of efficient control procedures for the many different species of midges encountered and the variation in habitats are too vast for a comprehensive study, although several control studies for special aspects are being undertaken by others.

In summary, California mosquito control agencies in much of the State are finding suburban development to present a major challenge to their resources. The rapidly increasing bulk of highly varied sources entails costly manpower, transportation and treatment costs. There is an urgent demand for research and development to help us efficiently cope with these problems and our abatement agencies are significantly broadening their activites and approaches in utilizing all possible resources in combatting the insect potentials attendant with population growth and development.

RECENT DEVELOPMENTS IN MOSQUITO CONTROL IN CALIFORNIA

W. D. Murray, Manager

Delta Mosquito Abatement District

One of the most interesting and important activities of the California Mosquito Control Association at the present time is the work of the Insecticide Committee on its development of a bulletin on insecticides and weedicides. This is, in part, a revision of a bulletin on insecticides published in 1956, but the present work also will include information on weed control.

Most districts in California began using DDT in 1946 and 1947. In 1949 mosquitoes in the Delta and several other districts became so resistant to DDT that a substitute was essential, and the one which proved to be effective was toxaphene. In 1951 the mosquitoes became resistant to this, and a switch was made to organic phosphates, parathion for field use and malathion for spraying in residential areas. In 1958 the Kings M.A.D. experienced resistance to ethyl parathion but found that methyl parathion was effective. In 1960 resistance to ethyl parathion was first noted in the Delta M.A.D., the resistant larvae of *Aedes nigromaculis* being about 650 times harder to kill than non resistant larvae. Methyl parathion was used after September 1 in the Delta M.A.D. Bayer 29493 was also effective but far more expensive than methyl parathion. It looks like methyl parathion will be about one-third more expensive than ethyl, however competition may bring it down in price.

The proposed bulletin discusses toxicity of parathion to people, and presents procedures for handling the material safely. Only a couple of cases of poisoning have occurred among California M.A.D.'s in nine years of use. One was an apparent suicide, the others were mild cases quickly corrected with the specific antidote, atropine.

Many districts are engaging in weed control about reservoirs and ponds. Permanent type materials such as simazin and CMU have been used in the winter time, and systemic materials such as Dowpon and amino triazole have been used in the summer.

THE CONTROVERSIAL ROLE OF INSECTICIDES

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Introduction

Pesticidies,particularly insecticides, can be either highly beneficial or extremely harmful to man in his administration of natural resources. Insecticides are practically indispensable in the control of vectorborne diseases, in farming, forestry, and even in some phases of fish and wildlife management. Yet, there is another side to the picture. Within the last five years there are undisputed cases where the application of pesticides has caused serious losses of valuable wildlife and soil organisms, as well as presenting serious threats to human health. In order to fairly evaluate the beneficial or detrimental effects of pesticides on our economy, both sides of the problem should be presented, and the role of the various materials used should be considered in terms of the greatest benefit to the public. The purpose of this paper, therefore, will be to review the potential benefits and hazards involved in the use of pesticides and to point out needs for the future in their application.

Benefits of Insect Control

The enhancement of human health through the control of vector-borne diseases has been one of the outstanding benefits of the use of organic insecticides during the last twenty years. Knipling (1953) estimated that during the first 10 years of use, 5 million lives were saved and 100 million illnesses prevented through the use of DDT for controlling such diseases as malaria, typhus, and dysentery. Largely through the use of modern insecticides for mosquito control, progress is being made towards eradicating malaria on a world wide basis.

It is estimated that in the United States alone there are 10,000 species of injurious insects, and that in spite of many effective control measures, they cause losses of approximately $4,000,000,000 annually (Hoffman, 1959). If control measures were not available, the annual losses would exceed this figure by several times. Within a few years after the introduction of DDT and other chlorinated hydrocarbons following World War II, outstanding control was obtained against insects that damage or destroy fruits, vegetables, tobacco, sugar beets, sugarcane, cereals, cotton, pastures, and livestock. Soon the yield of many of these crops jumped 10 to 20 percent or more, and the products were of much higher quality.

Forest insects, the greatest single hazard to forest production, are estimated by the Forest Service to be responsible for 40 percent of all the losses of saw timber and 28 percent of those of growing stock. Until DDT was found to be effective against defoliating forest insects, when dispersed by airplane over vast and inaccessible areas, it was not possible to protect our valuable timber resources. Since 1945, approximately 19 million acres of forest land in the United States have been sprayed with DDT in a highly effective manner.

The outstanding benefits obtained through the use of insecticides has lead to the development of many new materials and a tremendous increase in the quantities used. Entomologists and chemical manufacturers predict a fourfold expansion in the use of pesticides during the next fifteen years. Today, over 12,500 formulations and more than 200 basic control compounds are on the market. Most of the currently used pesticides were unknown ten years ago. Furthermore, most new insecticides are decidedly more toxic, generally more stable, and less specific in effect than those first produced.

Exact figures as to the total production or consumption of all pesticides are not available. However, the U.S.D.A. reports that 574,213,000 pounds of technical material of just 15 major chemical pesticides were produced in the U. S. in 1958. The Congressional Record for September 2, 1959, stated that 3,000,000,000 pounds of chemicals were sprayed over more than 70 million acres of our crops and timberland to kill insects, weeds, and plant diseases the preceding year. In total, well over 100,000,000 acres in the United States are sprayed, dusted, or otherwise treated with highly poisonous pesticides annually.

Pesticide Toxicity

While few would question the need for pest control measures, there is abundant proof that there often are immediate ill effects upon wildlife resulting from many of the eradication and control programs. In some areas, where the concentration of chemicals used has been high, there has been considrable evidence of subtle, indirect and long range effects that are often overlooked because of the delayed action when highly toxic, stable, and broad spectrum poisons are used in quantity (Cottam, 1960).

With the large quantities of toxicants that are being broadcast over the land, it is inevitable that some materials will reach our water courses in concentrations that are toxic to aquatic life. Numerous fish kills have been reported. Other aquatic life making up the food chain of fishes has been wiped out.

Spraying an extensive forest area against spruce budworm in the watershed of the Miramichi River in New Brunswick in 1956, at the rate of one-half pound of DDT per acre, produced a 91 percent kill of young salmon. Aquatic insects also were largely wiped out and some of these were not re-established sixteen months later.

In June, ,1958, approximately 302,000 acres of northern Maine forest were sprayed with DDT at the rate of one pound per acre to control spruce budworms. Studies were conducted on the effects of this toxicant on fish. Loss of trout was moderately heavy, with young of the year comprising 30 percent of the loss. Suckers, minnows, sculpins, and sticklebacks were most readily affected. Trout collected three months after spraying contained from 2.9 to 198 p.p.m. DDT.

This tendency of insecticides to accumulate and concentrate in the bodies of both plants and animals over a considerable period of time is causing concern among wildlife biologists as to the long term effects of such materials. That various organisms can store chlorinated hydrocarbons was clearly demonstrated at Clear Lake in northern California where DDD was used to control pest midges. Large scale treatment started in the summer of 1949, and was repeated in 1954. In December 1954, about 100 western grebes were found dead and still more succumbed in March, 1955. In 1957, another treatment was made to control the gnats. More grebes died at that time. Chemical analysis revealed these contained 1,600 p.p.m of DDD. Various fish were collected and chemically analyzed and their stored fat showed DDD ranging from 40 to 2,500 p.p.m. According to Cottam (1960) there is evidence that this accumulation of insecticide in the bodies of breeding pairs of grebes prevented the production of any young during the summer of 1960.

While many of the chlorinated hydrocarbon and organic phosphate insecticide have been listed as being the cause of fish kills, endrin has been the one most commonly listed. The infinitesimal amount of 0.6 p.p.b. will kill 50 percent of test bluegills in a period of 96 hours. According to Henderson (1959) the toxicity of the ten most commonly used chlorinated hydrocarbons to fish tested to date, in descending order of potency, is as follows: Endrin, toxaphene, aldrin, DDT, heptachlor, chlordane, methoxychlor, lindane, and B.H.C. Concentrations of considerably less than 1 p.p.m. of all of these compounds except B.H.C. were toxic to fathead minnows, bluegills, goldfish, and guppies tested over 96 hour exposure periods.

Inasmuch as many of the newer pesticides are highly toxic and non-selective in their action it is not surprising that considerable alarm is being shown today as to the possible effects of insecticides on human population. Articles have appeared which claim that insecticides, especially residues on foods, are the cause of many human and animal diseases. DDT, for example, has been claimed to be the direct cause of a virus disease and a contributing cause of hepatitis, asthma, cancer, pneumonitis, and insanity. The truth is, however, that the U. S. Public Health Service, even with intensive research, has been unable to confirm the allegation that insecticides,, when properly used, are the cause of any disease either of man or animals. When misused, however, they may be highly dangerous.

The danger from pesticides may be judged from mortality records and special surveys. In the United States during 1956, 152 deaths were caused by such materials. This indicates a need for greater caution in the handling of insecticides than is often shown in mosquito abatement work, crop, and forest spraying.

In order to prevent costly and unnecessary losses of valuable wildlife in the future more effective controls should be placed on the distribution and use of dangerous toxicants at the source. This should include more effective testing, registration, labeling, and distribution of poisons. More effective coordination between agencies and groups directing control is vital in operational programs. There is a critical need for more adequate support of basic research to establish safe limits of toxicants in the environment, and levels which are safe to various forms of wildlife. Where possible, toxicants that are selective and, that will give reasonable control of a particular pest and do the least damage to desirable forms of life, should be used. Finally, rates of application should be held to a minimum, and direct application to streams and to areas where rapid leaching might occur should be avoided wherever possible.

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PROFESSIONAL COMPETENCE: A MUST IN MOSQUITO CONTROL

George F. Knowlton

Utah State University

Leadership in mosquito abatement demands professional training and attitudes, sound judgment, good managerial ability, cooperative effort, initiative, willingness to keep abreast with developments in the field, with a wholesome and understanding approach to public relations problems. Selecting a district manager with these qualifications, backed by a Board of Trustees dedicated to the same objectives and ideals, launches a district into the best possible control program in view of the problems faced and the budget available to accomplish the desired objectives. Management is a full time, year around job for a well qualified person. The staff of workers should be adequate in numbers and training to meet the needs of the project. Close contact with existing conditions is all important.

Research is essential to continuing successful mosquito abatement programs. Problems of mosquito tolerance or resistance to larvacides and adulticides continue to develop. We are far from knowing all medical aspects of encephalitis and of our mosquito-disease relationships. Much remains to be learned of the ecology of many mosquito species. Our inter-relationships of mosquito control, wildlife production, pasture and crop residue problems, and other human relationships demand continuing study. Improvement in the efficiency of operations, and ways to secure greater effectiveness of programs, is a goal we must continue to seek. Only a progressive and well rounded research program will continuously move mosquito control forward to greater competence, and help it to accomplish its greatest possible service. Both basic and applied research are necessary to accomplish our ultimate objectives.

The extensive use of DDT in the same areas over a period of years has resulted in some species of mosquitoes becoming conspicuously resistant to this larvicide. Species which become resistant to DDT soon acquire resistance to dieldrin, chlordane, heptachlor, BHC, lindane, and other chlorinated hydrocarbon larvicides. For use over pastures or farmlands where we desire that no long-time residue be sprayed or dusted on food and forage crops, we frequently turn to organophosphorus compounds. These include parathion, malathion, EPN, Dipterex, Diazinon and Co-Ral. Cases of resistance to malathion and parathion have been reported. Resistance to the other members of this phosphate group can be expected if they are used extensively and over a long period of time.

To remain efficient, and to meet the changing conditions which are encountered in every district, the leadership must keep up-to-date on developments. State and national meetings should be attended by managers and keyboard members, so far as this is possible. The reports given, and the discussions carried on bring out research developments in the field. Through these meetings, including both the public and many private discussions, we learn how others have met and overcome obstacles which confront us. In return we probably have worked out procedures or solved problems helpful to others in the field. Professional meetings, and keeping up-to-date on the literature of the field, upgrades the workers and the work. This leads to more effective control, and frequently results in doing a better abatement job at less cost. Such professional meetings build morale and increase effectiveness of the workers who attend.

"In-service-training" may be desirable to increase efficiency, and to build interest and loyalty among staff workers who are not able to attend and participate in many state, regional or national abatement meetings.

Sound business judgment must guide the program. The proportion of the budget going for equipment, payroll help, transportation, insecticides, drainage, fill, etc., must be carefully worked out. The system of bookkeeping used must be adequate to meet the financial needs, and also include a usable method for keeping permanent records. Adequate maps, charts and reports are a part of the operation.

Professional competence leads to keeping abreast or ahead of general developments in and adjacent to the district. If a major highway, dam, or other large project is contemplated, it is well to study it carefully along with the engineer in charge. Often such study and wise planning leads to the creation of fewer breeding areas. Early planning often reduces the number and importance of breeding waters, to the extent that such is possible and feasible. In the same way, close relationships with all water management agencies may prevent the development of unfortunate situations, or facilitiate the correction of undesirable conditions which already exist.

Cooperation with sportsmen and wildlife agencies is important. Often, we can avoid using toxaphene, dieldrin, or other extremely poisonous materials in a situation severely detrimental to fish or other wildlife. Thoughtful planning often permits the using of a different material, at a dosage which will achieve mosquito control without undesirable side effects. Such cooperation and general understanding helps to avoid conflicts.

One of the most important responsibilities of management is an informed and professional attitude toward public health matters. Not only must we avoid flying over homes and garden while spraying parathion, but we must do everything possible to avoid depositing undesirable chemical residues on food and forage crops. This is a field of active citizen interest.

The provisions of the Miller bill, plus the development of resistance of some species of mosquitoes to the chlorinated hydrocarbons and also to some organophosphorus compounds, presents us with a real challenge. Control is no longer a matter of treating all areas with DDT. Mosquitoes in many areas have built up substantial resistance to DDT, so other materials must be used. As things now stand, if DDT is sprayed on alfalfa, pastures, or other forage crops, or on certain food crops, the manager and trustees of the district may be brought into court. What is **allowable** under the law rates first, and using the most effective thing we can, under the existing conditions, becomes a real and immediate problem of management. For instance, the U. S. Department of Agriculture and U. S. Food and Drug Administration have placed a 0-tolerance on DDT, aldrin, dieldrin, heptachlor, and heptachlor epoxide so far as forage alfalfa and certain other forage crops are concerned. This has caused many problems for the grower, as well as for the mosquito control crew. To a large extent these already have become our problems in mosquito control. We can no longer meet this vital situation by ignoring it, as sometimes has been done. Failure to meet the existing regulations (see USDA Handbook 120 for 1961) will result in poor public relationships. We earnestly seek to avoid poor public relationships and lawsuits.

Insecticide	Allowable p.p.m. on forage	Minimum days from last application to harvest
Aldrin	0	*
BHC		40 days*
Borax		15
Chlordane		*
DDT	0	*
Dieldrin	0	35 or longer*
EPN		
Heptachlor	0	30 to 90*
Malathion	8	7
Methoxychlor	100	7
Oils	Exempt	
Parathion	1	15
Paris green		Pellet formulation
Phosdrin	1	1
Pyrethrum	Exempt	
TDE (DDD)		Granular formulation*
Toxaphene		Do not use near lakes, streams or ponds.*

The United States Department of Agricultural Handbook No. 120 for 1961, states: "Do not feed plants treated with aldrin, chlordane, DDT, dieldrin, or toxaphene, ensilage made from treated plants, to poultry, dairy animals, or animals being finished for slaughter" (page 4). Do not apply to forage to be sold or to be shipped interstate.

*In general forage or pasture treated with asterisk-marked materials and should not be fed to dairy animals or animals being finished for slaughter (last 60 to 90 days).

1960 BITING COUNTS IN WEBER COUNTY

Earl A. Jenne,

Supervisor Weber Co. Mosquito Abatement District

Introduction

The biting counts were made with an objective to serve the immediate needs of a mosquito control district. The data thus gathered was and is preserved for future use, and this report is an attempt to analyze the data.

General Information

A total of 129 counts were made, but not all of them will lend themselves to the type of analysis used in this report. No mosquitoes were taken in 41 of the collecting periods, and 19 were in answer to complaints. An average of 11.4 mosquitoes were taken each collecting night regardless of the duration of the count. Most of the counts were of one hour duration, but 15 were less than one hour and 49 were longer than one hour. An average of 12.9 mosquitoes were collected during the hours of maximum biting activity. About 81%of the population of Weber County is located east of highway 84, and the average of the collections made in this area was 3.5 mosquites during the hour of maximum biting activity.

Bite Counts and Light Traps

The biting collections were compared with light trap collections, which were taken at the same time and in the same locality. There were 2.48 times as many mosquitoes taken in biting collections as in the corresponding light trap collections. When this factor is multiplied times the number of mosquitoes taken in a light trap it seldom approaches the number taken in the corresponding biting collection. This is influenced by the fact that the sexes were not separated in the light trap collections. The sexes were not separated deliberately, because they are not separated in the regular light trap counts made in the district. Of course for a mathematical relationship between light trap collections and biting counts to have any significance to the district it would have to be such that it could be applied to the methods of the district.

Bite Counts and Sunset

The time of sunset was taken from an almanac and converted to clock time as well as being corrected for the latitude.

The collecting periods during which from one to three mosquitoes were taken were analyzed and found to have been taken between the extremes of one half hour before sunset until two and one half hours after sunset. The average hour of maximum activity extended from 18 minutes after sunset until 78 minutes after sunset.

The collections of from 4 to 8 mosquitoes per hour of maximum activity ranged from one and one half hours before sunset until two hours after sunset. The average of these times is from 8 minutes after sunset until 68 minutes after sunset.

Collections of from 9 to 23 mosquitoes per hour of most activity were taken between one hour before sunset until one and one half hours after sunset. The average starting time was 4 minutes after sunset and the average ending time was 64 minutes after sunset.

Collections of from 24 to 164 per hour were made between sunset and one and one half hours after sunset. The average hour of maximum activity of these counts was from 12 to 72 minutes after sunset.

When the zero counts were studied it was found that a lower percentage of counts gave zero results during the first hour after sunset than at any other other time.

Aedes campestris was taken only in the first one half hour before sunset, but was only found in two collections.

Aedes dorsalis was taken in counts ranging from one half hour before sunset until two hours after sunset. The maximum activity was during the second half hour after sunset when 65% of the total collection was made.

Aedes increpitus was taken between the second half hour before sunset and the second half hour after sunset, but only eleven specimens were collected. The majority were taken during the first half hour preceding sunset.

Aedes nigromaculis were taken between the half hour preceding sunset and the second half hour after sunset. One half of those collected were taken during the first one half hour after sunset, and 43% were taken during the second half hour after sunset.

Aedes vexans were taken during the half hour periods from one half hour before sunset to the third half hour after sunset. The greatest number (61% of the total) were taken during the second half hour after sunset.

Anopheles freeborni were taken during periods from the first half hour before sunset to the fourth half hour after sunset. Nearly 46% were taken during the first half hour after sunset and nearly 45% were taken in the second half hour after sunset.

Culex erythrothorax was represented by a single specimen taken during the first half hour after sunset.

Culex tarsalis were taken between the first half hour before to the fifth half hour after sunset. Only one was taken before the sunset, and only two in the fifth half hour after the sunset. The largest collection was made during the second half hour after sunset, when 63% of the total were taken.

Culiseta incidens is represented by a single specimen taken sometime during either the first half hour before or the first half hour after sunset in a nonsegmental collection of one hour.

Culiseta inornata were taken between the first half hour after sunset and the third half hour after sunset. The greatest number (73% of the total) were taken during the second half hour after sunset.

All species combined were taken in greater numbers between the first half hour after sunset through the third half hour after sunset. The greatest number were taken during the second half hour after sunset when 58% of the total were taken. This time of maximum activity should be taken to supersede that given by the author a year ago in a similar report. (Jenne, E. A. 1960. Biting Records in Weber County. Proceedings of the Thirteenth Annual Meeting of the U.M.A.A.) The times of sunset for that paper were taken from an almanac and the time corrected for a latitudinal difference, but had not been changed to clock time. This made the sunset times used in that report 28 minutes earlier than they actually were, and lead to the erroneous statement that the period of maximum activity was the third half hour after sunset.

Biting Activity and Temperature

The temperatures recorded in this paper were taken at 505 West 12th Street in Ogden. Most of the temperatures were recorded about a half hour before the count and again about a half hour after the count. To put the temperatures in a usable form the median of the two recordings was taken as the temperature for the collecting period.

The extreme temperatures of the collecting periods ranged from 48 degrees to 97 degrees, and the median temperatures ranged from 49.5 to 90.5 degrees. Only one collection was made at a temperature below 60 degrees (49.5 degrees), and no mosquitoes were taken at that time.

Nine collections were made at median temperatures of 60 to 64 degrees and fifty mosquitoes were taken, but seven of the collecting periods yielded no mosquitoes. The average was 5.5 per count.

Twelve collections had median temperatures beween 65 and 69 degrees and a total of 17 mosquitoes were taken. The average collection was only 1.4 mosquitoes.

Twenty-three collections were made when the median temperature was between 70 and 74 degrees, and 42 mosquitoes were taken. Eleven of these were zero counts so the average collection was only 1.8 per hour of maximum activity.

Thirteen collections were made when the median temperatures were between 75 and 79 degrees, and 205 mosquitoes were taken. Only two counts were zeros, so the average collection was 15.8.

Fourteen collections were made at median temperatures between 80 and 84 degrees, and 516 mosquitoes were collected. This averages 36.8 per count.

Twenty collections were made when median temperatures were within the range of from 85 to 89 degrees, and 533 mosquitoes were collected. The average of these collections was 26.6.

Two collections were made when the median temperature was 90.5 degrees, and 26 mosquitoes were collected in one and 1 in the other. This is an average of 13.5 per collection.

This information indicates that more mosquitoes per collection were obtained at median temperatures between 80 and 84 degrees than at any other time.

The zero counts, counts of from 1 to 3, counts of from 4 to 8, counts from 9 to 23, and from 24 to 164 per hour of maximum activity were put on charts and analyzed. The data on these charts leads to the conclusion that mosquito biting activity is greater when the median temperature of the collecting period is above 80 degrees, and least active when the median temperature is below 76 degrees.

Aedes dorsalis were collected at temperatures ranging from 60 to 89 degrees. The most favorable temperature range seems to be between 80 and 89 degrees, and the largest collection was made at temperatures between 80 and 84 degrees.

Aedes increpitus was only taken in one collection when the temperature had been recorded, and in this instance the median temperature was 86 degrees.

Aedes nigromaculis were collected at temperatures between 75 and 89 degrees, with the largest collections between 85 and 89 degrees.

Aedes vexans were taken at temperatures between 70 and 89 degrees and the largest collection was between 85 and 89 degrees.

Anopheles freeborni were collected at temperatures ranging from 75 to 90.5 degrees, and the largest collection was taken between 85 and 89 degrees.

Culex erythrothorax was taken only once and the median temperature was 87 degrees.

Culex tarsalis was collected at temperatures ranging from 60 to 90.5 degrees. The larger collections were made at temperatures between 75 and 89 degrees, and the largest was between 85 and 89 degrees.

Culiseta inornata were taken at temperatures between 60 and 89 degrees. There were two temperature ranges which had higher collections than the rest. These highs were from 75 to 79 degrees and from 85 to 89 degrees.

This information in summary indicates that more mosquitoes per collection were obtained at median temperatures between 80 and 84 degrees than at any other time.

BITING ACTIVITY AND RELATIVE HUMIDITY

The relative humidity was taken at 505 West 12th Street usually one half hour prior to the count and again approximately one half hour after the count. The relative humidity ranged from 20% to 55% during the counts, wih the exception of one zero count which was taken between the extremes of 77% and 87%. Since ranges are so awkward to work with, in each case the median between the two readings was taken and used as the relative humidity or median relative humidity.

The total number of mosquitoes collected was summed up for each five percent range of relative humidity, and the results compaired. This data implies that the most favorable relative humidity for mosquito biting activity is when it is between 30% and 34%, and the next most favorable is between 25% and 29%.

The number of mosquitoes taken per collecting period at various relative humidities was determined and this data indicates that the most favorable relative humidity is between 30% and 34% and the next most favorable is between 25% and 29%.

The counts were grouped according to the size of the collections and the average relative humidities of the groups determined. The comparison indicated that the average median relative humidity ranged only from 29% to 31% except for the zero counts which went up to 37%. This, on the surface at least, indicates that the relative humidity had little bearing on the size of the collections, except that the higher humidity was less favorable.

The zero counts for each 5% range of relative humidity were recorded in a table alongside the total number of collections made at each range. A study of this table would lead to the erroneous conclusion that the greatest activity would be at relative humidities between 20% and 24%. This inconsistency seems to be due to the localities in which some counts were taken and the time of the year some were taken.

Aedes dorsalis were taken when the relative humidity fell between 20% and 44% with most being taken between 25% and 29%, and next highest between 30% and 34%.

Aedes increpitus were only taken in one count in which the relative humidity was recorded, and the median of this count fell between 20% and 24%.

Aedes nigromaculis was taken when the median relative humidity was between 20% and 44% with the greatest number (51% of the total) being taken between 20% and 24%. The next largest collection was taken when the relative humidity was between 25% and 29%. Thirty percent of the total were collected within this range of relative humidity.

Aedes vexans were collected at median relative humidities between 20% and 44%, but more (44% of the collection) were taken between 30% and 34% than at any other time.

Anopheles freeborni were collected when the median relative humidity was between 20% and 39% with most (69% of all Anopheles) being taken between 30% and 34%.

Culex erythrothorax was only taken once and that was at a median relative humidity of 32%.

Culex tarsalis were collected when the median relative humidity was between 20% and 44% with the highest counts (54% of the total) between 30% and 34%, and the next highest counts (35% of the total between 25% and 29%.

Culiseta inornata like most other species were collected within the range of 20% to 44% relative humidity. Sixty-one percent of them were taken when the median relative humidity was between 30% and 34%. The next group of high counts was when the relative humidity was between 25% and 29%.

In summation of the biting activity and relative humidity, the first thing to note is the inconsistent results obtained by different methods of analyzing the data. This implies that the relative humidity may have little to do with biting activity, or that in some cases other factors had a greater effect on the activity. When the available facts are considered they indicate that the highest activity rate is between 30% and 34% relative humidity, because 42% of the mosquitoes collected were taken then. The next most active range is from 25% to 29% when 34% of the total number of mosquitoes were taken.

Biting Activity and the Month of the Year

MAY

Two counts were taken in duck clubs in the month of May and a total of 26 mosquitoes were taken. This amounted to only 2% of the total number collected, but it also only represents 2% of the number of collections made. *Aedes dorsalis, Aedes campestris,* and *Culiseta inornata* were collected, with a combined average of 13 per collecting period.

JUNE

Twenty-eight collections were made in June of which eighteen were made in urban areas, eight in farm districts, and two in duck club areas. Thirty percent of the collections were made in June and a total of 316 mosquitoes were taken. This represents 23% of the total number collected. Six species were collected in June, and the collections averaged 11.3 per collecting night.

JULY

Of twenty collections made in July, thirteen were taken in urban areas, five were taken on farms, and two in duck clubs. Twenty-one percent of the seasons collecting was done in July and a total of 527 mosquitoes were taken. This is 38% of the seasons total collection. Representatives of seven species were collected in July and the average collection was 26.35 per night.

AUGUST

Twenty-six counts were made in August inclusive of sixteen in urban areas, six in farm districts, and four in duck club areas. Twenty-seven percent of the collections were made in August and 451 mosquitoes or 33% of the total collections was taken. Six species were represented in the collections which averaged 17.3 mosquitoes per night.

SEPTEMBER

Twenty collections were made in September of which seven were in urban localities, ten in farming areas, and three in duck club areas. Twenty-one percent of the actual collecting time was spent in September, but only 49 mosquitoes were taken. This is only three percent of the total number collected. *Aedes dorsalis, Culex tarsalis,* and *Culiseta inornata* were collected in September, but the average collection only included 2.45 mosquitoes for the hour of maximum activity.

On a monthly basis July had the greatest activity with the collections averaging 26.35 per night for 20 collecting nights. August came next in mosquito biting activity when the collections averaged 17.3 per night for 26 collecting periods.

Biting Activity and the Location

No mosquitoes were collected in 39% of the urban counts, 28% of the farm counts and 15% of the duck club area counts. Over nine per hour were collected in 5.6% of the urban counts, 41% of the farm counts, and 69% of the duck club area counts. Ten percent of the mosquitoes collected came from urban areas, forty percent came from farm areas and fifty percent came from duck club areas. In urban areas the counts averaged 3.5 per hour of maximum activity, in farm areas the counts averaged 19 per hour of maximum activity, and in duck club areas the collections averaged 51.8 per hour of maximum activity.

Predominance of Species

The species collected and the percent of the total represented by each are: *Culex tarsalis* 43%, *Aedes dorsalis* 21%, *Aedes nigromaculis* 17%, *Anopheles freeborni* 7%, *Culiseta inornata* 5%, *Aedes vexans* 3%, *Aedes campestris* 1%, *Aedes increpitus* 1%, *Culiseta incidens* .07%, and *Culex erythrothorax* .07%.

A similar study last year gave the following results regarding the percents of the total collection represented by the dominant species: *Culex tarsalis* 33%, *Aedes dorsalis* 21%, *Aedes increpitus* 21%, *Aedes nigromaculis* 10%, and *Culiseta inornata* 8%.

The most noteworthy difference between these two studies is in the case of *Aedcs increpitus* which represents 21% of the total collection in the earlier study and only 1% in this study. At least in part this difference is due to the fact that the largest collections of this species in 1959 were made in answer to complaints. In the course of answering these complaints the appropriate habitat for the species was visited, and several breeding places located. Access roads and trails were then cut through the brush to these secluded sites, so they could be treated. This has resulted in much better control of the species in this major breeding area.

Summary

1. A total of ten species were represented in the collections.

2. The maximum biting activity with respect to sunset was the second half hour after sunset during which time 58% of the mosquitoes were taken.

3. A similar report given by myself last year should be corrected to the extent that the times of sunset given were 28 minutes too early. This correction would change the time of maximum biting activity as given in that report from the third half hour after sunset to the second half hour after sunset.

4. The maximum biting activity with respect to temperature was when the median temperature of the collecting period fell between 80 and 84 degrees, and the next most favorable temperature was between 85 and 89 degrees.

5. There is some doubt regarding the effect of relative humidity as encountered in this study on the biting activity of mosquitoes, but the following is given for what it may be worth. The maximum biting activity with respect to relative humidity was when the median relative humidity fell between 30% and 34%, and the next most favorable was between 25% and 29%.

6. The maximum activity with respect to the month was during July, and the month of August came next.

7. Fifty percent of the mosquitoes collected came from duck club areas and only 14% of the collections were made there.

8. The five most common species collected are listed in the order of abundance: *Culex tarsalis, Aedes dorsalis, Aedes nigromaculis, Anopheles freeborni,* and *Culiseta inornata.*

FISH POND ORDINANCES ENACTED IN WEBER COUNTY, UTAH

Lewis E. Fronk

Director, Weber County Mosquito Abatement District

INTRODUCTION:

Gambusia fish have been stocked in ornamental fish ponds and lily pools in Weber County for over ten years. Each spring newspaper articles were published requesting the citizens report these ponds and pools to the mosquito abatement district either by telephone or postal card, and the district would in turn stock each pond with the mosquito fish. Over a period of years a total of seventy-two (72) ponds were located . Immediately after the article appeared in the newspaper, calls would come in for several days and then cease. We noted that the same people called year after year and most of the ponds reported were clean and well kept. People with filthy polluted ponds were undoubtedly ashamed and would not bother to report the condition.

Many ponds were found strictly by accident or by checking out a mosquito complaint. Locating these artificially created pools of water presented many problems. Some people in urban areas resented the mosquito operator invading the privacy of their back yards. In this age of the redwood fence many women take sun baths in their back yards in scanty sun suits and in one instance with only a bath towel. Dogs also present a problem. Most urban areas have dog ordinances which require dogs be tied or fenced in their property. The majority of the dogs are fenced in backyards where fish ponds are located and an operator attempting to invade the yard could easily be attacked.

1958 Encephalitis Outbreak

During the year 1958 an outbreak of equine encephalitis occurred in northern Utah. At the request of the Utah State Health Department and the various mosquito abatement districts the United States Public Health Service assigned biologists Louis J. Ogden and James V. Smith to the area to give technical assistance and make an appraisal of the mosquito control programs in northern Utah during the encephalitis outbreak. At the completion of the study specific recommendations were made for each organized mosquito abatement district in the state. Inasmuch as the Weber County and Salt Lake City mosquito abatement districts are heavily populated areas, it was recommended by Mr. Ogden and Mr. Smith that the districts conduct an intensified survey (block by block) of the cities, mapping all actual and potential sources of mosquito production and expand the fish planting programs in these districts.

October 1958 Board Meeting

All recommendations made by the United States Public Health Service were considered by The Board of Trustees of the Weber County Mosquito Abatement District at the October 1958 board meeting. Mr. Fronk, director of the district, reported to the group that at this time there was not enough man power available to warrant a "block by block" survey of Ogden City and other urban areas. He further suggested that the citizens themselves could make the survey by enacting a county ordinance requiring all artificial or man-made bodies of water such as fish and lily pools be reported to the Ogden City Health Department. The Ogden City Health Department could then forward the information to the abatement district. The board of trustees considered the proposal sound and a resolution was ordered drafted and considered for approval by the board at the November 1958 meeting.

Resolution

On November 10, 1958 the following resolution was drawn up by the Director and Board of Trustees of the Weber County Mosquito Abatement District: The resolution was endorsed by the district president Mr. J. B. Marsh, Dr. Arley Flinders Ogden City Health Dept., and Lewis E. Fronk President of the Utah Mosquito Abatement Association.

November 10, 1958

Weber County Mosquito Abatement District
505 W. 12th St.
Ogden, Utah

To: Board of County Commissioners
Incorporated Cities of: Huntsville, North Ogden, Ogden, Plain City, Pleasant View, Riverdale, South Ogden, Roy, Uintah and Washington Terrace.

From: Board of Trustees
Weber County Mosquito Abatement District

Subject: Resolution concerning ornamental fish ponds, lily pools and swimming pools in Weber County.

RESOLUTION

October 13, 1958

Whereas the construction of ornamental fish ponds, lily ponds, and swimming pools in our area are becoming more numerous each year, and

Whereas these pools and ponds provide excellent breeding places for not only pest mosquitoes but those capable of transmitting disease, and

Whereas it is almost impossible for the mosquito abatement district to locate the many ponds and

Whereas there has been an increase in western encephalitis in the past few years, and

Whereas Gambusia fish can be stocked in these ponds without cost to the property owner, and

Therefore be it resolved this 13th day of October that the Director and Board of Trustees of the Weber County Mosquito Abatement District urge the Board of County Commissioners and the various town boards to draft ordinances requiring those who have such ponds on their property, register them with the City Health Department.

Whereas the information can be forwarded to the Mosquito Abatement district, and

Be it further resolved that inasmuch as fish will be stocked in the ponds without additional cost to the property owner and knowledge of the ponds location will further mosquito abatement, we urge that the ordinances be drawn up as soon as possible.
Endorsed by: J. B. Marsh, President Weber County Mosquito Abatement District, Dr. Arley Flinders, City Health Department, Lewis E. Fronk, President Utah Mosquito Abatement District.

Drafting of the Ordinance From the Resolution

It was first suggested that one ordinance could be drawn up by the county attorney and passed by The Board of County Commissioners that would apply to all the communities in the county. The County Attorney Mr. Maurice Richards informed the district that one ordinance could not apply to the entire county. He stated that he could draw up an ordinance that would apply to the unincorporated areas only. He further stated that the incorporated cities would have to draft their own ordinances. In as much as the ordinances would be more beneficial to the urban areas the resolution was taken to the Ogden City Attorney, Mr. Paul Thatcher.

Mr. Thatcher suggested a rough draft be drawn up and be presented to the mosquito abatement board for approval. He also suggested the ordinance be passed by the Ogden City Council and then the other incorporated cities could adopt the same ordinance if they so desired.

Ordinance Passed

The fish pond ordinance was passed by the Ogden City Council four months later, April 1, 1959. It was later adopted by Huntsville, Pleasant View, Roy, and South Ogden. The towns of North Ogden, Washington Terrace, Riverdale and Plain City are expected to adopt the ordinance in 1961.

Ordinance No. 520

by Scott B. Price

AN ORDINANCE OF OGDEN CITY, UTAH, REQUIRING THAT ALL ARTIFICIALLY CREATED POOLS OF WATER WHICH ARE NOT COMPLETELY AND PERMANENTLY ENCLOSED BE REGISTERED WITH THE OGDEN CITY HEALTH DEPARTMENT.

WHEREAS, the construction of ornamental fish ponds, lily ponds, bird baths and wading and swimming pools in Ogden City is increasing and

WHEREAS, Western encephalitis, which is transmitted by mosquitoes, is a serious health hazard in Ogden City, and

WHEREAS, such artificial pools of water when constructed in the open and not enclosed are potentially breeding places for encephalitis carrying mosquitoes, NOW THEREFORE,

The Council of Ogden City Hereby Ordains

SECTION 1. The owner and occupant of any lands whereon is situated any artificially created or constructed pool of water, including, but not limited to fish ponds, lily ponds, bird baths and swimming and wading pools, which is not completely and permanently enclosed shall, within three (3) months from the effective date of this Ordinance, register every such pool with the Ogden City Department of Health upon forms to be provided by the Ogden City Director of Public Health. Such forms for registration shall specify the name of the owner and occupant of the lands upon which such pool is located, and shall specify the location of the same and shall describe in brief and general terms the nature of such pool. The person registering such pool shall furnish such other information as the Director of Public Health may reasonably require.

SECTION 2. Hereafter, before constructing or installing any pool of the kind described in Section 1 hereof, the owner and the occupant of the premises upon which the same is to be constructed shall register the same in the manner provided in Section 1 hereof.

SECTION 3. Any failure to comply with the requirements of Section 1 or Section 2 of this Ordinance is a misdeameanor and every person convicted thereof shall be punished by a fine in a sum not exceeding $50.00 or by imprisonment in the City Jail not exceeding 5 days, or by both such fine and imprisonment.

PASSED AND ADOPTED AND ORDERED PUBLISHED by the Council of Ogden City, Utah this 26 day of March, 1959.

Raymond S. Wright
MAYOR

ATTEST
Elizabeth M. Tillotson
City Recorder
Published April 1, 1959

Response To Ordinance

Passage of the ordinance was immediately published in the Ogden Standard Examiner. For weeks calls came into the Ogden City Health Department and also the abatement headquarters. The calls that were received at the abatement district were referred back to the Health Department, to prevent confusion and duplication. The health department recorded the information on special forms and then forwarded the information to the abatement district on other forms provided by the district. Over 600 calls were received in the first thirty (30) days after the ordinance was published. The people reported everything that resembled water. They reported rivers, canals, drain ditches, gutters, fish ponds, bird baths, lily pools and even fish hatcheries.

Recording Data

Each call was checked out and if found practical for planting fish was recorded in a card file. Two cards were made for each pond; one filed under township and the other filed alphabetically. The calls that were found impractical for fish such as canals, rivers, and fish hatcheries were discarded. The district now has some over 300 such ponds recorded. These ponds include mostly fish ponds, lily pools, and other small artificial bodies of water. Also potential areas are recorded and marked as such. Records are kept of not only ponds containing water but ponds that are dry and could contain water.

A map was also secured and all ponds located with colored pins. Red pins representing active or ponds containing water. Green pins were used to indicate dry ponds, and Yellow pins for those ponds impractical for fish planting but potential mosquito breeding places.

Conclusions

At the end of the first year the ordinance has proved itself sound. Hundreds of mosquito breeding areas are now being stocked with fish that otherwise might produce and probably have produced many of mosquitoes in the past. The passage of the ordinance has helped reduce the mosquito populations especially in the urban areas.

A MOSQUITO SURVEY OF SKULL VALLEY, TOOELE COUNTY, UTAH

Jay H. Linam[1, 2]

In 1958 a mosquito survey of Tooele County was initiated. This program was intensified in 1959 with particular emphasis placed on Skull Valley and environs. All possible breeding sites that could be located in this valley were periodically checked. Light traps were operated where possible.

The elevation of Skull Valley is approximately 4,500 feet. Considering that this region is commonly referred to as desert area, there is a surprising number and variety of sites suitable for mosquito production.

This survey revealed 4 general and 11 species to be present. A number of single-brooded *Aedes* species seem to have adapted well to this area. The number of temporary pools formed from melting snow and early spring rains provides excellent sites for these early forms. In mild, open winters, larvae of these species may be collected in February and March. This is considerably earlier than previous reported collection records from Utah (Carpenter and LaCasse, 1955; Rees, 1943; Richards, et al., 1956). It is probable that the eggs of these species require a certain water temperature before they will hatch. Favorable temperature conditions occur first at lower elevations (Nielsen, 1959). Mild winters would also allow this favorable temperature to be attained at an earlier date.

Aedes campestris Dyar and Knab

Larvae of this species were collected in temporary pools, most of which had a high organic matter content. Collections were also made from an area where a sewage lagoon had overflowed into the surrounding grass. The earliest larval collection was made March 3, 1959. The latest was April 26, 1958. A few adults persisted into the early part of August.

Aedes cataphylla Dyar

This species may be found at altitudes exceeding 20. All collections were from temporary pools. Larvae were not collected in this area after April.

This species may be found at altitudes exceeding 7,500 feet, in Utah. It is somewhat surprising that it can range down to 4,500 feet as in Skull Valley. This altitude must approach the lower limits of its range in Utah.

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Aedes dorsalis (Meigen)

This mosquito occasionally causes annoyance to residents of Dugway and Timpie. Larvae were collected from temporary pools, permanent ponds, sewage lagoons, irrigation waters, marshland, and abandoned water-filled excavations. Larvae appear about April 1, and both larvae and adults persist into September.

Aedes fitchii (Felt and Young)

March 3, 1959 marked the earliest larval collection. Larvae were commonly collected until the end of April. The first adults appeared about the first of April, rapidly declining in numbers during May. The species was entirely confined to temporary pools.

Aedes nigromaculis (Ludlow)

Two female specimens of *A. nigromaculis* were collected at GPI-1, Dugway Proving Ground, August 25, and September 3, 1958 by Linam and Collins. The species has not been previously reported from Tooele County. No larval collections were made. It is not known whether these adults came from a local unknown breeding site or migrated into this area.

Aedes niphadopsis Dyar and Knab

Larvae were collected throughout March and April. Adults were collected in April and May. The species inhabited not only temporary pools, but also the overflow areas of sewage lagoons.

Aedes schizopinax Dyar

A. schizopinax larvae were quite abundant in several locations during February and March of 1959. Yet only one adult collection was made. This is a female specimen taken in a light trap. This species seems restricted to temporary pools that have a large content of organic matter, usually decaying vegetation. In this instance the vegetation consists largely of salt grass (*Distichlis stricta.*) The pH of pools having large numbers of *A. schizopinax* larvae was 6.8 - 7.0. Other pools similar in size and pH concentration did not contain larvae of this species, perhaps due to lack of decaying vegetation.

Culiseta incidens (Thomson)

H. J. Egoscue collected larvae of this species, June 10, 1959, from a small water-filled depression near Erickson Pass. Larvae and adults were collected from nearly all the springs in the mountains surrounding Skull Valley. No collections of either adults or larvae were made in the valley.

Cuıeseta inornata (Williston)

This species was found to inhabit practically all available habitats, including the overflow area from sewage lagoons. Larvae and adults were collected from April into October.

Psorophora signipennis (Coquillett)

Rees and Nielsen (1955) report *P. signipennis* from Dugway, Utah, and from Government Well, northwest of Dugway Mountains. These collections of adults were made August 4, 1953 by J. L. Eastin, and August 11, 1953 by H. E. Cott. This is earlier than any larval collections made by the author. The species was collected from only one area during 1958 and 1959. The site studied by the author was a small pool only a few feet in circumference, formed by the drainage from a boiler room. The water was heavily polluted and the level of the pool fluctuated frequently Adults were collected August 25, 1958 by Linam and again August 13, 1959 by D. E. Johnson. Both of these collections were made at the above described site located at GPI-1, Dugway Proving Ground. One female was collected approximately 0.7 miles away from this known breeding source, inside a building, by H. Collins September 10, 1958. The latest larval collection was made by Linam September 8, 1958. The pool dried up completely soon after this latter collection. Other species associated with *P. signipennis* were *A. dorsalis, A. nigromaculis, Culiseta inornata,* and *Culex tarsalis.*

Culex tarsalis Coquillett

A very common mosquito found throughout the area. Larve were collected in May and persisted throughout the summer in all available habitats. This species occasionally becomes an annoyance to residents of Dugway. In this area it breeds around faulty sprinkler heads, in waste irrigation water, and the margins of sewage lagoons. *C. tarsalis* also causes annoyance to residents of Timpie, Utah, and to skin divers and bass fishermen in that area.

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