# PROCEEDINGS OF THE
# EIGHTEENTH ANNUAL MEETING
OF THE
# UTAH MOSQUITO ABATEMENT ASSOCIATION

*held at the*

"Y" CENTER
BRIGHAM YOUNG UNIVERSITY
PROVO, UTAH
March 26 and 27, 1965

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## NINETEENTH ANNUAL MEETING

# WILLARD BAY WATERFOWL MANAGEMENT AREA — A FEATURE OF THE WEBER BASIN WATER DEVELOPMENT PROJECT —

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The Weber Basin Project Authorizing Act of August 29, 1949 provided for preservation and propagation of fish and wildlife, a rather unique stipulation for a Federal water development project.

In keeping with his provision, investigations were conducted on the project area during 1949-51. Results of these investigations were presented in the Weber Basin Project Definite Plan Report of May, 1952. This report was fairly cursory, and the primary concern for waterfowl at that time was for preservation of water rights and for water delivery to Ogden Bay Waterfowl Management Area.

Fortunately, an opportunity to reevaluate the impact of the Project on fish and wildlife resources was afforded. Several aspects were reassessed in 1957 on the basis of additional operational data supplied by the Bureau of Reclamation. Of special concern was the area around the proposed Willard Reservoir which would inundate approximately 10,700 acres, most of which had some waterfowl value.

The Department had a filing for water from First Salt Creek which was to be used in an area destined for flooding by the reservoir. Other sections of the reservoir area, upon which we had no specific or assigned right, were also of considerable value to this resource. The reservoir itself, once constructed and filled, would have limited value to waterfowl or for waterfowl hunters.

To replace all this natural habitat which would be lost in Willard Reservoir, the Department proposed construction of a waterfowl management area. We also suggested installation of permanent concrete blinds on the top, outer side of the Willard Reservoir dike. This would have enabled waterfowl hunters to pass shoot ducks and geese flying either to or from the reservoir. This second proposal was later withdrawn as it was considered infeasible from several standpoints.

Our original design was for a waterfowl management area of approximately 1500 acres. General construction specifications were provided without any actual engineering. This proposal was guided by a general knowledge of construction needs for the type of development contemplated. The marsh development was proposed as a nonimbursable Project cost in the sum of $127,000. This figure, based on an actual engineering analysis and preliminary design prepared August 8, 1958, was later amended to $139,000.

The area selected for development was immediately west of the southwest corner of Willard Bay Reservoir. Land in this area was part of the old lake bed typical of that upon which the bulk of Utah's man-made waterfowl development has been constructed. It provided an excellent opportunity to develop good marsh habitat at a relatively low cost.

The plan and the $139,000 cost estimate were included in the Bureau's December, 1959, supplement to the Weber Basin Definite Plan Report which was approved by the Secretary of the Interior on August 9, 1960. Funding was proposed for fiscal year 1963 and was approved by Congress.

Suggestions by the Bureau of Reclamation with respect to the water level which we could maintain in their south drain created a need for some additional engineering in 1962. This work was accomplished, and contracts for transfer of funds and for approval of the revised plans were negotiated between the Department and the Bureau of Reclamation.

Additional problems in the design were noted during the spring of 1963, and more engineering and design changes were made by the Department. These changes were also approved by the Bureau of Reclamation and $139,000 was transferred to the Department in June, 1964. Construction was initiated in July of that year, and is continuing at this time. Total area within the dikes remains at about 1500 acres as originally proposed. However, the diked area is now composed of two units where initially it was proposed to create only a single, larger unit. The total area of the waterfowl management unit is considered at approximately 5100 acres.

Willard Bay of Great Salt Lake is an important and historic waterfowl area. We anticipate production of some 150 Canada geese and between six and seven thousand ducklings on the management area each year after the habitat begins to mature. The area should provide for approximately 4000 waterfowl hunter days use annually, and about 8800 ducks per year will be harvested within five years after completion of the project.

In summary I should point out there have been three designs of the development itself. In each instance we incorporated features which would not only benefit waterfowl and wildlife generally but also improve the area from the standpoint of mosquito and insect control.

We now have fourteen 24 inch outlets with a combined total of 56 feet of spillway surface, twelve 24 inch inlets with 48 feet of spillway, plus two flood water bypasses; one in the Bureau of Reclamation's south drain, which is the diversion point for the area, and the other on the west end of the upper water distribution system. Based on several estimates of water flow in both First and Second Salt Creeks, which are diverted into the development, we feel that these water control facilities are more than adequate to handle the water with which we will be confronted.

We believe we have a good design for the development and would welcome any of you at any time to visit the area and take note of what is being done.

## ROLE OF THE WILLARD DAM AND RESERVOIR IN THE WEBER BASIN PROJECT

GILBERT K. WALLACE
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Last stop for water. Do you recall seeing such a sign on the highway as you approached a long, hot climb ahead? The Bureau of Reclamation has put such a tag on Willard Reservoir where water of the Weber River is stopped in the nick of time from going to a salty death in the Great Salt Lake. The natural flow of the Weber River and its main tributary the Ogden River, which is not claimed or diverted by water users' along the Weber River system, has in the past gone on its merry way past the Ogden Bay Bird Refuge on to the Weber Delta and into the Great Salt Lake where it has evaporated without having benefited mankind. This is no longer so. This natural flow consisting of the surplus high flow not regulated by upstream reservoirs, the winter flow which passes through upstream powerplants and flow originating below the upstream reservoir, now hits a detour at the Slaterville Diversion Dam and is sent on its way north through the Willard Canal and into a fresh water impoundment. This is Willard Reservoir.

The purpose of the Willard Reservoir is to provide a space to store and conserve water for man's use. And what will be man's use of this water? As you are aware the Bureau of Reclamation in the United States Department of Interior is in the business of building water oriented facilities to conserve water and reclaim and irrigate land for agricultural purposes. Willard Dam and Reservoir, first and foremost, was built for this purpose. Without little or any additional cost, however, the Willard Dam and Reservoir can be and is being utilized for other purposes. Among these are included the development of water supplies for municipal and industrial purposes. Recreation oriented to boating and other water activities plays a big role at Willard. A warm water fishery will be available to those fishermen who like to try their skill on something beside mountain trout. The fact that water during high flows can now be diverted from the natural course of the Weber River, a certain measure of flood control can be attributed to the Willard Canal and Reservoir system. All of these factors working together make Willard a multiple-purpose project. Willard Reservoir in addition to serving these purposes also has an effect on other aspects such as waterfowl and insect life. You will hear further from others on this panel on most of these subjects.

Today I would like to treat the subject of Willard Dam and Reservoir and its role in the Weber Basin Project. This may best be brought out by answering the question, "How is man to use the Willard Dam and Reservoir?" This facility along with the Willard Canal and the Slaterville Diversion Dam is an integral part of the Weber Basin Project. It was not only the Willard Reservoir that was constructed for the purposes I just mentioned, that of providing irrigation water, municipal and industrial water, flood control, recreation, and fish and enhancement.

All in all there are five other reservoirs in the Weber Basin Project that in one way or another serve these same purposes by storing, conserving, and making available water for various uses. They include Wanship Dam, East Canyon Dam, and Lost Creek Dam on the Weber River system, and Pineview Dam and Causey Dam on the Ogden River system. All of these are in the mountain valleys east of the Wasatch Mountains. These facilities, operated in conjunction with the Willard Dam, provide supplemental water supplies for the four-county area of Summit, Morgan, Davis and Weber Counties. Most of the water is used along 45 miles of the Wasatch Front from the north end of Salt Lake City to Box Elder County.

To understand Willard Dam and Reservoir's role in this scheme it is necessary to understand what the situation was before Weber Basin Project came into the picture. Many of the water users located west of Ogden out toward Great Salt Lake obtained their irrigation water from the natural flow of the Weber River and from storage water from the upstream Echo Reservoir. In the planning of the Weber Basin Project it was seen that if these water users could be supplied from some other source the water they had been using could instead be diverted to irrigators, municipalities and industries located on the higher areas to the east near the Wasatch Mountains. This was the area where water demands were growing rapidly. This is where Willard Dam and Reservoir came into the picture. By using water from Willard Reservoir to supply the needs of those who, for instance, had been supplied from Echo Reservoir, it is then possible to use Echo water by exchange on the highlands to the east. To do this a rather unique system of diversion-conveyance and storage was developed. At Slaterville, on the Weber River, a diversion dam was constructed which in the winter and spring months takes the surplus flow of the Weber River and diverts it into a relatively flat canal with a capacity of 950 c.f.s. and this canal conveys the water north 11 miles into the Willard Reservoir.

The Willard Reservoir is relatively shallow with a maximum depth of 30 feet. It has a capacity of 215,000 acre-feet and a water surface area of about 15 square miles. The structure is very unique in that the reservoir is almost completely surrounded by the dam with 90% of the shoreline abuting the dam and only 10% of the shoreline against natural ground. Another unique feature of this reservoir is the fact that it lies below the land it is to serve. In order to use the storage water it is lifted at two pumping stations and conveyed in a reverse direction through the same Willard Canal that brought the water to the reservoir. Some of the water is turned out of the canal along the way, some is conveyed back to the Weber River for distribution where some is again pumped into another canal that will convey it as far south as 30 miles from its

origin in the Willard Reservoir. Most of this water is utilized for irrigation purposes. About 48,000 acres of land are eventually to be irrigated with this water, with 44,000 a.f. to be used to replace water that is exchanged for use on the higher lands and another 70,000 a.f. to serve previously unirrigated lands and to supplement inadequate supplies. Some of the water is pumped back to the Weber River and used to augment the flow to the Ogden Bay Bird Refuge in the time of year when the water supply to the Refuge is otherwise critically low. Any industry locating within the service area of the Willard Reservoir will have water made available to it according to its needs.

As of this date no water deliveries have yet been made from Willard Reservoir for the dam was just recently completed. The first water was diverted from the Weber River into the reservoir about 5 months ago in November 1964. The reservoir is approximately one-half full today. Full utilization of the storage water in the reservoir will probably not occur before 1970 or even 1975 — or until the demand makes it necessary.

The operation of Willard Dam and Reservoir is not without expected problems. For one thing it is recognized that because of its location in the Great Salt Lake Valley, where temperatures reach 100 degrees in most summers, and the fact that it has a large water surface; there will be excessive evaporation. It is estimated that about 3.5 to 4 feet of water will be evaporated from the surface of this reservoir each year. This amounts to about 15,000 acre-feet or about 7 percent of the total capacity.

At the mountain reservoirs where the water is relatively deep and cool and the water surface is relatively small, the evaporation is almost negligible. On the other hand 7 percent evaporation is much better than 100 percent, which is what it was when this water was wasted into Great Salt Lake. We are looking with interest on research now being made on reducing evaporation from large bodies of water.

Another problem may be the extensive mud flats that will probably be evident as the reservoir water surface is pulled down each year. An attempt has been made to reduce this problem as much as possible by constructing drainage channels from isolated water pockets to the minimum level of the reservoir. High ground water and artesian pressure under the reservoir area will tend to keep the area damp. Additional drainage ditches may be required if the situation warrants.

Other problems may present themselves as operation of the reservoir gets underway, but with faith in man's ingenuity I expect they will each one be surmounted.

With the construction and completion of the Willard Dam and Reservoir a challenge has been met and conquered. A few years ago such a plan was only a dream. Now it is a reality. New challenges have taken its place, however, because man must ever grow and seek new horizons. Even now plans are being made whereby waters of the Bear River, which are surplus to that river system's needs will be diverted into Willard Reservoir, greatly increasing its yield.

Conservation of water is vital to man's progress in the arid West and Willard Dam and Reservoir is certainly one conservation measure that will do its part. Thank you.

## A SUMMARY OF SOME RECENT ACTIVITIES OF THE DISEASE ECOLOGY SECTION CDC, USPHS, GREELEY, COLORADO

A. D. Hess and F. C. Harmston[1]

During 1964, the Disease Ecology Section conducted research on the ecology and control of selected communicable diseases highly endemic or enzootic in the Western States, particularly streptococcal infections, plague, tularemia, Colorado tick fever, and arthropod-borne encephalitis. Technical assistance was also provided on water resource vector problems to State departments of health and to Federal agencies.

In plague studies, use of the passive haemagglutination test for serologic epizootiology greatly expanded the potentialities of field investigations. Studies of 12 human cases of tularemia in South Dakota indicated the dog tick (*Dermacentor variabilis*) to be the principal vector. In two-thirds of 23 human cases of Colorado tick fever in Colorado, infected ticks (*Dermacentor andersoni*) were contacted during recreational activities mostly in mountain areas between 7000 and 8000 feet elevation. In mixed outbreaks of western encephalitis (WE) and St. Louis encephalitis (SLE) in Colorado and West Texas, *Culex tarsalis* appeared to be the principal vector. Virus transmission rates in chicken sentinel flocks showed a very high level of virus activity in the Texas Panhandle during the 1964 season.

## LOW VOLUME AIRPLANE SPRAYS FOR THE CONTROL OF MOSQUITOES

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There has been a great deal of interest in low volume airplane sprays for the control of insects in the last two years. This paper is a review of some of the information that has been obtained on the control of mosquitoes by this method.

That the use of low volume and/or highly concentrated sprays is really not new has been pointed out by others. During the last war, for example, personnel of the U.S. Department of Agriculture, Entomology Research Division, conducted airplane spray tests against mosquito larvae with as little as 1 pint of 20% DDT. They also worked on equipment designed for use of concentrated insecticides. Travis et al. (1950) ob-

[1] From the Disease Ecology Section, Technology Branch, Communicable Disease Center, Public Health Service, U.S. Dept. of Health, Education, and Welfare, Greeley, Colorado 80632.

tained good control of mosquito larvae in Alaska with as little as 4 ounces of 20% DDT spray per acre. More recently, according to Messenger (1963), the British obtained excellent results against locusts with their "Micronair Rotary Atomizer." Messenger (1963) tested this spray equipment and found it produced a more uniform droplet size than other equipment investigated. Further research on materials and equipment (Messenger, 1964) led to the practical use of technical malathion for aerial control of several insect species. Tests on grasshoppers (Skoog et al. 1965) and other insects showed that good control, at least in some situations, could be obtained with as little as 2½ to 4 ounces of technical malathion. The insecticide diluted slightly with oil or solvent was about equally effective. Dilution of the material improved the flow rate.

The results obtained in these tests have stimulated interest in the use of low volume sprays for the control of other insects. Two papers on the control of adult mosquitoes were presented at the recent meetings of the AMCA at Tampa, Florida.

A paper by Knapp and Roberts (1965) gave information on the control of adult mosquitoes in Kentucky with undiluted malathion. Good results were obtained with low dosages in these tests. Kills of other insects in the sprayed areas were also reported by the authors.

A paper by Glancey et al. (1965) presented the results of tests with malathion against adult salt-marsh mosquitoes in Florida. Applications of 2, 4, and 9.6 fluid ounces per acre gave kills of 91, 94, and 99.9%, respectively, in 24 hours. These authors noted that the percent kill was greater in the 24-hour counts than in counts made after 6 hours and suggest that residual malathion may extend control for several days.

In the Florida tests four of the especially designed miniature rotary atomizer nozzles developed by A. N. Higgins of the Plant Pest Control Division, Agr. Res. Serv., U.S.D.A., were used. These atomizers are screen sided cylinders fitted with small propeller blades which cause them to spin when the airplane is in flight. The mesh of the screen wall of the cylinder and the speed of spinning control the size of the droplet. The speed can be controlled by adjusting the propeller blades.

Tests of low volume airplane sprays for the control of mosquito larvae by T. D. Mulhern et al. (1965) were also reported at the Tampa, Florida meetings. These tests were made in California against several different species of mosquito larvae. A CallAir® plane equipped with four No. 8001 flat spray nozzles was used to apply undiluted technical malathion against mosquito larvae in the Merced area. The 33-foot boom had 4 nozzles. Two of the nozzles were inserted 29 inches from each end and the other two 117 inches from each end. The nozzles were placed in the boom so that they pointed backward at an angle of approximately 45° when the plane was on the ground. Applications of 0.5 lb. per acre of malathion gave kills of 60 to 67% and tests at higher dosages gave complete kills. Further tests with malathion were delayed by lack of suitable test plots in areas where the larvae were not resistant to this insecticide. Addition of an emulsifier in future tests will probably increase the effectiveness of this insecticide to mosquito larvae.

In addition tests with fenthion, or Baytex® as it is also known, were made with a 150-horsepower CallAir plane. Eight No. 8001 flat spray nozzles were used on the 34-foot boom for these tests. The nozzles were placed at the ends of the booms and at distances of 5½, 11, and 14 feet from the ends. This arrangement of the nozzles produced what appeared to be a quite even distribution of the spray droplets over a 66-foot swath width. A 60-foot swath width was used for this series of tests.

The fenthion-oil spray was tested at approximately 7 liquid ounces per acre. The 7-ounce application contained 0.1 lb. of technical fenthion and 8% B-1956 emulsifier (a glycerol phthalic alkyd resin). This was made up to the 7-ounce volume with a petroleum oil having a specific gravity of 0.9965.

A series of 4 tests of the 7-ounce-per-acre formula were made on third and fourth-instar larvae of *Aedes nigromaculis* (Ludlow) in irrigated pastures. The tests were conducted in the Tulare and Kings Mosquito Abatement Districts. The larvae in a number of test plots were highly resistant to parathion and some were also partially resistant to fenthion. Three of the tests in which 7 liquid ounces per acre were applied gave 100% kill in 24 hours and an 80% kill was obtained in the 4th test.

Results obtained in these tests suggested that application of 8 to 12 ounces per acre of this fenthion-oil-emulsifier combination may be effective in routine spray applications against larvae of *Aedes nigromaculis*.

Plugging of the small orifices of the spray nozzles on the spray booms may give trouble when nondiluted insecticides or insecticides and oil combinations are used. Installation of a screen filter between the tank and boom after these have been thoroughly cleaned usually solves this problem. Recycling of undiluted malathion through a bypass system that connects the spray pump outlet with the spray pump inlet is also recommended to warm the insecticide and prevent variation in its rate of delivery (Messenger, 1963).

In our California tests the effect of applying lower volumes of insecticide emulsion sprays for larval control was also investigated. Applications of 1 and 2 quarts per acre of fenthion and parathion emulsions were compared with those of 1 gallon per acre, the rate at which these materials have been widely used in California for a number of years. Applications of 1 and 2 quarts per acre were made by reducing the numbers of spray nozzles by ¾ and ½, respectively.

Applications of ½ gallon of emulsion per acre containing 0.1 lb. of parathion or fenthion gave complete kill in tests against larvae of *Aedes nigromaculis* in pastures and against several other species in rice fields. Effectiveness of 0.1 lb. of fenthion applied at 1 quart per acre ranged from 75 to 100%. Further evi-

dence of the effectiveness of the application at a half-gallon per acre was provided by the Fresno Westside Abatement District where 25,465 acres were sprayed at the half-gallon rate in August and September of last year and by the Eastside District which treated 10,000 acres at the same rate.

Low volume airplane sprays have many advantages. One of the most important will undoubtedly be the reduced cost per acre for insect control. Planes applying such small dosages will exhaust their fuel supply long before the insecticide tanks are empty, and pilots will need rest periods before either of these tanks need filling.

The use of technical or highly concentrated material may also present certain problems. It is understood that technical malathion has caused kill of bees in situations where little or no kill would have been expected with standard sprays. The possibility that greater residues and/or hazards might result from the use of technical or highly concentrated insecticides should not be underestimated. Also, spotting of automobiles by the concentrated spray of malathion was reported at the 21st Annual Meeting of the American Mosquito Control Association at Tampa, Florida.

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## CONCLUSIONS TO DATE FROM COOPERATIVE MULTI-PURPOSE WATER MANAGEMENT STUDIES CONDUCTED IN UTAH[1]


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A cooperative project was initiated in Utah in September, 1961 to study, develop, and improve water management practices applied to multi-purpose beneficial use of water. The water considered in this study is present along the southeastern shores of the Great Salt Lake and would eventually flow into the lake if not diverted. The water is being used principally to produce pasture for livestock, salt grass for harvesting, wildlife marshes primarily for waterfowl and muskrats with some fish and upland game birds, and various recreational facilities.

Preliminary and progress reports on this project have been prepared and released by Don M. Rees, Frank D. Arnold, Dean M. Andersen, and Glen C. Collett and are available on request. See attached references.

The research is being conducted on three adjacent areas: The Lake Front Gun, Fur and Reclamation Club, a privately owned club; Farmington Bay Waterfowl Management Area, operated for public use by the Utah State Department of Fish and Game; and the Wheeler Machinery Company Test Area, which is being developed for agricultural purposes and the propagation and management of wildlife, primarily waterfowl.

The source of this water is from run-off from irrigation, storm gutters and sewers, seepage from canals, discharge from industrial and municipal sewage treatment plants, streams originating in the mountains, and artesian wells and springs. Because most of this water has been used one or more times before it reaches the study areas, the term "reusable" water is applied to distinguish it from primary water use. The prior use of this water often impairs its quality and its beneficial uses are restricted by this impairment. As it passes through agricultural land, the water increases in salinity, and organic matter and bacteria are added from municipal and industrial wastes. The quality of the soil on the land where this water is used also restricts the beneficial uses of the water.

The land and the water in the study area can be beneficially used in the development of marshes for waterfowl and other wildlife and, to a limited extent, agriculture, especially in pasture land. Some current water management practices, or lack of water management, have resulted in the production of mosquitoes in a variety of situations. The present project is expected to provide demonstration areas that will show how certain kinds of water management practices can


[1] This research project is being supported in part by funds provided by the Research and Training Grants Branch, Division of Water Supply and Pollution Control, Public Health Service, Research Grant WP-00027.

minimize the production of pest and disease-bearing mosquitoes and at the same time increase crop yields, produce improved conditions for wildlife production and management, and improve other beneficial uses of the land and water in this and other similar areas. The approach to this study has been one of cooperative effort, planning, and research in which seven federal and three state governmental agencies, privately owned companies, and individual property owners have actively participated in the program with the principal investigators.

The methods and procedures and some of the results of this research have been presented in previously released reports.

Some of the conclusions supported to date as a result of this research program are:

A. WATER:

1. Because of the high salinity and the sodium hazard, water flowing into the Lake Front Gun Club and Farmington Bay Waterfowl Management Area is of limited agricultural value except for use in growing salt and alkali tolerant plants.
2. Endemic plants of value to waterfowl grow abundantly even though the water is of low agricultural quality.
3. Data gathered indicate that wildlife propagation is the most practical use of the water because of the saline conditions which exist in the water and the soils adjacent to the Great Salt Lake.
4. The water flowing into the Wheeler Machinery Company Test Area is of high quality and no restrictions are placed upon its use for agriculture.
5. Effluents of the sewage treatment plants in the study areas are considered to have limited beneficial use without additional treatment. It should be noted that three of the plants will have the effluents chlorinated early in 1965. This should result in a considerable improvement in water quality of the effluents from these plants.
6. The water supply into the study area varies both on a seasonal and a yearly basis. In 1964 the daily mean discharge per month varied from 58.4 cfs to 528 cfs in the Surplus Canal, the water source for the Lake Front Gun Club.
7. This variation results from changes in the amount of precipitation and from the varying amounts used by prior water users.
8. This extreme variation in the water supply is a necessary consideration in planning a water management program for mosquito control and waterfowl management.

B. MOSQUITO CONTROL AND IRRIGATION

1. Productivity on agricultural land can be increased through draining, leveling, fertilization, and the application of proper amounts of water.
2. Adequate facilities for uniform and rapid distribution of the water over the unit to be irrigated are necessary for irrigation.
3. Adequate facilities for rapidly removing the surface water from the irrigated unit are also essential.
4. The above measures will reduce or eliminate mosquito production on agricultural land.
5. Adequate disposal of the irrigation run-off water is a necessary element of mosquito control and improvement of the water and soil on these study areas.

C. MOSQUITO CONTROL AND WILDLIFE MANAGEMENT:

1. Not all parts of the marsh are mosquito producing and not all areas which produce mosquitoes are equal in productivity.
2. Not all marsh areas are equally suitable for wildlife production and management.
3. Some of the factors which affect mosquito production and distribution on a marsh are the type and density of the vegetation, water depth, water fluctuation, water quality, climatic conditions, and the mosquito control measures applied.
4. These same factors affect the production and distribution of waterfowl and other wildlife.
5. Six species of mosquito larvae and seven species of adults have been collected in the study areas.
6. Vegetated areas from which the water is repeatedly removed and reflooded are high in mosquito production, especially of *Aedes dorsalis*, a flood water mosquito. These areas are generally characterized by salt grass (*Distichlis stricta*) vegetation.
7. Salt grass areas shallowly flooded (4-8 inches) are also highly productive of *Culex* and *Culiseta*, the more permanent water mosquitoes, if the water remains for two weeks or more when climatic conditions and other requirements are suitable.
8. Salt grass that is repeatedly flooded provides a hazardous habitat for duck nests and is of little value in providing food for ducks. Salt grass which is not flooded during the mosquito season is used extensively and safely by ducks for nesting, and without flooding salt grass areas do not constitute a mosquito problem.
9. Mosquito production in emergent marsh plants such as *Scirpus olneyi, Scirpus acutus, Scirpus paludosus* (bulrushes) and *Typha* sp. (cattails) varies with the vegetative type and density and the water depth but it is generally lower than in the flooded salt grass.
10. These emergent marsh plants are used by waterfowl for nesting and food.
11. No mosquito production was found in the submergent vegetation (*Rupia maritima, Potamogeton pectinatus* and *Chara* sp.).

12. These submergent plants are used extensively for food by the waterfowl.
13. Water management practices such as water confinement, permanent impoundment, controlled water depth, controlled seasonal drawdown, permanent removal, and controlled flood irrigation can materially reduce mosquito production.
14. Through water management, plants that are desirable for food, nesting, and cover can be greatly increased in number and more widely distributed on the units.
15. Water management practices for mosquito control are compatible with approved waterfowl management practices.
16. Physical facilities such as dikes, channels, drains, access roads, and adequate inlets and outlets are essential for proper water management. Modification of terrain through shore line improvement and deepening of ponds is also necessary in some areas to facilitate water management practices suitable for waterfowl and destructive for mosquitoes.
17. Mechanical or chemical control of vegetation may be desirable in some areas for both mosquito control and wildlife management.
18. A water management program suited to the multipurpose objectives of the water on each unit and the requirements necessary to integrate and accomplish these objectives should be formulated by all persons who are concerned with the water and land use in a particular unit.

A detailed report and discussion of these conclusions is presented in the third annual report of this research project (Rees et al. 1965).

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## CURRENT INSECTICIDE PROBLEMS


Reed S. Roberts and George F. Knowlton

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As we consider the control of mosquitoes by means of chemicals, 1964 might be called the year of the big "Pull-Back." Last year we recommended withdrawal of nearly all control uses for the chlorinated hydrocarbons, especially if there was the slightest chance that forage crops or dairy cattle would be affected in any way. With the development of rapid gas chromatography methods which will detect pesticide residues in food, in parts per billion, it became necessary to adopt different control procedures to keep the residues out of the food. We have had to drastically readjust some of our agricultural and mosquito control spray programs in order to comply with the current restrictions.

Securing maximum mosquito control, with minimum cost, and without creating any objectionable residue problems in the face of changing standards, has presented a continuing challenge to mosquito abatement people. Maintaining good public relations while adjusting to these changes is essential in keeping public support and acceptance of our work.

This year, as in 1964, we need to exercise caution in the use of DDT, TDE or DDD, dieldrin, BHC, endrin, lindane, chlordane, heptachlor, deutero-DDT, aldrin, and other chlorinated hydrocarbons. These chemicals must not be applied to alfalfa or other forage crops or pastures if there is any possibility that this feed would then be consumed by dairy cattle. As long as the tolerance for pesticides in milk remains as zero, these and related pesticides should be used only in areas where they will not create any problems. Heifers which will freshen within one year should not be pastured on grass being treated with the above named chlorinated hydrocarbons, or fed upon alfalfa seed crop chaff or similar feed if any of these chemicals were used on the growing plants.

The phosphate insecticides, such as malathion, parathion, methyl-parathion, diazinon, Baytex, Dibrom, and Vapona, are in the organophosphate group. Some of

these tend to be much more poisonous to operators than are the chlorinated hydrocarbons, so due care must be taken while handling and applying them. Parathion and meta-parathion are considered highly toxic. When these compounds are used, be sure to follow all of the safety measures listed on the printed container label. After waiting the designated number of days, following application with a phosphate insecticide, treated crops may be harvested and fed to stock without fear of pesticide residues appearing in the milk.

The fact that some insecticide formulations tend to drift easily, from their site of application to crops in nearby fields, creates problems of residue contamination. Dusts often drift very long distances, thus, the use of granules or sprays should be considered under many of our conditions. When the wind is 5 miles per hour, spray drift can contaminate food and forage crops some distance away. Drift of pesticides must not be permitted to create serious problems.

In the home we can use the "bug bombs," or one of the following commercial household sprays or home mixed sprays, as follows: 2 percent chlordane in oil or water, 5 percent DDT, 0.5 percent dieldrin, 1 percent malathion or 0.5 percent dichlorvos. These chemicals should be kept out of the reach of children.

We should not apply aldrin, dieldrin, BCH, or lindane over crop land where their use would result in objectionable tastes or residues with root crops. This matter becomes even more important when one realizes that some of these chemicals will persist in the soil for several years.

A whole series of new pesticides is in the process of being developed. A number of these have shown excellent promise against larvae or adult mosquitoes. However, until these are fully developed and have received federal registration they should be used only on an experimental basis, and then only in areas where they will not contaminate cattle feed or foods.

We are not yet to the place where chemosterilization of mosquitoes by Apholate, Tepa, Metatepa, or some related control chemical is likely to revolutionize our control practices. Large scale tests in the foreseeable future, using these newer pesticides, attractants and repellents, if proven successful, could result in new mosquito abatement practices.

Some of our problems which are of public concern, relate to misuse, carelessness, neglect and ignorance as to how to use pesticides. To establish the best possible public relations, a continuing public educational program is necessary.

The public may need to know that the success of our program is often adversely affected by unusual weather conditions, restrictions concerning the use of common insecticides, and the development of resistance to insecticides by the mosquitoes. An adequately informed public is more likely to continue its support of our abatement programs when things don't go just right than will an uninformed or misinformed one.

If we are unable to materially reduce the number of mosquitoes within an area for some reason, maybe we'd better tell the people why. Otherwise they may feel that the program is ineffective. Too often, the presence of mosquitoes within the confines of an abatement district is interpreted by critics as evidence that mosquitoes cannot be controlled or else that the program is poorly managed.

Maybe we need to explain to the public again and again the difference in meaning between the terms control, abatement and eradication. To some people, if we haven't gotten rid of all of the mosquitoes, gnats, midges, crane flies and mayflies, we haven't controlled the mosquitoes. Do they know that eradication cost ten times more than control? Even then it would likely be impracticable. We need to keep the public informed as to the changing needs in mosquito control procedures.

In the interests of good public relations we must not jeopardize someone else's forage crops or honey bees through drift or careless application of pesticides.

Our product is a well-managed mosquito abatement program. We need to keep the quality of our product high and to accomplish this we need the support of an intelligent and well informed public.

## SOME ASPECTS OF MOSQUITO CONTROL IN CALIFORNIA

JOE D. WILLIS, *Manager*
*Shasta Mosquito Abatement District*
*Redding, California*

During the past three years, I have had the opportunity of visiting all but a few of the mosquito abatement districts in the State of California. In California there are 49 mosquito abatement districts, 2 pest abatement districts, 3 county health departments, 1 flood control district and several cities carrying on mosquito control, and I have certainly found a wide variety of control methods used by these local departments.

In many of these districts, because of their size and the nature of the sources created by the extensive use of irrigation water, their primary control is by the use of airplanes. It would not only be impractical but impossible to obtain mosquito control by any other method; and, when we compare the cost per acre, we all realize, especially those of us who are unable to use planes, that control can be achieved much cheaper on a per acre basis this way than to still use the old power and hand spraying methods. Unfortunately, many of us, because of the size of our districts and the physical makeup of these districts, are unable to make use of airplanes for larviciding purposes; and we, therefore, must still rely on power sprayers, misting machines, and hand spraying in our larviciding program.

Aerosoling, to control adult mosquitoes, was extensively used in California a few years ago; however, it is now only occasionally used by some of the districts as an emergency measure.

Our District, in Shasta County, with an area of about 100 square miles, is located at the north edge of the Sacramento Valley and includes both valley and

foothill areas. There are three cities within the District and a large number of rural subdivisions. At least in our District, and I believe this is true in most districts, it has not been necessary for the mosquitoes to come to the people, the people have gone to the mosquitoes. The suburban sprawl is bringing more and more people into contact with agricultural and wilderness areas and, in turn, to mosquitoes.

In the early days of mosquito control in California, the major sources were inland swamps, tidal marshes, foothill streams, and the pools and ponds left by the dredging operations of the gold seekers. Such is not the case now. Agriculture, in the form of rice culture, irrigated pasture, alfalfa, and cotton, rapidly replaced and surpassed these native areas as sources of mosquitoes. Many areas of California are now in the midst of a third era where houses have replaced pastures, shopping centers and industrial sites occupy former cotton fields and orange groves. The mosquito control operator, who used to travel the open fields, is now going from house-to-house looking for sources of *Culex pipiens*.

At the present time, the population of our State is approaching 19 million. The population is increasing at the rate of about 16 hundred people per day. In less than a year and a half, this population will be over 20 million people. Those in the State, who are charged with the responsibility of planning for the future of California, are looking ahead to a population of over 40 million people by the end of the Century. The 60 local agencies involved in mosquito control are hard-pressed to keep pace with this population explosion. These agencies are spending well over 6 million dollars a year for mosquito control in an area of about 36 thousand square miles. However, in the Central Valley of California, there are still large areas where there are severe and uncontrolled mosquito problems. Fortunately, there have been no recent serious outbreaks of mosquito-borne diseases in these areas and, therefore, because of lack of assessed valuation and various other reasons, no districts have been formed. This often creates a severe problem for the districts that are located in these valleys, since, in many cases, it is just a simple matter of mosquitoes flying over an imaginary line from these uncontrolled areas causing considerable annoyance to adjacent districts.

There is no doubt that, in future years, there will be thousands of square miles added to mosquito abatement districts. At the present time, there are well over 8 millon acres under irrigation in the State. With the completion of the California Water Plan, there will be at least 16 million acres under irrigation. Thus, it is imperative that mosquito control be extended to these areas.

One of the major problems associated with the rapid population increase in California is the demand for the development of additional recreation facilities. Many of our mountain areas, while providing tourists, vacationers, and sportsmen with unparalleled opportunities for camping and fishing in beautiful surroundings, also provide them with hordes of viciously biting "snow mosquitoes." No fisherman, who has made an early spring hike into a sierran meadow, will ever forget them! During the past 3 or 4 years, Colonel Stanley Carpenter's investigations into the biology and ecology of these mosquitoes in California has provided much needed information on methods of providing control over these high mountain species.

California is a remarkably diversified State. It might be well to explain a few of the variations that we have in California which make our mosquito control work somewhat different from some of the other areas of the United States. There are about 1,200 miles of sea coast with thousands of acres of marsh land areas. We have vast mountain areas with many peaks almost three miles high. There is the great Central Valley of California which stretches over 400 miles from North to South. Temperatures range from the subtropic to the artic. Precipitation ranges from less than two inches, in many parts of the Southern deserts of California, to 10–20 inches in the Central Valley and to well over 100 inches in some of the Northern Coastal and inland areas. There are over 18 million acres of forest and over 14 million acres of cultivated, urban and industrial lands. It is not an exaggeration to say that much of this beautiful and productive area of our State would be uninhabited were it not for the dedicated work of well over 600 employees of mosquito abatement districts.

Historically, the mosquitoes were identified with the stagnant waters of swamps and marsh lands. That was where mosquitoes came from. More and more this is changing as many of these areas are being reclaimed. Now the mosquitoes come from the very lands we grow our crops on, and this complicates our control efforts. We must go on private property to control the mosquitoes, and we must control them in such a manner that we do not interfere or damage whatever the farmer is producing. This will be compounded as the central water system advances towards completion. Many of these areas will become multi-purpose in the near future which makes the solution of these problems more complex. We are now finding it necessary to recharge our underground water supplies by the surface spreading of vast amounts of water; there is also a growing need for adequate water for water-fowl protective areas. The ground disposal of sewage, from this growing population, in oxidation ponds and waste stabilization lagoons, has also added sizeable areas of surface water.

Many of these areas, in addition to being favorite producing areas for mosquitoes, also are producing great masses of gnats and midges which, in many parts of California, have already created serious problems. At the present time, many districts are involved in gnat control, several mosquito abatement districts are already involved in fly control, and one district is actively carrying on wasp control. In our own area, ten years ago there was no thought of gnat control. However, during the past two years, we have been actively investigating the gnat problems in our District in preparation for the eventual necessity of providing control over these noxious insects. All of this tends to show that the future operational control problems which face

mosquito abatement districts in California are very complex. Hopefully, the research programs of the State Department of Public Health and the University of California will provide us with answers to some of these problems. Since the beginning of mosquito control in California, we have been helped and guided, in our efforts to obtain good mosquito control, by these two agencies. This has certainly been a major help in coordinating our programs through the State. Recently there has been developed, through the efforts of many people within the organization of mosquito abatement districts, the State Health Department, and the University of California, a joint committee on arthropods of health importance. This committee has been established to review all vector control research to assure that it is necessary, that the University and the State Health Department carry on complementary programs, and to eliminate the duplication of efforts between the two agencies. I believe that this is probably the best thing that has happened for the future of mosquito control in California. This will greatly expand research on mosquitoes in California and, as a result of this intensified effort, I believe we will soon have some of the answers we have been seeking for so many years.

I might briefly mention one of our problems on which expanded research is planned and which is of vital concern to mosquito control workers in California. This is the rapidly progressing resistance of mosquitoes, particularly *Aedes nigromaculis* and *Aedes melanimon* to the organic phosphate insecticides. These mosquitoes have succeeded in becoming increasingly resistant to ethyl and methyl parathion, malathion and apparently may be able to have the same degree of success with fenthion (Baytex). The research program of the Bureau of Vector Control calls for an intensive surveillance program to detect the development of and the degree of resistance to these insecticides by mosquitoes during the coming year. Investigations into environmental factors, which may be contributory to the appearance of resistance, will be a part of this surveillance. Basic research-seeking, to explain the physiology of mosquito resistance to organic phosphate insecticides, is also a major activity of the Bureau of Vector Control's investigation unit. If we are to continue to rely on insecticides as a major weapon to control mosquitoes, we must have the answers to some of these questions.

Last, but not least, I would like to mention something about the activities and problems of the association of mosquito abatement districts in California. This association had its beginnings around 1930 and, during the past 35 years, has developed into a valuable and effective organization. There are presently 45 corporate members, including all but a few of the active mosquito control agencies in California. Through the board of directors of the association and the numerous active committees, a constant effort is being made to improve the effectiveness of mosquito control in the State.

Recently a special committee of the California Mosquito Control Association has been attempting, and we hope successfully, to obtain special registrations of emulsifiable fenthion and parathion formulations for the exclusive use of mosquito control districts in California. These registrations would, in effect, separate the special usages, which mosquito abatement districts make of these materials, from the agricultural applications, which are bound by certain restrictions, incompatible with effective mosquito control.

In closing, I would like to leave this thought with you; much of the work of a mosquito abatement district goes unnoticed. The importance of your job can be likened to housework. The only time it is actually noticed is when you don't do it.

## LARGE SCALE GRANULAR PARATHION PRE-TREATMENT OF A DUCK CLUB AREA IN THE COLUSA MOSQUITO ABATEMENT DISTRICT

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The Colusa Mosquito Abatement District was formed in 1958 and consists of 140 square miles. A considerable problem to the District has been the Butte Sink, a 15 square mile area of Sutter County lying east of the District at the foot of the Sutter Buttes and north of Sacramento 70 miles. This area is composed mainly of privately-owned duck clubs. Beginning in August of each year, this land is flooded to attract ducks. Shortly thereafter, very heavy populations of *Aedes melanimon* move into the District's eastern boundary and subsequently into the City of Colusa.

In the past, the District has made some attempt to protect the City of Colusa by selective aerial adulticiding the thermal aersol outside of the populated area, but the efforts have been largely futile due to the large area involved. Since the District budget was insufficient to control this area, it was obvious that control could only be attempted if the area were annexed. Annexation proceedings were therefore initiated, and in January, 1964, the Butte Sink became part of the Colusa Mosquito Abatement District.

The control method decided upon was granular parathion, applied as a pre-treatment. Accordingly, aerial photographs of the Sink were purchased and maps of the treatment area were prepared. The California Department of Fish and Game was notified two years prior to the treatment to allow them sufficient time for any test experiments which they might feel would be necessary. They were again notified immediately prior to the first treatment date and invited to monitor the control program to determine whether or not any deleterious effects upon wildlife occured. They had performed laboratory tests to determine if doves and pheasants could be killed by granular parathion prior to flooding of the area, and also observed the Sink after treatment for evidence of bird kill. Their findings showed that doves, but not pheasants, would accept the granules when penned in the laboratory, but

field observations indicated no evidence of damage to doves.

A 450 H.P. stearman equipped with a venturi spreader, was calibrated to deliver two pounds of 5% Durathion volclay granules per acre over a 50 foot swath, resulting in a dosage of 0.1 pound per acre of actual toxicant. The presence of tall willow and cottonwoods precluded the use of conventional ground flags, but some type of marker was necessary because of the lack of landmarks and the long aircraft runs. Weather balloons inflated with hydrogen were therefore anchored to cords which allowed them to float about 175 feet above ground at spaced intervals. The pilot found that the balloons were visible for a considerable distance. These balloons when inflated, attained a size of 3½' to 4' in diameter .

Preliminary estimates of the necessary amount of material were prepared on the basis of acreage measured from the aerial photos. The calculated area was 8140 acres, requiring 16,280 pounds of granules: the actual total applied was 16,800 pounds. Two adjoining control agencies, the Sutter-Yuba and Butte County Mosquito Abatement Districts, contributed two and four tons of granules respectfully, since each was plagued by some of the mosquitoes from this Butte Sink area. The two M.A.D.'s also provided a man to assist with the balloons as markers. The balance of the man power, granules, and flight time was assumed by the Colusa M.A.D.

The control was generally excellent. Larval inspections after flooding showed that a miss had occurred at one site; hand treatment in a limited area took care of the problem. Subjective observations of the smaller numbers of *A. melanimon* in and near the City of Colusa were supported by the results of light trap collections. In late September and early October, 1964 counts were less than 10% of the 1963 levels.

## PROGRESS IN MOSQUITO CONTROL IN UTAH COUNTY

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*City-Council Health Department of Utah County*
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Utah County experienced its first full season of mosquito control in 1964. Many of the problems of a new program were encountered in 1963 when control measures were carried out during August and September.

The late snow storms were responsible for an unusually large amount of breeding area in low lying pastures adjacent to Utah Lake and the Provo River. These in addition to the usual breeding areas proved too much for the small control force to cope with early in the year. After this early problem, control measures were adequate in most parts of Utah County for the remainder of the year.

Aerial spraying was used extensively during the spring and early summer months in an attempt to control the large populations of *Aedes dorsalis*. Liquid parathion was used in most cases with liquid Baytex being used on a trial basis in some areas. Fixed wing aircraft was used primarily, however, helicopters were used to spray 900 acres in May with excellent results.

Parathion and Baytex were used at a rate of 0.1 pound per acre in both spray systems. These were mixed with diesel fuel when applied by fixed wing, and water when applied by the helicopters. The rate of application of finished spray was one gallon per acre with the oil sprays and two gallons per acre with the water sprays. There has been no indication of plant damage in areas treated with the oil sprays.

In using Baytex to treat some of the persistant breeding areas, it was hoped that a sufficient residual effect could be obtained to reduce the frequency of applications as compared to parathion. This residual effect was obtained in one large marsh area of 600 acres at the north end of Utah Lake. A water spray was applied by helicopter at a rate of two gallons containing 0.1 pound Baytex per acre. This was applied in late May 1964. This area was not treated by air for the remainder of the season. Further treatment was required only in small areas easily controlled with 1% parathion sand core granules applied with the Skeeter Bater. This does not mean that near total control was achieved with this one application. The application of insecticide coincided with the pumping of water from Utah Lake into the Jordan River to be used for irrigation in Salt Lake County. This resulted in lowering the lake level and the water receded from the large marsh area by mid June.

Applications of Baytex in oil using the fixed wing aircraft were at a rate of one gallon containing 0.1 pound per acre produced varying results. In some instances a residual was obtained but in others it was not noticeable. The reasons for these differences are not known.

Control personnel used Baytex in power sprayers and to a limited extent in knap-sack sprayers. The most widely used individual piece of equipment was the Skeeter Bater in the application of granular parathion.

One interesting incident occurred in May of 1964. Several isolated ponds in railroad borrow pits were present in one general area. Inspection showed all to be good producers of mosquitoes with one of the ponds having a predominance of pupae. Those ponds with larvae were treated with 1% parathion sand core granules while the pond with pupae was treated with an oil and Baytex mixture. The oil and Baytex had been mixed for use in a fog applicator but was the only oil immediately available. This was applied by a knap-sack sprayer at a standard rate. Weekly inspections followed showing larvae to be present at each inspection in ponds treated with granular parathion. Larvae did not reappear in the pond treated with the oil and Baytex until the sixth week following treatment.

The 1965 program will be operated on the same budget as 1964, $32,815.00. A small percentage of this amount will be used to purchase new equipment while most of it will be spent for salaries, insecticides, air

spray services, and maintainance and operation of present vehicles and equipment.

Field supervision of the program will be the responsibility of the City-County Health Department of Utah County as has been the case in the past.

# COMPARISON OF THE OVIPOSITION PREFERENCE IN THE MOSQUITOES **AEDES DORSALIS** AND **AEDES NIGROMACULIS** TO SODIUM CHLORIDE CONCENTRATIONS[1]

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*Aedes dorsalis* (Meigen) and *Aedes nigromaculis* (Ludlow) are mosquito species known to develop in irrigated pastures. Where both occur they are generally believed to co-inhabit the same waters. However, upon more critical inspection it has been found that within the same pasture some areas appear to be almost entirely inhabited by *A. dorsalis* while in others both species are present. It is also evident from these inspections that the immature stages of *A. dorsalis* are present in marshes with relatively high salt concentrations and the immature stages of *A. nigromaculis* do not appear in these areas. It thus seems apparent that *A. nigromaculis* is more selective or responsive to environmental factors or is less tolerant than *A. dorsalis* to environmental conditions which affect development of the immature stages.

The work to date on habitat differences appears to favor oviposition site selection preference by the female rather than factors affecting development of the immature stages. This is also the opinion of Wallis (1954) and De Zulueta (1950).

From results obtained from 150 quantitative chemical analysis for soluble salts from selected breeding areas of these two species, it appears evident that soluble salt concentrations and/or kinds exhibit an important influence upon whether or not a given species will oviposite in a particular area.

In this study wild females of both species were collected in the field every three to four days, allowed to take the blood meal from a guinea pig and then the two species separately placed into cages 20" x 9" x 9". In these cages 10 petri dishes were placed containing a range of sodium chloride salt concentrations. Two of each of five concentrations were used in each cage at dilutions of 0, 0.5, 1.0, 1.5, and 2.0% chloride ion (not to be confused with percent sodium chloride). Each dish contained 50 ml of solution in which paper toweling was placed in such a way as to form a wick of 50 sq. cm to serve as an oviposition site when moistened by the given solution.

The dishes were removed and the eggs counted every three days, and fresh solutions placed in the cages. Each time the ten dishes were placed into the cages completely at random, in order to offset as nearly as possible any location within the cage which might be more favorable to oviposition.

The cages were kept at a humidity of 80% during the tests, with 12 hour light and dark periods. The temperature ranged from 72° to 77°F throughout the test period.

During this study 14,696 eggs were obtained from a total of 285 *A. dorsalis* females averaging 51.6 eggs per female over a 35 day period. Due to very low yields of eggs from *A. nigromaculis*, averaging 14.4 eggs per female, only 2,254 eggs were obtained from 153 females of this species during the test period. There was, however, a very marked preference shown to the salt free oviposition sites by the latter species. The results are summarized in the following chart.

| Salt Concentrations | | *Aedes dorsalis* | | *Aedes nigromaculis* | |
|---|---|---|---|---|---|
| In % Cl | In % NaCl | No. eggs laid | % of Total | No. eggs laid | % of Total |
| 0.0 | 0.0 | 3,759 | 26 | 1,223 | 54 |
| 0.5 | 0.82 | 4,849 | 33 | 572 | 25 |
| 1.0 | 1.65 | 2,761 | 19 | 255 | 11 |
| 1.5 | 2.47 | 2,237 | 15 | 181 | 8 |
| 2.0 | 3.4 | 1,090 | 7 | 23 | 1 |
| | | 14,696 | | 2,254 | |

## CONCLUSIONS

As a result of this preliminary work, it appears evident that the ovipositing females of both species show definite selective response toward the presence or absence of sodium chloride and to variations in concentrations of the salt.

*A. nigromaculis* appeared to prefer no sodium chloride to any of the concentrations available to them during the study as 54% of the eggs were deposited on distilled water. A sharp decrease in preference was exhibited by this species to the presence of sodium chloride and to increases in concentrations of the salt.

*A. dorsalis* exhibited a greater preference for 0.5% CL concentrations to distilled water with 33% of the eggs deposited on 0.5% CL and 26% on distilled water. A decreasing preference was shown to concentrations of 1.0% CL and higher by this species.

It is too early in the study to be sure how much of the overall difference in oviposition in the two species is due to salt concentrations in the selection of the oviposition site and the number of eggs deposited. The low percentages of eggs obtained from both species seems to indicate that other important factors such as possibly color of the oviposition sites are necessary for complete deposition of eggs.

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[1] This research is being supported by funds provided by the National Institute of Health Predoctoral Fellowship F1-GM-24,213

# PROCEEDINGS OF THE
# NINETEENTH ANNUAL MEETING
OF THE
# UTAH MOSQUITO ABATEMENT ASSOCIATION

*held at the*

UNION BUILDING LITTLE THEATER
UNIVERSITY OF UTAH
SALT LAKE CITY, UTAH
September 12 and 13, 1966

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# RESOLUTION

*Whereas, Oscar Vernon Lopp devoted his talents, time, and efforts to improve the health and comfort of his fellow man and in so doing developed an outstanding mosquito abatement district in California, and*

*Whereas, he provided effective leadership in developing cooperative efforts between fish and wildlife management and mosquito control agencies in an effort to preserve our wildlife heritage and eliminate the nuisance of mosquitoes and the threat of mosquito-borne diseases, and*

*Whereas, he willingly shared his knowledge and accomplishments with others and, at the time of his sudden and fatal illness, was giving greatly appreciated and valuable assistance to the people of Utah in an effort to help improve mosquito control and wildlife management programs in this state, and*

*Whereas, his talents were great and his accomplishments were many and significant and have resulted in making the world a more pleasant and better place in which to live,*

*Therefore, be it resolved that members of the Utah Mosquito Abatement Association and other friends in Utah hereby express their appreciation for the friendship, association and assistance of Oscar Lopp, and extend to his family and many friends in California our deepest sympathy and an expression of regret for our mutual loss.*

UTAH MOSQUITO ABATEMENT ASSOCIATION

LARRY NIELSEN, *President*

September 15, 1966

# PROCEEDINGS OF THE NINETEENTH ANNUAL MEETING UTAH MOSQUITO ABATEMENT ASSOCIATION

## UTAH MOSQUITOES — THEIR PUBLISHED HISTORY: SUPPLEMENT II

LEWIS T. NIELSEN[1] AND JAY H. LINAM[2]

This is the second supplement to a paper by Linam and Nielsen which appeared in the Proceedings of the Sixteenth Annual Meeting of the Utah Mosquito Abatement Association in 1963. This supplement contains references to Utah mosquitoes which have appeared since the first supplement was published.

In 1964, the Utah Academy of Sciences, Arts and Letters, published the *Cumulative Index, 1908–1958, Utah Academy of Sciences, Arts and Letters*, prepared by Margaret W. Schell. This index brought to the attention of the authors several previously overlooked papers which are now included in this supplement.

Abbreviations used are CMCA (California Mosquito Control Association), UAS (Utah Academy of Sciences, Arts and Letters), UMAA (Utah Mosquito Abatement Association.

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## REVIEW OF PROGRESS IN COORDINATED CONTROL

By KENNETH D. QUARTERMAN[1]

The previous speaker, who was the first Chairman of the National Mosquito Control-Fish and Wildlife Management Coordination Committee, has outlined the activities of the Committee during its initial years. During this period the Committee carried on extensive correspondence with the directors of all of the existing mosquito abatement districts, fish and wildlife management workers, State agencies with responsibilities for mosquito control or wildlife conservation, research fund granting agencies, and colleges and universities having departments of entomology, zoology and/or fish and wildlife management. The purpose of this correspondence was to have the workers in mosquito control and fish and wildlife management define problems in their respective areas that affected both groups, to bring these to the attention of potential research and research fund granting agencies, to urge joint participation by representatives of both groups in any research projects undertaken to find solutions to the problems that had been presented, as well as for other similar problems that might arise in the future, and to stimulate the formation of local, state and regional coordination committees, patterned after our National Committee.

In the past several years, the Committee has devoted most of its efforts toward the stimulation of, and participation in, regional conferences on mosquito control and wildlife management. The objectives of these conferences have been to bring the professional workers of the two groups together so that they might become better acquainted with each other on a person-to-person basis, to provide a forum for the exchange of information and views on their respective activities and problems of mutual interest, and to promote the establishment of local, state or regional coordination committees.

Our Committee co-sponsored and participated in the two Conferences on Mosquito Suppression and Wildlife Management, held at Yosemite National Park in October 1962 and May 1964, that were stimulated and organized primarily by the California Mosquito Control Association. As a result of the first of these conferences, your Utah Mosquito Control-Fish and Wildlife Management Coordination Committee was formed, the first State committee of its kind. Following the second conference, the California Mosquito Suppression-Wildlife Management Coordinating Committee was established.

In November 1964, our Committee organized and participated in the First Gulf Conference on Mosquito Suppression and Wildlife Management that was held at Lafayette, Louisiana. As outgrowths of this conference, there were established a local coordinating committee in Lee County, Florida, under the name of Southwest Florida Conservation Clearinghouse, and a regional committee, called the Northern Gulf Coordinating Council on Wildlife Management and Mosquito Control, serving Mississippi, Louisiana and eastern Texas.

Most recently, our Committee organized and participated in the Northeastern Conference on Mosquito Suppression and Wildlife Management at Newton, Massachusetts in April 1966. This conference was co-sponsored by the Commonwealth of Massachusetts in April 1966. This conference was co-sponsored by the Commonwealth of Massachusetts Department of Natural Resources, Commonwealth of Massachusetts Division of Fisheries and Game, Commonwealth of Massachusetts State Reclamation Board, Massachusetts Audubon Society, Northeast Division of the American Fisheries Society, Northeast Section of the Wildlife Society, Northeastern Mosquito Control Association, University of Massachusetts College of Agriculture, and our National Committee. The conference was well attended, and some interest was expressed in establishing state or local coordinating committees, but we have not yet been informed of the actual formation of any such groups.

The Southwest Florida Conservation Clearinghouse is made up of representatives of the local news media, Lee County Conservation Association, Southwest Florida Audubon Society, U.S. Fish and Wildlife Service, Isaak Walton League, Florida Forest Service, Lee County Mosquito Control District, and other organizations having an interest in conservation. The SFCC meets monthly. On a rotation basis, each member discusses the activities of his particular organization, with the program each month being devoted to a single organization's activities. In this way everyone has become reasonably well acquainted with what is going on in the county with respect to mosquito control and conservation. Special problems may be brought up for consideration at any meeting. Outside speakers are also brought in occasionally to talk on subjects of mutual interest to the community. The Clearinghouse also acted as host for the Florida Conservation Week, October 24–30, 1965. This was a major endeavor for the young committee, but everyone gained much in understanding and information relating to the complex work of conservation. While such projects are of real value, the main purpose of the Clearinghouse remains to provide a forum where any interested agency or individual can present proposals for new projects or discuss problems which may be of concern to the group.

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Your own Utah Committee is perhaps the best example of a State-level coordinating group in action. The program of this meeting is ample evidence of the beneficial relationships that can be achieved by the cooperative efforts of such a committee.

The Northern Gulf Coordinating Council on Wildlife Management and Mosquito Control held its first annual meeting in New Orleans, Louisiana in December 1965. This group has plans to broaden its activities on a more regional basis and perhaps change its name to the Gulf States Council on Wildlife, Fisheries, and Mosquito Control, with State-level segments holding their own meetings as required and the regional council meeting periodically every few years. In this area there are many diverse groups affected, including rice growers, cattlemen, crawfish farmers, oil producers, fur trappers, water-way managers, mining industries, and land developers, as well as the usual mosquito control and fish and wildlife management workers. The breadth of interest in the coordination groups is well illustrated by the fact that its current Chairman is a biologist employed by a commercial sulfur producing company in Louisiana.

From this brief discussion, it is obvious that the concept of local, state and regional coordinating committees to deal with the day-to-day problems involving both mosquito control and wildlife management and conservation, is gaining wide acceptance. The clearly demonstrated benefits that have resulted from the activities of such committees as have been established to date are stimulating others to follow their examples.

The concept of coordination in pest control activities has become widely accepted in the control of pests. The Armed Forces Pest Control Board, which grew out of a scientific group established just prior to World War II, coordinates requirements for and reviews research on pest control measures within the Department of Defense and coordinates such programs with other agencies. Among other things, the Board investigates and makes recommendations concerning new products and methods of pest control, and thus effectively controls the kinds of pesticides and formulations available on the military standard supply list. The Board is comprised of representatives of the Army, Navy, Marine, Air Force, and Coast Guard, and has liaison representation from the U.S. Public Health Service, Department of Agriculture, and U.S. Fish and Wildlife Service. New pesticides, before being considered by the Board, must be recommended by one or more of the liaison agencies mentioned above. The Board prepares technical information, arranges for training of military entomologists, and represents the Department of Defense on other committees and governmental and scientific groups.

The Vector Control Subcommittee of the Interagency Committee on Water Resources has been active for some years in promoting the control of mosquitoes and other aquatic pests through the more efficient use of water, particularly irrigation water. This Subcommittee has representation from all of the Federal agencies concerned with water management, such as the Public Health Service, Agriculture Research Service, Soil Conservation Service, Bureau of Reclamation, U. S. Army Corps of Engineers, Fish and Wildlife Service, Tennessee Valley Authority, etc. The Subcommittee has stimulated, and representatives of its member agencies have participated in, a number of research and demonstration projects on water management. Most of these are in the West, and you are no doubt already familiar with some of them, especially those carried out here in Utah.

The most influential of the coordination groups in the country is the Federal Committee on Pest Control (FCPC). This Committee was first established in 1961 as the Federal Pest Control Review Board, by joint action of the Secretaries of the U.S. Departments of Agriculture, Defense, Interior, and Health, Education and Welfare. The Board was reorganized as the FCPC in July 1964, again by joint action of the Secretaries of the four Departments.

Membership on the FCPC is by appointment by the Secretary of each Department represented. Each Department names two members and two alternates. Current membership includes representatives from the Forest Service and Agricultural Research Service in the Department of Agriculture, the Public Health Service and the Food and Drug Administration in the Department of Health, Education and Welfare, the Office of the Secretary and the Bureau of Sport Fisheries and Wildlife in the Department of the Interior, and the Office of the Secretary and the Armed Forces Pest Control Board in the Department of Defense.

The FCPC annually reviews all pest control programs conducted by or supported by in any way, any unit of the Federal government. Since most State agencies receive Federal funds to support their programs of pest control and conservation, this means that most of these "State" programs are also reviewed by the FCPC. In 1965, the FCPC reviewed 86 pest control programs involving some 20 different Federal agencies. To date in 1966, the FCPC has reviewed over 100 such programs submitted by more than 30 Federal agencies.

In reviewing each of these program proposals, the FCPC considers the benefits expected to be achieved, the potential hazards or damage that might result and any special precautions that are to be, or should be, taken, weighs these factors, and decides accordingly. In many cases, the program proposals are modified to meet objections raised during the review. The FCPC operates on the basis of unanimity of views with regard to program reviews. In cases where there are objections raised to program proposals that cannot be resolved, the FCPC notifies the Department involved concerning the unresolved objections. Although the powers of the FCPC with regard to pest control program reviews are advisory in nature, no Department to date has chosen to ignore adverse action by the FCPC.

In addition to its function of reviewing Federal pest control programs, the FCPC also now has review and

coordinating responsibilities for all other Federal activities related to pest control and pesticides (except Federal registration), including research, public information, and monitoring of the environment. As in the case of pest control programs, the program plans of Federal agencies in these other areas of pest control and pesticides are reviewed and coordinated by the FCPC through special subcommittees established for that purpose. To date there have been established a Research Subcommittee, a Monitoring Subcommittee, and an Information Subcommittee. Membership on these Subcommittees includes representation from other units of the four Departments represented on the FCPC itself, as well as representation from other Federal agencies such as TVA.

At the State level as of June 1966, many have State Committees for Coordinating Programs on pesticides and/or pest control. Of the 51 State or Territorial governments (50 States and Puerto Rico), 33 have Interagency Committees composed of representatives of appropriate State Departments, such as Health, Agriculture, Forestry, Industry, Extension Service, Experimental Station, Game and Fish, Water Conservation or Pollution, Food and Drug, etc. Some of these also have representation from private organizations, such as Trade Associations. Sixteen States have only University Committees, with representation from appropriate departmental units within the University system. Twenty-nine States have both Interagency and University Committees. Four States have only Interagency Committees. Only two States (Alaska and Connecticut) have neither an Interagency nor a University Committee.

These State Committees serve the same general function as the FCPC with regard to review of State programs on pest control and pesticides. Some also have regulatory powers covering the registration and/or use of pesticides in their respective States.

Several years ago our National Committee wrote to the State mosquito control and fish and wildlife agencies in each of the States having three or more organized mosquito abatement districts in operation at that time, recommending they consider the formation of State-level coordinating committees. Some of these cited the existence of the interagency pesticide coordinating committees mentioned above and expressed the view that coordination of mosquito control and conservation could be accomplished by these committees. Our National Committee recognizes that this could be done, but we have rather serious doubt that it will be done in actual practice. We still feel that there are definite needs for, and many advantages to be derived from, more specific mosquito control-fish and wildlife management coordination committees operating at local and/or State levels to deal with problems affecting these interests, and we strongly recommend the establishment of such committees in those areas where they are not already in operation.

# WATERFOWL INTERESTS IN RELATION TO VECTOR CONTROL PROGRAMS

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## Introduction

The interests of wildlife, on developed and managed Utah marshlands, in vector control programs may be thus stated: We recognize the need for vector control programs, but they should be carried out with the least interference to wildlife on areas developed specifically for wildlife. This interest has been recognized, I am sure, by those responsible for the mosquito control programs in the northern part of the State of Utah over the past several years. Personnel of the responsible agencies recognize many of the values of wildlife and in a large measure are directing their programs with wildlife in mind. So, we are pleased on the one hand, but see a threat from the mosquito problem and other conflicts brought on by man's activities to the welfare of our wildlife on the wetlands of our State.

## Waterfowl in Danger

Waterfowl, other waterbirds, and their habitats on the eastern side of the Great Salt Lake Valley are in greater danger now than ever before from a number of threats including: (1) encroachment by civilization (2) scarcity of water, and (3) pollutants in one form or another.

Just ten short years ago a report (Shaw et al. 1956) said this: "Undisturbed marshes, swamps, and overflow lands have many inherent values and a variety of uses . . . Millions of Americans rely on wild animals to furnish them with healthful outdoor recreation . . . Other values of wetlands include storage of ground water, the retention of surface waters for farm uses, stabilization of runoff, the reduction or prevention of erosion, the production of timber, the creation of fire breaks, the procession of an outdoor laboratory for students and scientists. . . . Some wetlands provide good fishing." Undisturbed wetlands, and particularly developed waterfowl refuge and management areas in the saline marshlands of the west, are rare indeed. The natural and artificially created wetlands in and near Great Salt Lake do indeed furnish many of the above services, but are threatened as are the very birds they were created to protect.

In a century of wetland exploitation aided by the Swamp Land Acts of 1849, 1850, and 1860 nearly 65 million acres of wetlands in 15 states were transferred from federal to state administration for the purpose of expediting their drainage. It now appears that at least 45 million of the original 127 million acres of natural wetlands in the U.S. have been drained or destroyed. However, as natural wetlands decreased in the west or were endangered, artificially created wetland acres were added to the acreage until today, perhaps, no less than 175,861 acres of managed marshes supplement

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the 1,174,400 acres originally in Utah (Smith, undated, Shaw and Fredine as of 1964), of these developed lands 61,815 acres were under State ownership and 96,046 acres under jurisdiction of the Federal Government (Low, 1964). It is essentially these waterfowl management areas, enhanced beyond the original native marshes from which they were built, that are endangered today through man's activities.

The value of marshlands is difficult to ascertain. Their contributions to humans have both negative and positive sides. As reservoirs for mosquitoes and other undesirable pests their values are on the negative side, while the afore mentioned uses are on the positive side. It has been conservatively estimated that an acre of marshland in a New York State setting is worth $20 per acre per year, which when capitalized at 5 per cent gives $350 to $400 as the value per acre (Benson and Perry, 1965). What our monetary values are here in the saline marshlands of Utah is problematical, but undoubtedly they will be in the same general neighborhood. Today these resources are seriously threatened and some areas are in eminent danger of being destroyed.

### Encroachment by Civilization

During the past few years the constant and ever increasing encroachment of man's activities nearer the marshes along the Wasatch front from Brigham City to Salt Lake City has been noted. Man has moved closer to the developed marshes as rural acres have developed into urban acres, as man has put greater pressures on some of the marshes and boarding water areas for water skiing, boating, fishing, grazing and other uses. We have noted mosquito control operations on the developed marshes where planes fly at low elevations back and forth over these marshes — just another source of harassment to the water birds and other wildlife.

As man and his interests move ever nearer the marshes, the pressure for vector control programs will undoubtedly increase. Our concern would be the effect which insecticides used for mosquito control has on wildlife. The presence of DDT has been adequately demonstrated in ducks and other water birds and in their eggs and offspring. The potential dangers of this residue and many others have been recorded from current research of the Fish and Wildlife Service in their annual reports on pesticide wildlife studies (U.S. Fish & Wildlife Service, 1960, 1962, 1963, 1964, and 1965) and this agency will continue to study this subject in many places.

### Scarcity of Water

The role played by water in our civilization was appropriately stated by Hansen (1964) and because it summarizes the situation so accurately, I would like to quote in part:

"Water resources is not only the key to the future . . . but water resources is the foundation of the past as well as the future. Senator Robert S. Kerr has said:

"We can bequeath our children cities of iron and stone and aluminum, but we had better be sure we give them water to make them liveable.

"Water is not only the most important resource — it is **the only** basic resource. Other resources man can get along without or he can provide substitutes or synthetics. But water is the key to establishment, growth, and survival of the individual, community, and the industry. . . . Land is productive in proportion to the water supply, and without water recreational potential is sterile."

Gottschalk (1965) says, "In wildlife management equation, habitat is the ultimate factor . . . without waterfowl habitat there is no waterfowl resource."

Water is the life blood of our marshes (habitat) as well as our agricultural croplands. It has been estimated that water consumption for irrigated lands in the State of Utah is 2,900,000 acre feet and that the non-beneficial consumption from marshland mud flats etc. is 3,400,000 acre-feet (Utah State University and Utah Water and Power Board, 1963).

The water diverted by the State to support waterfowl and our wetlands has been estimated at 5,850,000 acre feet compared to 5,000,000 acre feet for irrigation or 20 per cent more for waterfowl. From information given at the hearings in Utah before the Senate Select Committee on National Water Resources, it can be estimated that diversion of another 750,000 acre-feet of water will be needed for waterfowl before 1980 (Hansen, 1964).

We challenge the statement by the Utah State University and the Utah Water and Power Board (1963) that water for marshlands should be in the non-beneficial classification; it should be changed to the beneficial use classification.

As has been pointed out by Hansen (1964) the large amounts of water now needed to adequately support the established and managed marshlands in Utah is evidence that our concept of beneficial use is rapidly changing etc.

Industrial demands for water are increasing as is made evident by the development of industry in the cities, and will be an ever greater demand when the potential industries for metals, fertilizers and other products from Great Salt Lake become a reality.

In a recently completed study of the water requirements on Utah's marshlands, it was pointed out that for one of the State's management areas, Howard's Slough Waterfowl Management Area, 46 inches per year and that amount is required largely during the April through September growing season in order to maintain a productive marsh (Christiansen and Low, 1966).

Climatic variations, likewise, may offer a threat to wetlands because in years of scarcity of rainfall or snow pack the marshes may go dry or become too saline for beneficial growth of plants and food organisms.

As drainage projects increase, the quality of the water entering marshlands will increase. During the middle and late summer (July and August) the only water entering the Bear River Refuge is drainage water from farms, that is highly laden with salts and other pollutants (Gunther, 1966). At the present time, September, three of the five Units at Bear River Bird Refuge are completely dry.

As impoundments increase in number for agricultural purposes, more water will be taken that normally flows to our marshlands. For example, water which normally flowed through Ogden Bay Management Area creating a flushing effect during the spring, fall, and winter will in all probability be diverted during these periods largely to the Willard Bay Reservoir on the lower Weber River.

Further studies of a more critical nature need be made on the water requirements of the marshlands in our State, including the effects of pollutants, and refinements on the methods and techniques used to determine amounts of water needed.

POLLUTANTS:

*Salinity*

Salinity is a form of pollution which is often ignored on our western marshes because it is oft times though of as having always been there. However, with increasing water scarcities this type of pollutant may become serious. It may be of interest to know that when water measures 10 mmhos it is carrying about 11 tons of salt per acre-foot (Christiansen and Low, 1966). It is fortunate that our marshes can be operated on waters of lower quality than those desired for agricultural purposes, but the important food and cover plants cannot stand ever increasing high concentrations of salts. In fact, the best germination, growth, and seed and tuber production of important aquatic plants such as sago pondweed, hardstem and alkali bulrush are obtained in fresh water (Teeter, 1963, Kaushik, 1963). A substantial reduction in all forms of growth was recorded at substrate levels exceeding 10 mmhos. However, the desirable aquatic plants can tolerate levels up to 5 or 6 mmhos (3200 to 3800 parts per million without too adverse effects) and production of sago pondweed tubers has been shown to be greatest at 3,000 ppm (Teeter, 1963).

It is not sufficient to merely fill the ponds or Units at the beginning of the season and to add no further water throughout the season. Salinity increases tremendously through the hot summer months when salinity levels are often raised to 40–50 mmhos, having the equivalent of 25,000 to 32,000 ppm, or 75 to 90 per cent of that found in ocean water. Thus, it is essential that a salt balance be maintained. With increasing demands of agriculture and industry this will become increasingly difficult. Surely, one of the effects of the excessively high levels of salinity will be change for the worse in the plant — invertebrate — and bird food chain.

*Lead Shot Pellets*

Each year not less than 12,000,000 pounds of lead shot are expended by sportsmen in pursuit of waterfowl in the United States (Annonymous, 1966). This spent lead is an insidious source of death for ducks since the birds pick up the shot on the bottom of the marsh as they dabble for seeds and grit and retain it in their gizzards for indefinite periods, usually resulting in lead poisoning. The loss of ducks from this source is difficult to ascertain, although, it is conservatively estimated that 1,750,000 ducks are lost each year to this source of marsh pollutant (Annonymous, 1966). It has been shown that only one pellet of No. 6 shot is sufficient to kill a mallard under experimental conditions, although, mallards or some mallards have survived after having been fed several pellets (Bellrose, 1959).

Our studies in Utah point out that little or no decomposition takes place in lead pellets deposited on the bottom of the saline marshlands (Nelson, 1965). The arms and ammunition industry is not optimistic about finding a suitable lead substitute, but believes that regulating the shot used by gunners to one size of shot that will sink out of range of the ducks in the shortest time would be desirable (Baker, 1966). Again we found that different-sized shot sink into the marsh soil at different rates, with the larger shot sinking farther and faster. A question yet unanswered, but which we are studying, is how deep into the soils will a duck probe for a seed or a lead pellet? After lead pellets sink beyond the depth to which ducks feed, the pellets are no longer a potential cause of mortality. Regulation of water levels may also be a management tool for reducing the availability of lead shot to ducks.

*Other Pollutants*

On occasion, other pollutants may effect wetlands habitats or their inhabitants. For example, oil residues from refineries are sometimes dumped from trucks or other containers around the shores of the marshes or in rivers leading into the marshes and have killed ducks and other birds. Such oil pollutants are seriously detrimental in entrapping the birds with which they come in contact by encasing the wings and feathers so heavily that the birds cannot fly.

Siltation, likewise, may be detrimental but may also be a blessing. Through the centuries the best soils from our mountains and farm lands have been washed into the streams and deposited in the marshlands. Often this silt covers up salt deposits and might, thus, serve to freshen a body of water. On the other hand, excessive siltation may cause the decrease or death of desirable plants and invertebrates. Often carp in high densities not only loosen and break off the plants in their quest for invertebrate food but by so doing cause roiliness of the water sufficient to decrease the growth of desirable plants. Carp populations in excess of 200 pounds per acre were detrimental to sago pondweed (Robel, 1961).

Western duck sickness, or botulism, a form of pollution on our marshes, was once a serious threat to waterfowl, but has not been reported in serious outbreaks in late years. However, much research work is still being done on this along with studies of parasites at the Avian Research Center, Bear River Bird Refuge.

*Pesticides*

The immensity and complex nature of the pesticide residue problem can at best be understood only after much study. Yearly about 8,000 manufacturing firms mix about 500 chemical compounds into more than

60,000 registered pesticide formulations. The problem will undoubtedly be compounded as the products increase from our pesticide industries from an estimated 783,000,000 pounds in 1964 to twice that amount in the next 12 years. (Fish and Wildlife Service, 1966). The seriousness of potentially dangerous residues is brought into focus when it is recognized that 1 acre in 10 in the continental United States is treated annually with an average of nearly 4 pounds of pesticides and that on some areas as much as 176 pounds per acre of residue has accumulated in the top few inches of soil of some heavily treated areas (op. cit.).

The constant danger of insecticide residues to wetland environments is recognized. Much work is being done in this field to determine levels present in marsh environments and their animal life (U.S. Fish and Wildlife Service, 1963). The danger to ducks has been pointed out by Shelton and others (Bureau of Sport Fisheries & Wildlife, 1964). At Utah State University a research project is aimed at finding the effects of dieldrin residues on mallards (Utah Cooperative Wildlife Research Unit, 1966). In this study sub-lethal doses of this insecticide are fed to adult mallards and the behavioral patterns of their young are studied to detect any abnormal activities which may be caused by the sub-lethal insecticide residues.

However, the seriousness of pesticide residues on all our wildlife including big game, upland game, and water birds has been repeatedly demonstrated and has been summarized by the U.S. Fish and Wildlife Service (1963, 1964, and 1965). More recently the dangers have been brought to the public's attention in such popular media as the Outdoor Life (Peakall and East, 1966). In the latter publication direct and indirect mortality has been pointed out from many studies on species of game and non-game alike. The presence of more than legal limits of residues of some of our synthetic chlorinated hydro carbon insecticides as DDT, dieldren and heptochlor in the meats of the wild animals suggests that if the animals were not to die of these effects that they may no longer be safe for human consumption.

It is my understanding that the popular DDT of a few years ago is no longer used for mosquito control. The long time stability of DDT (up to 5 years or more or a half-life in the environment of about 10 years) in wet soils makes one wonder how much is yet available to our wildlife in the marshes.

And yet, direct application of pesticides to our marshlands may be but a small part of the potential dangers inherent from pesticide residues for these residues may be carried to our marshes in our streams from farms and forests in ever increasing amounts. The decomposition of these residues and the deposition rate in the tissues of our game and non-game, as well as in the items in their food chains, need to be even more thoroughly investigated. The principle of "biological magnification" has been recorded many times. In this process organisms absorb a chemical in concentrations which greatly exceed those found in the environment. Those that survive pass along their load of chemicals to the next higher animal in the food chain. The predator, the highest animal on the food chain, eventually may get a lethal dose (Parker, 1964). We should constantly be on the lookout for ways of accomplishing control of pests, including mosquitoes, other than by the use of the ever increasing popular pesticides.

During the past several years the study of reusable waters by Rees (et al. 1966) has suggested methods of wetland management that can be used to effectively control mosquitoes and that are least injurious to wildlife interests. More on this subject, I am sure, will be reported at this conference.

Springer (1958) earlier pointed out several methods of environmental control that have proved satisfactory under certain conditions where insecticides might not be advisable. The methods that he indicated might well be reviewed as possibilities in Utah marshlands.

## What We Must Yet Learn

In the mere recognition of the potential dangers, we have a start in the right direction as far as vector control programs and wildlife are concerned. Certain things we must yet learn are:

(1) Habitat manipulation equally conducive to reducing mosquito breeding sites and enhancing wildlife habitat. We need further research and adequate demonstration in this area.

(2) The role of residues and other pollutants in directly and indirectly affecting game species, their foods and water must continue to be a matter for questioning and research. Particularly is this important since our marshes are at the ends of the streams and are often in closed ecosystems; they often have little or insignificant drainage for months at a time during the period of maximum exposure to pesticides.

(3) Increasing attention must be given to protecting the marshes and their inhabitants in the face of increasing human pressures, such as direct harassment, demands of the resource for additional recreational pursuits, excessive use by livestock, and lastly, any ill-planned mosquito suppression programs intended to relieve the discomfort and disease danger to people living near wetlands.

(4) The economic values of marshlands although partially recognized, have not yet been spelled out in detail. This we must do to justify (a) fair adjudication of valuable water for marshland maintenance and (b) adequate research programs that will aid in the perpetuation of the resource in a manner that is compatible with other interests.

## Summary

Mosquito control programs must be carried on in the interests of human health and happiness. We are pleased with the cooperative approach to better programs being made through the efforts of the Utah Mosquito-Wildlife Coordination Committee. We have made progress. Our concern would be that the control programs be carried out with the least interference possible to the wildlife on our wetlands.

Wildlife interests are becoming increasingly concerned and interested in mosquito control programs,

particularly with respect to the use of insecticides. It is likely that further limitations on the use of such toxicants will be needed.

Increasing mosquito resistance to chemical insecticides has once again emphasized the importance of environmental control methods. The danger of insecticides to water birds, directly and indirectly, is recognized. The research efforts of those people concerned with vector control programs to demonstrate other means of control, including environmental approaches, is commendable. In the final analysis, however, wildlife interests must continue to seek answers and information on the effects of pesticides that will guide users toward safer and more target-specific pesticides. We must know the effects on reproduction, on the behavior of the animals, on the effects of residues concentrated through the food chain. Our goal must be to obtain an accurate measure of pesticide hazards to the entire Nation's wildlife resources, which includes its wetland components.

And finally, our marshlands are endangered from other advances and pressures of man and nature that make the vector problem but one of many that we in Wildlife must consider in the management of these vast and valuable resources.

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## AN EXAMPLE OF MOSQUITO SOURCE REDUCTION THROUGH WATER MANAGEMENT AND LAND IMPROVEMENT

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Today's mosquito control technology involves much more than the application of insecticides to destroy mosquito larvae and adults. Among the techniques used are the application of insecticides, draining or filling, proper water management in irrigated areas, altering of the aquatic environment to make it unsuitable for mosquito larvae and the use of biological control agents. All of these techniques are used by mosquito control agencies in Utah and throughout the country.

In Utah most of the mosquito production that annoys man and threatens his health is the result of irrigation practices. When the Mormon Pioneers first moved into the Valley of the Great Salt Lake, they settled along streams from the Wasatch Mountains and along a small river flowing from a fresh-water lake, now known as Utah Lake, into Great Salt Lake. This stream was named the River Jordan because like the River Jordan it flows from a fresh-water lake to a salt-water lake. These areas were selected for settlement because they were near available water that was needed to raise their crops in the desert.

At first irrigation systems were constructed to take water only short distances but as the population grew the irrigation systems were expanded to cover much larger areas. The expansion in irrigation was necessary in order for the land to support the population but there were detrimental side effects. Overuse of irrigation water, seepage from ditches, and inadequate disposal of waste water created a serious mosquito problem. The flat area along either side of the Jordan River in the southern part of Salt Lake County became water logged because of seepage from higher ground. Homes and farms along the river were abandoned and the land became marshy and mostly useless except for areas that produced some forage, usually poor, for horses and cattle. The area remains this way today and is one of the major mosquito producing regions in the South Salt Lake County Mosquito Abatement District.

Since mosquito control is difficult under these conditions and the immediate future offers no prospect of changing the conditions that cause this land to have excessive water, the South Salt Lake County Mosquito Abatement District is working cooperatively with property owners to make the land again productive and eliminate mosquito production by utilizing and managing the excessive amount of water. The procedure is expensive and progress slow, but as land values increase more property owners will be willing to make the necessary investments. One serious mosquito producing area along the Jordan River was selected by the district for an attempt to eliminate mosquito production and increase land value.

The following steps were taken to improve the area: (1) Construction of a large deep drainage ditch to allow the water table to be lowered; (2) deepening and enlarging areas where water seeped to the surface and connecting these enlarged areas to the drain; (3) installation of water level control devices to maintain constant and desirable water levels in the ponds and to allow complete drainage when necessary; (4) leveling the surrounding land and planting proper forage crops. In this example Tall-Crested wheat grass, alta fescue and Sweet Yellow Clover were planted. The several ponds constructed were planted with trout. The fish grew rapidly with only occasional supplemental feeding and provided both food and sport in a short time. Most ponds constructed in this area would not support trout because of temperature, but warm water fish such as bass would do well. One pond, deeper than the rest, was used for swimming.

The accomplishments of this cooperative project are: (1) The elimination of a serious mosquito producing area; (2) the development of a wildlife habitat in the form of fish ponds; (3) the development of an improved pasture that supports over sixty head of cattle on land that previously would support only a few.

Managers of mosquito abatement districts are frequently trained biologists or have such people available on their staffs. They welcome the opportunity to work cooperatively with other agencies and individuals to make the best possible use of our resources without creating serious mosquito problems.

## COOPERATIVE WATER MANAGEMENT FOR MOSQUITO CONTROL AND WILDLIFE PRODUCTION

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On Utah marshes, particularly those bordering the eastern shores of the Great Salt Lake, some water management has been applied since the early settlement of Utah. During this period of almost a hundred and

twenty years, the concept of what is beneficial use of water has changed considerably and this has determined the objectives and extent of the water management programs on these marshes. For approximately the first fifty years of this period, water management was confined largely to the production of grazing, feed, and bedding for livestock. Tremendous numbers of waterfowl, fur-bearing and other game animals were harvested by sportsmen, commercial trappers, and hunters, but water management for the actual production of these animals was not extensively applied.

Prior to the beginning of this century some attempts were made by individuals and groups of sportsmen to construct dikes along the shores of the lake to improve existing marshes and create additional marshlands for waterfowl and other wildlife. These efforts were tolerated or ignored by other people living in the vicinity of these marshes as the water being used was considered "waste water" and unsuitable for other purposes. Since this impounded water covered some land formerly used for grazing, there was a conflict of interests with the stockmen using these areas. Later, some stockmen and land owners found it profitable to combine the raising of livestock and waterfowl. Leasing permission to hunt waterfowl on certain marshland, for a stipulated fee, became more lucrative for stockmen than the income from grazing livestock. In some instances it has now become a combination of producing and harvesting livestock, salt grass, waterfowl, muskrats, carp, pheasants and other wildlife or a combination of any or all of these marketable crops.

As organized clubs have diked and developed large areas into marshlands, and since the Utah State Department of Fish and Game has established waterfowl management areas at Farmington, Ogden, and Willard bays, and the United States Fish and Wildlife Service has established the Bear River Refuge, a greater need for more and better water management practices has become essential. This need has developed because available water does not always meet the requirements for proper maintenance of these extensive man-made marshes during seasons or years of low water supply. In addition, the available water for these marshes is appreciably diminishing as the human population increases and of necessity the water supply going to the marshes has been diverted for use in agriculture and industry, and to meet the demands of our growing cities.

In the process of using water it has been found that mosquitoes are produced as the result of some existing water management practices. We are all aware that mosquito production in Utah is not confined to the waterfowl marshes. Some species of mosquitoes are produced in great numbers on farms by irrigation water, and in burrow pits, gutters, catch basins, fish ponds, and containers in which water is confined in rural and urban communities. A continuous campaign to eliminate these mosquito-producing sites is being conducted by personnel of Utah mosquito abatement districts with those responsible for these man-made mosquito-producing situations. This is also part of the cooperative effort for mosquito control and improved water management practices.

Due to the general theme of this conference and the participants attending, I have been requested to discuss a cooperative effort we are developing in Utah to improve water management practices applied for the production of wildlife and the control of mosquitoes. I am better acquainted with this program as it has been developed on the eastern shores of the Great Salt Lake in Salt Lake and Davis counties and will cite examples of cooperation in this area. I am aware that similar programs are in progress in Weber and Box Elder counties. These programs will be described later during this conference.

In 1929 it was determined that large broods of *Aedes dorsalis* (Meigen) mosquitoes are produced on the marshes north and west of Salt Lake City. Later it was found that at times these mosquitoes migrate into the city creating a considerable annoyance for the inhabitants.

It was learned upon further investigation that this species of mosquito is produced on the marshes in the shallow areas covered with salt grass when these areas are temporarily flooded with water. It was found that the females lay their eggs on the moist soil as the water disappears from the flooded areas. The eggs may remain viable in the dry soil indefinitely; then, each time the area is reflooded during the warmer season of the year, the eggs hatch into larvae which may mature into adults within five days from the time of hatching. As the water disappears, more eggs are laid on the soil and the cycle is repeated.

With this information, a program was initiated by the Salt Lake City Mosquito Abatement District to prevent unnecessary and repeated flooding of these salt grass areas whenever water is available. This has been a slow and laborious effort that has been in progress for some thirty-seven years, but the more recent results have been greatly rewarding.

In the more permanent water on the marshes, species of Culex and Culiseta mosquitoes lay their eggs on the surface of the water in the emergent vegetation around the margin of these bodies of water. These mosquitoes, under favorable conditions, are produced on the marshes in considerable numbers but generally do not migrate as far or create the annoyance in the cities that is produced by *Aedes dorsalis*. It has been found that the production of these latter species can be greatly reduced by water management such as controlling the depth of the water and by shoreline modifications.

In attempting to manage water for mosquito control it was necessary to work with all interests concerned with water use and management on the marshes. It was found that use of water to produce grazing and forage for livestock was of considerable importance in some areas but the use of water for the production and management of waterfowl and other wildlife was generally more significantly related to mosquito production. Both of these interests have been included along with all other water users in the cooperative effort to improve water management prac-

tices for greater beneficial use of the reusable water on the marshes bordering the eastern shore of the Great Salt Lake.

The following are some of the results of this cooperative effort. First, this conference is a very significant outgrowth of this cooperative effort whereby those directing mosquito control are meeting with those in charge of the production and management of waterfowl and other wildlife in an attempt to discuss and solve mutual problems of water management on marshes. This conference is one of many meetings that have been held in Utah to consider this problem of water management. The program and attendance at this conference are evidence of our mutual concern.

In November, 1962, the Utah Mosquito Control — Fish and Wildlife Coordination Committee was formed. This Utah organization was patterned after the national committee organized for this purpose. The Utah committee consists of three members with a representative from the Utah State Department of Fish and Game, the Fish and Wildlife Service, and the Utah Mosquito Abatement Association. This committee has been functioning since its organization and has prepared and distributed information pertaining to the meetings and programs of fish and wildlife and mosquito control agencies.

A cooperative study of water management on these marshes was conducted for four years terminating in November, 1965, in which the following agencies actively participated:

*Federal agencies*: Agricultural Research Service, Soil Conservation Service, Hydrology Section of the Weather Bureau, Public Health Service, Fish and Wildlife Service, Bureau of Reclamation, and the Water Resources Division of the Geological Survey.

*State agencies*: Department of Health, Department of Fish and Game, and the Office of the State Engineer. The Utah Mosquito Abatement Associations, organized gun clubs, a marsh development company, and private individuals were included in this cooperative study.

Funds to support this study were provided by NIH through the Water Pollution and Control Board in a research grant to the University of Utah. All collaborating agencies actively participated and contributed their time and "know-how" to this project. It was an outstanding example of cooperative effort and the results attained were more comprehensive and authoritative as a result of the combined efforts of many specialists in their respective fields.[1]

Currently a similar three-year cooperative study was started this year in which the same agencies are continuing as collaborators. Funds were awarded by the Public Health Service, CDC, to the University of Utah, to conduct this study in which an attempt is being made to measure quantitatively certain aspects of water management as it pertains to mosquito control and wildlife.[2] You will have an opportunity this afternoon to see the three study areas where this work is being conducted, and to hear more about these research programs.

To supplement this, the United States Department of Agriculture, Research Division, Entomology Section, has awarded a three-year research grant to study the biology and control of horseflies and deerflies on these marshes.[3]

Three other significant events have recently taken place that will, in some respects, greatly influence future use and management of water on these marshes. In order to understand the importance of these events, it must be made clear that much of the land now developed into marshes was utilized for this purpose as the water of the Great Salt Lake receded and the lake bed became available for marshland development. This land is claimed by the adjacent property owners, the State of Utah and the Federal Bureau of Land Management. In legislation enacted by the federal government becoming effective in August of this year, the State of Utah has the option of purchasing or establishing by legal action ownership of the land claimed by the federal government. Private land owners will have to determine with the State their rights to this land. In addition, the water used to develop much of these marshes in Salt Lake and Davis counties is reusable water originating as drainage from irrigation and other sources. There is no legal title to this water but there are claims filed in the office of the state engineer far beyond the amount of water available.

In the summer of 1961 during a scarcity of water, the state engineer temporarily divided the water in the Jordan River and Surplus Canal for agricultural use and use on the waterfowl marshes. In so doing, the production of waterfowl was officially recognized as a beneficial use. The waterfowl hunters have been aware of this for a long time but this has been repeatedly denied or questioned in the past by other water users.

An attempt is now being made through the office of the state engineer to adjudicate the reusable water in the lower Jordan River and the Surplus Canal according to use and the legality of claims filed in that office. To accomplish this an extensive study is being made to determine the amount of water available in this system and its current and past use. The state engineer has appointed a committee with representatives from agriculture, industry, wildlife interests, and mosquito control to assist in this appraisal and settlement. An official "water master" was appointed this year to assist in the management of this water.

It is significant to note that all of these actions have been on the basis of cooperative efforts to improve water management practices on these marshes for greater beneficial use for all concerned. This can only be fully accomplished when legal rights to the land and the water have been established and the owners are made responsible for the beneficial use of this water.

It is evident from this report that a cooperative water management program for mosquito control and

[1] This study was supported in part by funds provided in Research Grant WP-00027, Department of Health, Education and Welfare, Public Health Service, National Institutes of Health, Research and Training Grants Branch, Division of Water Supply and Pollution Control.

[2] This study was supported in part by funds provided in Research Grant CC-00171, Department of Health, Education and Welfare, Public Health Service, National Communicable Disease Center.

[3] This project is supported in part by funds provided by Research Grant No. 12-14-100-8070 (33), Agricultural Research Service, Entomology Research Division, United States Department of Agriculture.

wildlife production is in operation in Utah and that considerable progress has been made with plans for greater success in the future.

## VECTOR CONTROL PROGRAMS IN COLORADO

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Vector problems in Colorado are similar to those of most other Western States, the major areas of activity being in mosquitoes and encephalitis and rodents and plague. There are other aspects of vector control in the planning stage. The degree of interest and activity regarding these problems has varied throughout the State in recent years, depending upon the severity of the situation at the time. The aim of the State Health Department is to promote continuing programs to better meet the obligations created by these vector problems.

Mosquito control has received considerable emphasis in recent years. There was sufficient authopode-borne encephalitis in 1964 to rank Colorado the national leader on a per capita basis. This was followed by an encephalitis outbreak of epidemic proportion which ranked first in total number of cases in 1965. The U.S. Public Health Service, Disease Ecology Section, at Greeley, Colorado had predicted this major outbreak prior to the manifestation of any cases.

When flooding occurred along the eastern river basins in mid June of 1965, vast breeding areas were made available to *Culex tarsalis*. This coupled with the alarming rise in virus activity as determined by the Disease Ecology Section, made mosquito control the major summer activity in many areas of the State. The flood was responsible for making money available for emergency mosquito control. This was the first experience in mosquito control for many Colorado residents. Their satisfaction has increased the interest in more efficient local control programs.

The organization for mosquito control in Colorado consists of one abatement district and numerous locally operated city programs. The local programs are still unfortunately attempting to control adults. The district located in Durango is a small one and is not a full-time operation, but is giving good control. The organized district concept has gained momentum in Colorado. Three new districts are in the process of being organized at this time. Two of these have excellent chances for success, while the third will have trouble getting organized because of a limited tax base.

State Health Department activities have stressed surveys to define the problems and determine the control methods suited for each specific area. Source reduction is always stressed, along with larval control practices. Adulticiding is discouraged as the major function of any control program.

The local health departments are carrying out some control and are conducting some detailed pre-control surveys. The City-County Health Department of El Paso County, located in Colorado Springs, is an example of one of these departments with an intensive survey program. They also have transplanted *Gambusia affinis* from Ogden, Utah as a beginning for control in ornamental pools and other small empoundments in 1967 providing a sufficient over-wintering population is maintained.

During this year of 1966, the most interested areas in mosquito control have been the mountain recreation areas. The source of mosquitoes in these localities is the flooded mountain meadow. These meadows are in a continuous flooded condition from early spring until mid-summer when the meadows are then drained to allow them to dry sufficiently for the removal of the meadow-grass hay. The *Aedes* populations in these meadows are intense and the annoyance is severe. The prompting for the control in these areas is the tourist along with the livestock present in the area. Control methods in these areas has consisted primarily of the use of Baytex sprayed at 1/10th of a pound per acre in a gallon of oil per acre. This has given excellent control of adults as well as three weeks larval control in these meadow habitats.

Baytex has been registered for application in meadow and pasture areas in the State of Colorado. This registration states that animals being grazed in pasture areas being treated with Baytex should be removed for a period of two days if the complete pasture is sprayed. If only a part of the pasture is to be treated, then there is no need for the livestock to be removed. Baytex was also the principal insecticide used during the control of mosquitoes following the flood in 1965. This also was applied at the rate of 1/10th of a pound of Baytex in a gallon of oil per acre. There were some 194 thousand acres treated in this manner during the emergency situation in 1965.

Plague surveillance is becoming more important in Colorado with the increased plague activities in neighboring states. Colorado State University is conducting field studies on the habits of prairie dogs in an apparent endemic area in the vicinity of Fairplay, Colorado at an elevation of 10,000 feet. The Disease Ecology Section is also carrying out studies in other areas of the State.

Time and personnel do not permit a sustained plague detection program by the State Health Department. The local health departments and other agencies are cooperating in the observation of prairie dog and other rodent activity. However, flea collections have been made from prairie dog burrows by personnel of the State Health Department in association with members of the Disease Ecology Section.

An integral part of plague surveillance is concerned with the domestic rodent populations at city dumps. Rodent control is conducted by the municipality and by the U.S. Fish and Wildlife, Predator Control Section. Some eastern Colorado cities have heavy rat populations. No rats have been found in western Colorado and apparently they will not become established even in the larger cities on the west slope.

Another area of interest which is somewhat unique to Colorado in regard to Vector Control is that of Colorado Tick Fever. Studies are contemplated regarding this affliction and as soon as personnel and time can be alloted for this, these studies will be instituted. Other vector activities conducted by the State Health Department would be a general type of nuisance insect that is encountered in general sanitation and general health department activities. There is no set program regarding surveillance for control for roaches or flies, however as these problems arise, they are worked into the normal work schedule.

## COORDINATION AND RESPONSIBILITY IN WILDLIFE MANAGEMENT AND MOSQUITO CONTROL

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*Utah State Department of Fish and Game*
*Salt Lake City, Utah*

Recently, the cause of conservation has become extremely popular. However, too often this popularity is given "lip service" only, and when it comes to whether wildlife values will be protected, often the only criteria used in this determination is how much it costs. Not whether a resource will be damaged, destroyed, or altered.

As a resource agency the Utah State Department of Fish and Game is well aware of many types and kinds of responsibilities that are entailed in the management of the State's wildlife resource. We realize that we have an obligation to surrounding communities, to the various mosquito abatement districts, and neighboring landowners in the management of our marsh complexes in a manner that produces the smallest number of noxious insects. Yet our principal goal and responsibility must remain with the waterfowl resource. We feel there is little need for conflict between interests of wildlife and mosquito control, if both the wildlife management and mosquito control are initiated and carried on by competent professionals.

During the past several years great strides have been made in Utah in eliminating and solving areas of mutual concern between mosquito abatement districts and wildlife managers. Organizations such as the Fish and Wildlife Coordinating Committee have done much to bring many of the problems into the open and help solve these problems through discussion.

However, there are two areas where problems of coordination between wildlife interests and mosquito control still exist. These are: coordination of activities on field levels, and the reliability of certain research activities.

In Utah, coordination between wildlife and mosquito control interests has been excellent on administrative levels and a great deal of real progress has been made. Breakdown of coordination appears to be at field levels with day to day management practices of wildlife and mosquito interests. For the most part these problems are minor and can be worked out among the parties which are directly concerned. In most cases, this would be the individual Waterfowl Management Area Superintendent and the Mosquito Abatement District Manager. These problems can be taken care of by simple communication and discussion.

At times (and these are relatively few) certain management practices such as banding, census, etc. call for cessation of mosquito control activities on our management areas. By the same token, we realize that much of the work done in mosquito control has to be taken care of when weather and climatic conditions are favorable. The solution to these problems is frequent communication on field levels between the Department and the involved abatement districts. If coordination and communication at field levels, was of the same caliber experienced on administrative levels, problems would be minimal.

The practice of questionable research programs and the subsequent publication of information obtained under those conditions is more difficult to combat. Almost without question these projects are carried on by well intentioned individuals. Still many of these projects are poorly conceived, poorly planned, and poorly executed. The only planned portion of the project is the distribution of "information."

Too often data of this type is given wide ranging publicity and has a tendency to push established management practices into the background. This is harmful to the resource.

A great deal of this research is carried on by individuals who lack backgrounds in wildlife management. Their competence as a researcher on wildlife matters has no practical value and consequently the value of research is greatly impaired. It is as inappropriate for an individual with no wildlife background to enter into the complex problem of waterfowl management and mosquito control as it would be for a person with no knowledge of mosquito problems to attempt the same project. Information gathered under such conditions is of no value; it simply is a waste of time and money.

The solution to this problem is in the planning of individual research projects and the selection of a qualified individual overseeing this program. If the program calls for detailed knowledge of both wildlife problems and insect control, two individuals should work on the project to see that all facets of the problem are adequately covered.

Research must be carried on at the same professional levels that day to day work is undertaken or they are of no value. Worse than having little value in itself, they can harm established management practices that have proved to be beneficial to wildlife and insect control interests.

Both wildlife interests and mosquito control have an obligation to see that areas of common concern are managed to benefit both sides.

# URBAN MOSQUITO CONTROL IN LOS ANGELES COUNTY

GARDNER C. MCFARLAND, *Manager*
*Southeast Mosquito Abatement District*
*South Gate, California*

Los Angeles County terrain varies from desert plain to foothills and high mountains. Rainfall varies from one inch to 30 inches, with the average in the Los Angeles City area of approximately 13 inches, although the average is made up of precipitation varying from four inches to 38 inches with the low rainfall years predominating. As a result of this semi-arid climate, water importation has been resorted to on a large scale. Approximately 1,350,000 acre feet of water from the Owens Valley and Colorado River are imported annually which will be supplemented with several million acre feet of water from the Feather River Project.

Mosquito problems have been present for many years, although before the great industrial and residential developments, they were localized in the relatively few year around water sources. Occasionally severe general mosquito problems developed as a result of major flooding.

As Los Angeles County developed, mosquito potential and problems increased to a large degree. This increase was due to the greater use of water industrially, agriculturally, and domestically, together with the development of water carrying structures such as storm drains.

The need for formal mosquito control resulted in the formation of 4 mosquito abatement Districts, Southeast, Antelope Valley, Ballona Creek, and Compton Creek. Other agencies such as health departments and several cities also carry out mosquito programs on a limited basis.

As an example of this need, the Southeast Mosquito Abatement District, formed in 1952 has grown from 155 square miles to 466 square miles with a growth of assessed valuation from $406,000,000 to $4,243,685,984. The population served has increased from 400,000 to 2,200,000.

Although the mosquito problems are primarily urban, considerable rural type control is still required. This rural control involves agriculture including dairies, irrigated pasture, truck crops, nurseries, other livestock, poultry, large acreages of alfalfa, and other agricultural crops.

Urban problems which are predominant include a variety of sources which are of major scope: drainage structures, water spreading basins, gutters, cemetery vases, industrial wastes, backyard sources such as swimming pools, potable water reservoirs.

A typical summer month workload for the Southeast Mosquito Abatement District includes:

I. *Rivers, Creeks, and Channels*:

| | | |
|---|---|---|
| Improved channels | 97 | miles |
| Unimproved channels | 95 | miles |
| Underground storm drains | 2560 | miles |

II. *Agricultural*:

| | | |
|---|---|---|
| Water Troughs | 350 | |
| Acreage — permanent pasture | 2500 | acres |
| Acreage — dairy drains | 20.5 | acres |
| Ditches — dairy waste | 2.0 | miles |
| Ditches — irrigation | 6.2 | miles |

III. *Industrial*:

| | | |
|---|---|---|
| Sumps | 123 | |
| Valve Boxes | 2,000 | |
| Acreage | 12.7 | acres |
| Ditches | 8.9 | miles |
| Cemeteries | 11 | |
| Flower urns in cemeteries | 225,000 | |
| Oil well cellars | 550 | |

IV. *Domestic*:

| | | |
|---|---|---|
| Roadside ditches | 69 | miles |
| Gutters | 1950 | miles |
| Catch basins | 2440 | |
| Vaults | 280 | |
| Swimming pools | 250 | |
| (Total pools — approx. 70,000) | | |
| Ornamental pools | 80 | |
| Fish ponds, backyards | 400 | |
| (approximate) | | |
| Backyard containers | 300 | |
| (Buckets, plastic pools, pet dishes) | | |

V. *Miscellaneous*:

| | | |
|---|---|---|
| Flood control basins | 1100 | acres |
| Salt marshes | 75 | acres |
| Parks — golf courses — | | |
| Irrigation runoff (ditches) | 2.5 | miles |
| Lakes | 18.5 | acres |

Mosquito fish given to public — May 1, 1966 — September 1, 1966 — 11,730. The District made 130 plants during the year, totalling 300,000 mosquito fish.

The above data is a summary of mosquito breeding sources that must be regularly controlled in the summer time as often as once a week. Not included are intermittent sources that require routine survey and inspection.

The mosquito which causes the most trouble is *Culex quinquefasciatus* although 12 other species listed below are involved in the District's program.

Chironomids are of considerable importance in the area due to the close proximity of thousands of people to the midge breeding grounds such as water percolating basins, concrete lined channels, water reservoirs, and other standing water sources. As a result of this midge problem, the Los Angeles County Flood Control District contracts with the District for control of midges in all flood control water conservation basins.

In order to carry out the control procedures listed, the 4 Districts employ as many as 54 personnel in the summer with winter-month employment down to 25.

Mosquito control in Los Angeles County, with the exception of the Antelope Valley MAD, is a year-around operation although the scope in winter time is about one-third the summer level. Equipment and methods are similar to those of other agencies nation-

MOSQUITOES COMMON TO THE DISTRICT

| *Scientific Name* | | |
|---|---|---|
| *Aedes nigromaculis* | pasture mosquito | irrigated pastures and flood plains. |
| *Aedes sierrensis* | western tree-hole | tree holes and artificial containers. |
| *Aedes squamiger* | California salt-marsh | salt marshes resulting from tidal overflow or rains. |
| *Aedes taeniorhynchus* | salt marsh | salt marshes resulting from tidal overflow or rains. |
| *Anopheles franciscanus* | field mosquito | sunlit pools, stream margins, and rice fields. |
| *Anopheles freeborni* | western malaria | clear pools with matted algae. |
| *Culex apicalis* | | seepage waters |
| *Culex erythrothorax* | tule mosquito | standing water choked with tule-type vegetation. |
| *Culex peus* | foul water | foul water sources such as industrial and agricultural wastes. |
| *Culex pipiens quinquefasciatus* | southern house | foul water sources such as septic tanks, dairy drains, catch basins, and underground storm drains. |
| *Culex tarsalis* | western encephalitis | most fresh waters and occasionally in brackish sources. |
| *Culiseta incidens* | cool weather | most fresh and brackish waters, and artificial containers. |
| *Culiseta inornata* | winter mosquito | most fresh and brackish waters, and artificial containers. |

wide, however, little or no fogging is resorted to. Almost complete emphasis is placed on larval control, biological control, and source reduction. Probably more right-hand, automatic transmission jeeps are used than any place in the country, due to the hundreds of miles of gutters required to be sprayed.

In conclusion, mosquito control procedures and techniques are not much different than in other areas except for the urban magnitude of Los Angeles County, which necessitates the concurrent program of working with a multitude of agencies such as cities, elected officials, department heads, water agencies, city managers, and an awful lot of people.

## SOME ASPECTS OF POLLUTIONAL EFFECTS ON THE AQUATIC ENVIRONMENT

NORMAN V. CHAMBERLAIN[1] AND RUSSELL N. HINSHAW[2]

During the past year the Department of Fish and Game has conducted some investigations of pollutional effects on the Jordan River Drainage as they relate to fish and wildlife interests. Our primary purpose in conducting these studies has been to assess pollution damage from the standpoint of biological considerations and to identify sources of this pollution. This data will subsequently be used by our Department and the State Pollution Control Board in arriving at a suitable classification of this system.

Pollution is not the only major deterent to fish and wildlife interests on this river system. Dredging and rechanneling activity for flood control purposes has, in many areas, produced an unstable bottom of shifting sand and fine gravel substrates. This condition prevents the establishment of a stable vegetated bottom which is a necessary requisite in the production of a normal, well balanced population of aquatic invertebrates. Heavy withdrawals of water for agricultural and industrial purposes also exert detrimental influences in this respect, particularly during periods of low flow.

Physically the Jordan River is made up of three distinct sections each of which displays characteristics not common to the other two. The river flows north from Utah Lake to Great Salt Lake, a stream distance of some fifty miles. At least six major tributaries and a number of lesser ones empty into it. From its outlet at Utah Lake to about 14600 South (Bluffdale Road) the river is deep, wide, meandering, and heavily silted. Water temperatures are relatively high and aquatic vegetation is reduced due to turbidity. Bottom fauna production is generally poor being characterized by more tolerant forms which can adapt to silted conditions. Fish are of the warm water variety such as catfish, white bass, yellow perch, carp, and suckers.

From Bluffdale to about 4800 South (Murray) the river is swift and shallow with a sand and gravel bottom. Turbidity is much reduced due to the influence of many small clear springs entering in this area and also to almost total withdrawals of water just south of Bluffdale for agricultural and industrial use. Water temperatures are cooler, aquatic vegetation more abundant, and bottom fauna production is generally good. Some stretches in this section, however, are composed

of unstable sand and fine gravel due to dredging disturbances. These areas are extremely limited in production of aquatic vegetation, bottom fauna, and fish life. Where stable bottom conditions prevail there are good populations of rainbow and brown trout although some rough species of fish also occur here. Brown trout in this area are self-sustaining, spawning either in the main stem of the river or in small clear water tributaries. Rainbow trout fingerlings and catchables have been stocked by the Department. Growth of these fish is good and angling in this section of the river is a popular sport.

From 4800 South to Great Salt Lake the river assumes another character, becoming deep, channelized and sluggish. This section is badly polluted and generally very turbid due to returned irrigation water as well as the pollution load. The bottom substrate is typically silt and shifting sand with many areas composed entirely of sludge beds. Water temperatures are elevated and bottom fauna organisms confined to only two or three types capable of withstanding an extremely polluted environment. Fish species are predominantly carp, chubs, and suckers although trout occasionally are found in the upper portion of this section.

The Jordan River and its tributaries are the receiving waters for a variety of waste effluents originating from industrial, municipal, and agricultural sources. At the present time industrial wastes include those from a beet sugar refinery, a mink food producing plant, a vanadium processing mill, several mining operations, and a number of petroleum refineries. Within the past five years, however, the river and its tributaries have also been the recipient of wastes from three meat packing plants, a uranium processing mill, several metal processing smelters, and a large commercial laundry firm. Within recent years these contributors have ceased discharging raw wastes either because of imposed control measures or because of voluntary changes in their processing. In some cases the industry concerned has simply gone out of business.

Agricultural operations contribute pollution loadings in the form of fertilizers, pesticides, seepage from feed lots and corrals, and dissolved and settleable solids material from return irrigation flows.

Domestic municipal wastes are contributed in the form of secondary treatment plant effluents from eleven plants and waste effluents from three culinary water treatment plants located on tributaries of the river.

In order to obtain the necessary data for this study, sampling stations were established on both the upstream and downstream side of each pollution contributor. In many cases it was possible to utilize the upstream station of one contributor as the downstream station for another and in so doing avoid much needless duplication. At each of these stations a prescribed set of parameters was tested on a monthly or bimonthly frequency. These included chemical and physical data such as dissolved oxygen, carbon dioxide, pH, temperature, specific conductance, settleable solids, alkalinity, and hardness. In addition, a separate study for dissolved oxygen levels on a 24 hour basis once a month was completed for a period of one year. Bottom fauna samples were also taken at each station and these constitute what is probably the most important single set of criteria for assessing biological degradation due to pollution. Fish populations were sampled throughout the river by means of electro-shocking. This data was also used in evaluating the impact of pollution on the Jordan River.

Most of the pollution problem on the Jordan River is concerned with habitat alteration and destruction resulting from chronic organic pollution. This has produced extensive sludge bed formations and heavy silt depositions. These conditions effectively prevent the establishment of normal aquatic vegetative cover and a stream bed substrate capable of supporting a well-balanced and varied population of aquatic invertebrates.

In the case of one major contributor of pollution, a sugar mill, the organic material and the silt depositions discharged are on a massive scale. Determinations made in 1964 (Utah Department of Health) showed an average in excess of 10,000 cubic feet of settleable solids per day being discharged. BOD loadings for this same period averaged 670 milligrams per liter. A normal, unpolluted river averages a BOD of 5 milligrams per liter or less. The annual BOD contribution in this case exceeds three million pounds. These same determinations conducted in 1965 indicate a reduction of some 60% for settleable solids and BOD loadings. It is obvious from this that the industry is attempting to effect some degree of control.

Aquatic organisms may be used to indicate the severity of the pollution load a river carries. Generally speaking, the greater the variety of species or kinds of organisms present, the cleaner the water would be considered. As pollution degrades the environment less tolerant forms are reduced in numbers or eliminated. Ultimately a single form capable of tolerating grossly polluted conditions may take over entirely and be present in prodigous numbers.

Bottom fauna analysis constituted an important phase of this study and provided a valuable index in assessing biological degradation due to pollution. Some of the results of these investigations are outlined in the following graphs.

*Discussion of Graph Material*

Total river mileage is over fifty miles. The area of concern from the standpoint of the most serious pollution is about half of this distance and is located in the center of the valley within the populated and industrialized areas.

Major tributaries and sampling stations are illustrated.

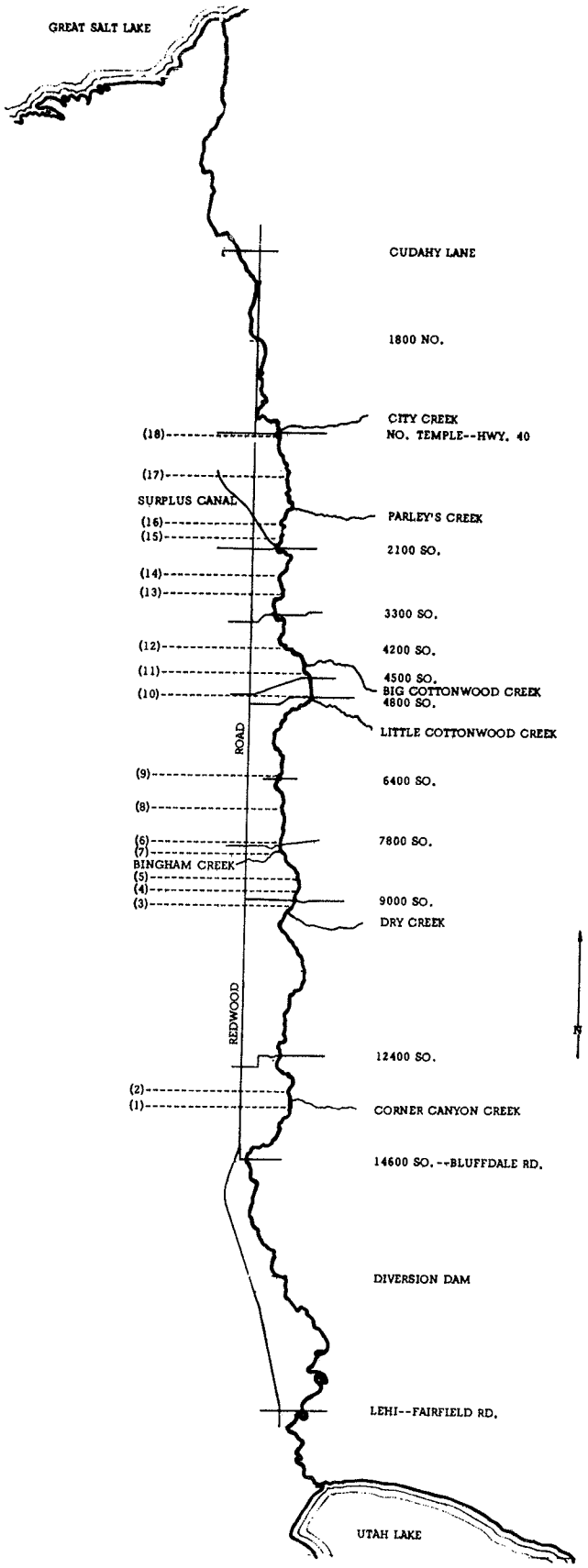



Figure 1. Stations Investigated in the 1965-66 Study.

These graphs represent the total species or kinds of organisms found at each station. We were fortunate to have the results of an earlier bottom fauna study by Dr. Arden Gaufin (University of Utah) available for comparison with the present study. Figure 2 represents this study, conducted ten years ago. Station locations for the two graphs do not coincide exactly so that Station 4 on the top graph is Station 1 on the bottom graph.

At the upper stations note a large variety of species representing a relatively clean water situation with a well-balanced population of organisms.

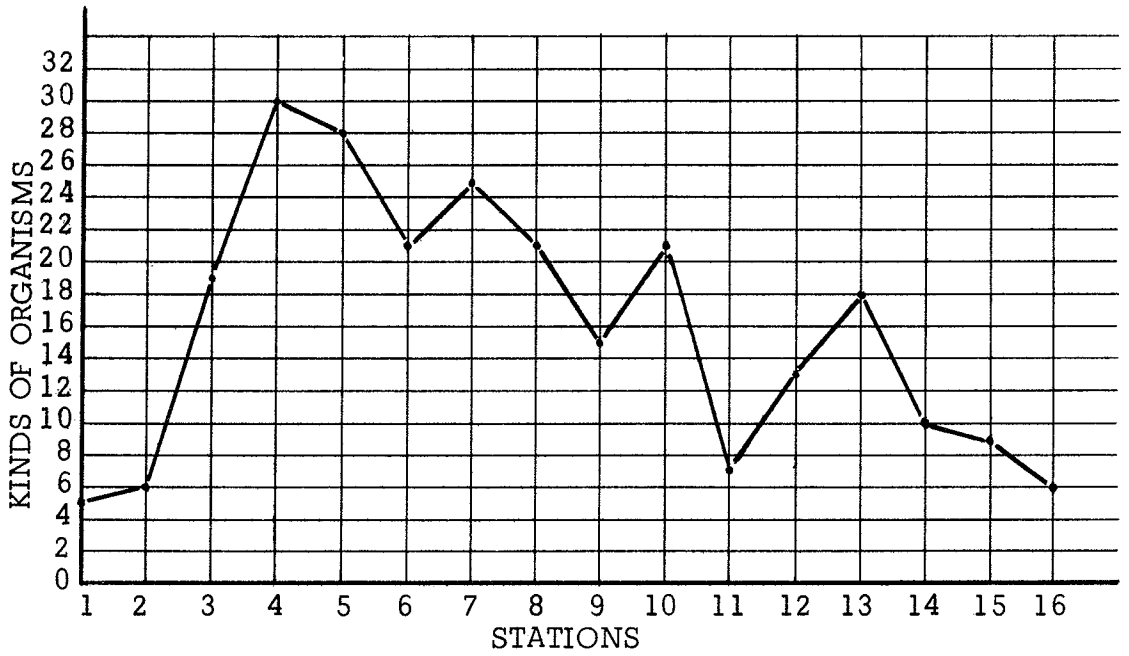



Figure 2. Total Kinds of Organisms at Each Station, 1956-58 Study.

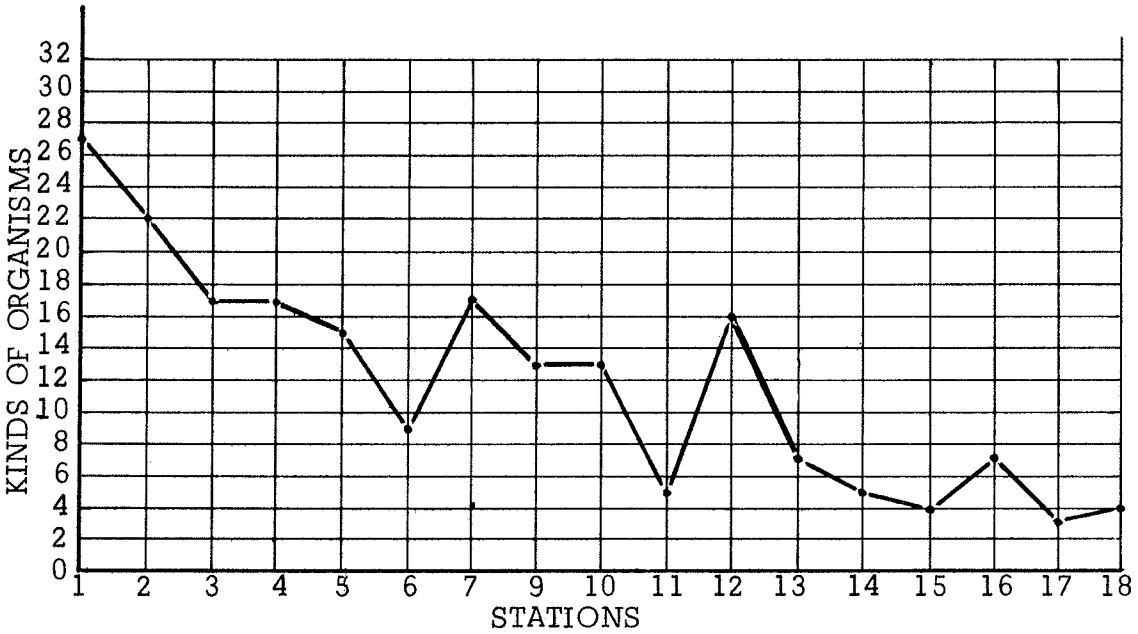
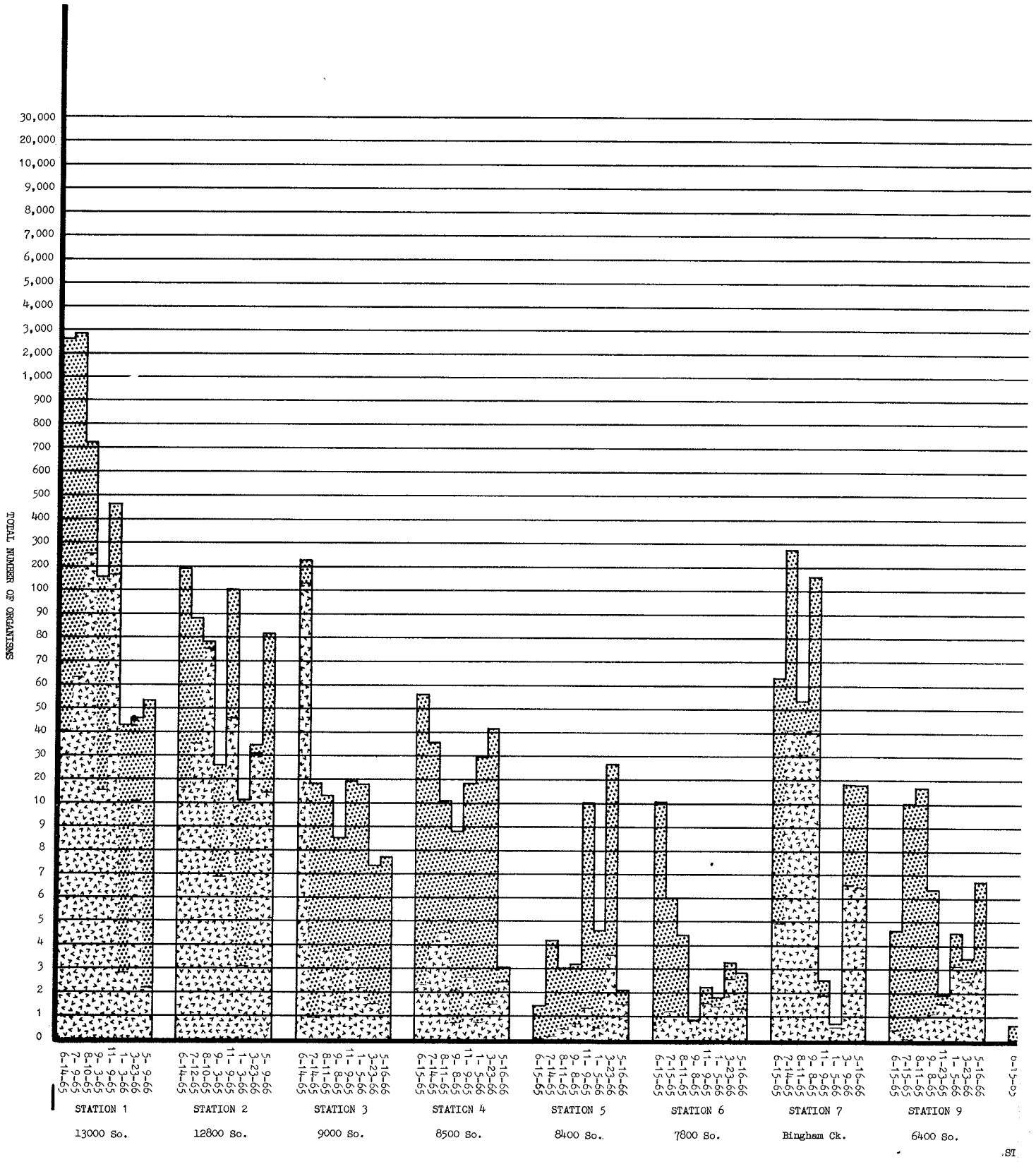



Figure 3. Total Kinds of Organisms at Each Station, 1965-66 Study.


TOTAL NUMBER OF ORGANISMS
30,000
20,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
9
8
7
6
5
4
3
2
1
0
6-14-65
7- 9-65
8-10-65
9- 3-65
11- 9-65
1- 3-66
3-23-66
5- 9-66
6-14-65
7-12-65
8-10-65
9- 3-65
11- 9-65
1- 3-66
3-23-66
5- 9-66
6-14-65
7-14-65
8-11-65
9- 8-65
11- 9-65
1- 5-66
3-23-66
5-16-66
6-15-65
7-14-65
8-11-65
9- 8-65
11- 9-65
1- 5-66
3-23-66
5-16-66
6-15-65
7-14-65
8-11-65
9- 8-65
11- 9-65
1- 5-66
3-23-66
5-16-66
6-15-65
7-15-65
8-11-65
9- 8-65
11- 9-65
1- 5-66
3-23-66
5-16-66
6-15-65
7-14-65
8-11-65
9- 8-65
11- 9-65
1- 5-66
3- 9-66
5-16-66
6-15-65
7-15-65
8-11-65
9- 8-65
11-23-65
1- 5-66
3-23-66
5-16-66
6-15-65
STATION 1
13000 So.
STATION 2
12800 So.
STATION 3
9000 So.
STATION 4
8500 So.
STATION 5
8400 So.
STATION 6
7800 So.
STATION 7
Bingham Ck.
STATION 9
6400 So.

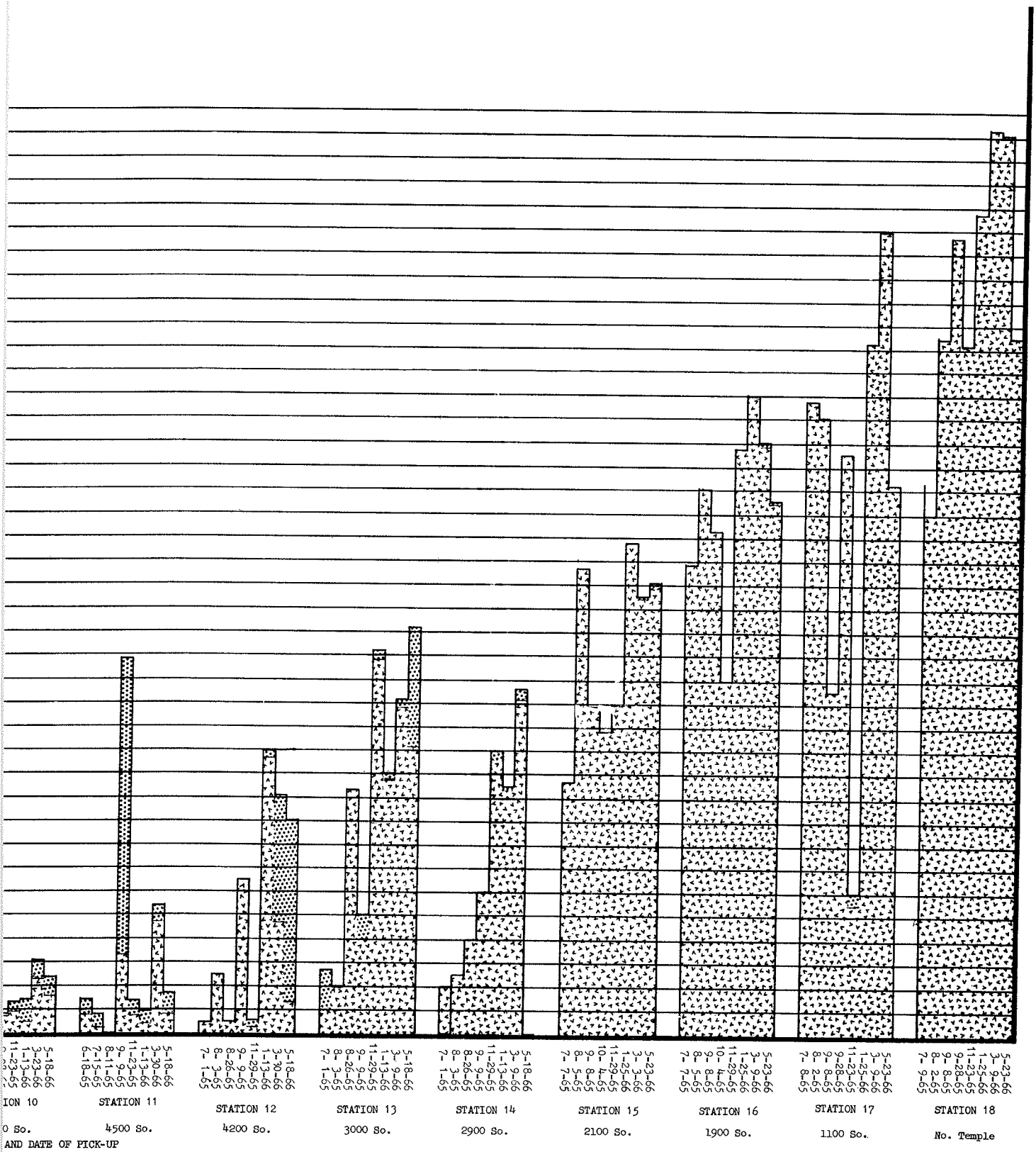



Figure 4. Total Numbers of Aquatic Invertebrates of Each Station--1965-66 Study.

There is a steady and progressive decline in the number of kinds of organisms from south to north on the river in both studies, however, this decline is much more strongly emphasized in the recent study. Note that from Station 13 to Station 18 on the recent study only 4 to 6 species are present — of these, tubificid worms constituted over 95% of the total. The presence of this organism in this quantity indicates an environment grossly polluted by organic material.

Dr. Gaufin's study ten years ago shows a greater variety of kinds of organisms present at almost every station. In the 1965 study many of these kinds were totally absent. This reduction in species is most likely attributable to the progressive increase in severity of pollution during the past ten years.

The bar graph represents total numbers of organisms per square foot by each sampling date for each station. The lighter portions represent tubifex worms. The dotted areas represent all other species. Note the progressive increase in numbers of tubifex worms from Station one to eighteen, especially Stations thirteen through eighteen. The lower end of this section of the river is composed almost entirely of sludge beds. With few exceptions the only organism present is the tubifex worm. In this case the polluted environment has created conditions which are well suited for occupancy by this organism while at the same time virtually all other organisms are excluded. For optimum growth tubifex worms require a soft sludge substrate and large quantities of organic nutrients. They can survive in very low concentrations of dissolved oxygen. They are extremely tolerant to types of pollution which preclude the presence of most other aquatic organisms. Note that at Stations 17 and 18, tubifex numbers exceed 2,000 per square foot, even reaching over 20,000 per square foot on several samplings. These numbers are also typical of spot samplings made farther north on the river but not represented on the graph. The reduction of organisms shown at Station 2 is probably due to the adverse influence of old dredging operations which have created an unstable shifting bottom and consequently poor production of bottom fauna.

Station 5 shows a markedly reduced population of organisms. This is probably attributable to the influence of large loadings of oxygen depleting wastes from a mink food producing plant located just upstream. Larger quantities of mink food are produced from May through October when the young mink are born and reared. At this time there is also a corresponding increase in the volume of waste discharged. The adverse effect on bottom fauna is readily apparent for these months. After the killing season when pelts are harvested, mink food production is greatly reduced and bottom fauna initiates recovery.

Station 7, located on Bingham Creek, plainly shows the effects of sugar beet waste (silt, beet pulp, and unreclaimed sugar) discharged from this stream by a sugar beet refinery. An otherwise healthy bottom fauna is reduced almost to zero during the months this mill operates, shown here for November and January. Recovery of bottom fauna is immediate following mill shut down in February. The influence of this waste effluent is also reflected in Station 6 just downstream from Bingham Creek and also on Station 10 and 11 where bottom fauna numbers are reduced for this period.

Stations 10 and 11 show greatly reduced populations of organisms for all sampling periods. This can probably be attributed to the influence of several sewage treatment plant effluents and also to the fact that this part of the river has been subjected to dredging activity in past years and has an unstable sand and gravel bottom which will support only limited numbers of organisms.

Station 12 reflects some degree of recovery. This is probably due to dilution water entering from Big Cottonwood Creek immediately upstream, even though waters of the creek are polluted to a degree by sewage effluent from a sewage treatment plant at this location.

From Station 12 to 18 numbers of organisms increase greatly, however, this is somewhat misleading because, as has been pointed out earlier, these organisms are predominantly tubifex worms and indicate an extremely polluted situation.

Here, as with the previous bar graph, total numbers of organisms per square foot are represented for each station by the pickup date of each sample. Again, the lighter areas represent tubifex worms while all other species are represented by the dotted portions.

On this study, conducted ten years ago, note a more uniform number of organisms present at all stations with no appreciable gaps as in the more recent study indicating a lesser degree of organic pollution effecting bottom fauna. Less sewage in the aggregate was being discharged then, in fact, a number of sewage treatment plants now present were not here at that time. Tubifex worms while present were not found to occur in greatly elevated numbers even on the north end of the river as they were in the 1965-66 study.

This study was conducted as a cooperative effort by the Utah Department of Fish and Game, Fisheries Division and the University of Utah, Department of Zoology and Entomology.

Norman V. Chamberlain is a fisheries biologist for the Utah Department of Fish and Game. Russell N. Hinshaw is a graduate student at the University of Utah, Department of Zoology and Entomology. Much of the information presented in this report was obtained by Mr. Hinshaw as a partial requirement for his M.S. Degree. Graphs presented in this report were prepared by Mr. Hinshaw specifically for his M.S. Thesis. For more complete information the reader is referred to the M.S. Thesis by Russell N. Hinshaw, THE POLLUTIONAL DEGRADATION OF THE JORDAN RIVER AS SHOWN BY AQUATIC INVERTEBRATES, 1966, University of Utah.

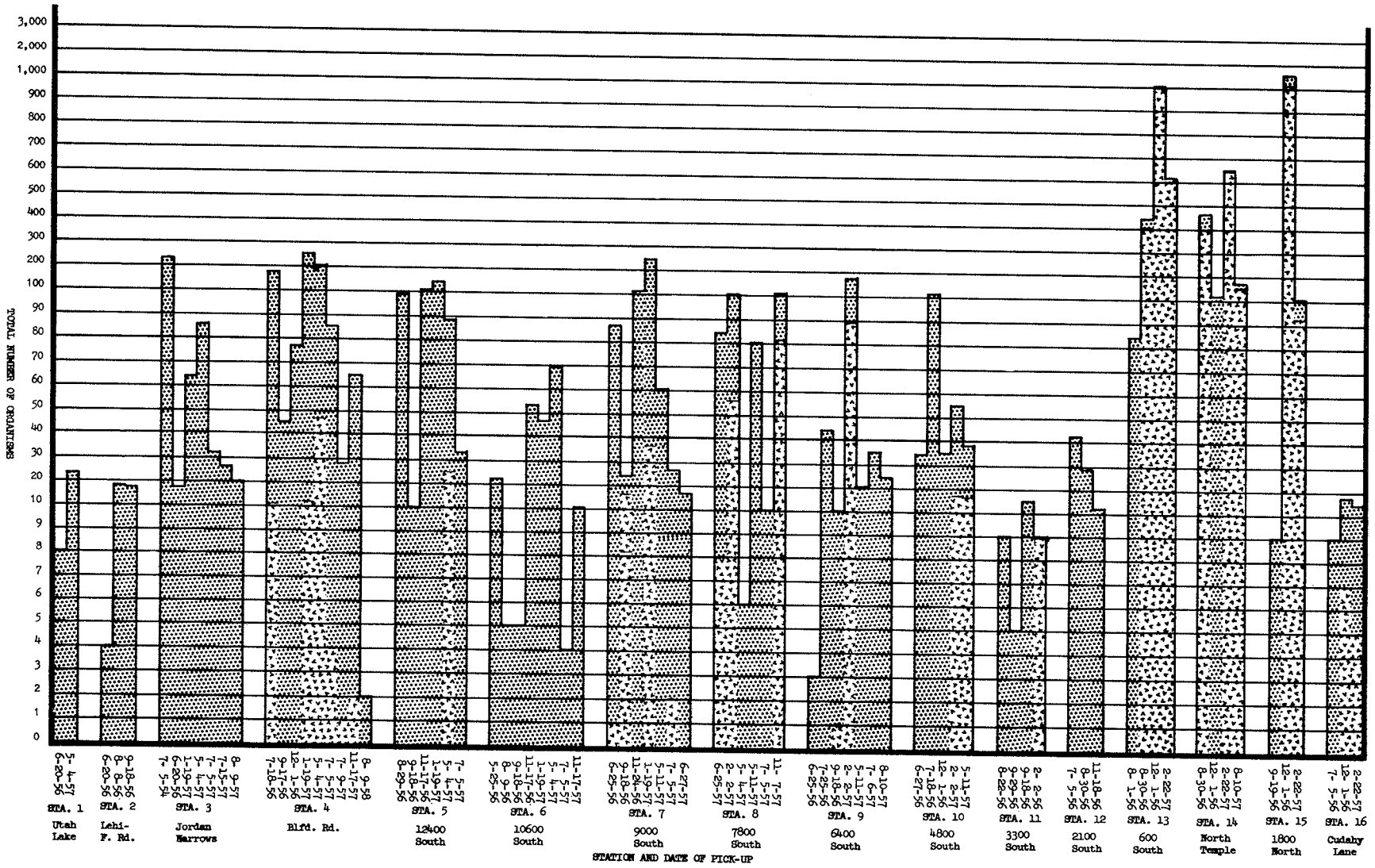



Figure 5. Total Numbers of Aquatic Invertebrates of Each Station--1956-58 Study.

# REVISED CONSTITUTION AND BY-LAWS OF THE UTAH MOSQUITO ABATEMENT ASSN.

Adopted at the 8th Annual Meeting of the Association
Ammended at the 13th Annual Meeting

## CONSTITUTION

### Article I. Name

The Name of this organization, an unincorporated association, shall be "UTAH MOSQUITO ABATEMENT ASSOCIATION."

### Article II. Objects

The objects and purposes of the association shall be to promote close cooperation among those directly and indirectly concerned with, or interested in, mosquito control and related work, to increase the knowledge of mosquito abatement, and the advancement of the cause of mosquito abatement and extermination in the State of Utah and elsewhere. The Association may also encourage and undertake such other insect control problems as the Association may determine.

### Article III. Membership

*Section A.* The membership of the Association shall consists of three classes: Active members, Contributing Members, and Honorary Members.

*Section B.* Active members shall consist of three categories: District Members, Associate Members and Individual Members.

1. District Members shall be any duly constituted mosquito abatement district created under the provisions of the laws of the State of Utah. Each such member shall have five votes to be cast in person by five Trustees present at the time of voting. District Members shall constitute the majority of votes eligible to be cast at any voting.

2. Associate Members shall be agencies, departments, institutions, commissions, civic organizations and other nonprofit groups interested in or concerned with mosquito abatement. Each such member shall have five votes to be cast in person by five designated representatives present at the time of voting.

3. Individual Members shall be any person interested in or concerned with mosquito abatement who desires affiliation with the Association. Each such member shall have one vote to be cast in person at the time of voting.

*Section C.* Contributing Members shall be any commercial or profit-making organization which desires affiliation with the Association. Each such member shall have no vote in the Association.

*Section D.* Honorary Members shall be any individual who has performed outstanding service in the interest of mosquito abatement and who has been elected to honorary membership for life by a two-thirds majority vote of active members present at the time of voting. Each such member shall have no vote in the Association.

*Section E.* All applications for membership shall be subject to approval by the Board of Directors.

### Article IV. Revenues

*Section A.* The revenue of the Association will be derived from dues paid by members from the sale of publications, from donations and contributions and from such other sources as may be approved by the Board of Directors.

*Section B.* The dues for members shall be as follows:

| | | |
|---|---|---|
| 1. | District Members | $75.00 |
| 2. | Associate Members | 10.00 |
| 3. | Individual Members | 2.00 |
| 4. | Contributing Members | Minimum 10.00 |
| 5. | Honorary Members | None |

### Article V. Officers

*Section A.* The elective officers of the Association shall be a President, Vice President and a Secretary-Treasurer. A Director will be appointed by the Board of Trustees of each District Member not represented by an elective officer. The elective officers and the duly appointed directors shall constitute the Board of Directors. Only Active Members shall hold office.

### Article VI. Duties of Officers

*Section A.* The President shall preside at all meetings of the Association, annual and special, and at all meetings of the Board of Directors. He shall maintain and exercise general supervision over the affairs of the Association, subject to the authority of the Board of Directors, and shall discharge such other duties as usually pertain to the office of President.

*Section B.* The Vice-President shall exercise the powers and perform the duties of the President in the absence or disability of the President or in case of a vacancy in the office of the President. He shall also perform such duties as may be assigned to him by the Board of Directors.

*Section C.* The Secretary-Treasurer shall keep full and correct minutes of all meetings of this Association and of the Board of Directors. He shall be responsible for the maintenance of all membership records, conduct the correspondence of this Association, and issue all notices of meetings. He shall collect and receipt for all dues, assessments and other income. He shall deposit promptly all funds of this Association in such depositaries as shall be approved and designated by the Board of Directors. Checks in payment of obligations of this Association shall be signed by the Secretary-Treasurer. He shall, under the direction of the Board of Directors, pay all bills of this Association and make such other disbursements as are necessary and incidental to the operations of the Association. He shall, at the annual meeting of this Association, and if directed by the Board of Directors at special meetings, make full and true report of the financial condition of this Association. He shall perform such other duties as are usually incident to the office of Secretary-Treasurer and as may be assigned to him by the Board of Directors. The Secretary-Treasurer, with the approval of the Board of Directors and with the assistance of the Publications Committee, shall publish and distri-

bute the proceedings and other publications of this Association.

*Section D.* The Board of Directors shall meet upon the call of the President, or upon the request of three (3) or more members of the Board of Directors directed in writing to the Secretary-Treasurer. At least five (5) days prior notice in writing shall be given by the Secretary-Treasurer to all members of the Board of Directors as to any meetings of the Board of Directors: the time and place of such meetings shall be designated by the President. A majority of the members of the Board of Directors shall constitute a quorum for the transaction of business, and action by the Board of Directors shall be upon the vote of a majority of those members present at any meeting of the Board of Directors at which a quorum is present.

Section 2. The Board of Directors shall manage the affairs of this Association and shall have power:

(a) to fill any vacancy among the officers of this Association, including the membership of the Board of Directors;

(b) to appoint a Publications Committee of not more than five (5) to assemble, edit and cause to be published the proceedings of the annual meeting of this Association, and of such special meetings as the Board of Directors shall direct;

(c) to appoint an Auditing Committee of three (3) who shall audit the accounts of this Association and report thereon at the annual meeting of this Association;

(d) to appoint a Program Committee of not less than three (3) for each annual meeting and for any special meeting. The Secretary-Treasurer shall be ex-officio a member of any Program Committee;

(e) to appoint such other committees as it may deem to be necessary of useful in conducting the business of the Association;

(f) to prescribe the duties of officers of this Association not otherwise prescribed in the By-laws of this Association.

(g) to prescribe rules and regulations for the conduct of the affairs of this Association, as are not inconsistent with the provisions of the By-laws of this Association;

(h) to determine the number and price of each publication which shall be distributed to the various members of this Association, and to others; to approve lists of non-members who may receive publications without charge;

(i) to accept or reject applications for membership in this Association, except Honorary Membership, and to prescribe rules and procedure in relation thereto.

## Article VII. Nominating and Election of Officers

*Section A.* At least 15 days prior to the annual meeting of the Association the President shall appoint, subject to approval by the Board of Directors, a Nominating Committee consisting of five Active Members.

*Section B.* The Nominating Committee shall determine its nominees for the elective officers of the Association. It shall, ten days prior to the annual meeting, send to each active member the names of the nominees selected. It shall also receive prior to the time of voting, nominations made in writing and signed by not less than three Active Members for any elective office in the Association. Nominations may be made from the floor at the time of election of officers.

*Section C.* Officers of the Association shall be elected by majority vote at the annual meeting of the Association, and shall serve until the next annual meeting following their election or until the election of their successors.

## Article VIII. Meetings

*Section A.* There shall be an annual meeting of the Association, for the election of officers, the presentation of papers and discussions on mosquito abatement and related subjects, and such other business as may properly be brought before it. Such meetings shall be held at such times and places as the Board of Directors shall prescribe. At least 7 days prior notice shall be given to all members as to the time and place of the annual meeting.

*Section B.* Special meeting of the Association may be held whenever the Board of Directors deems such meetings necessary, or whenever ten or more Active Members shall make a written request thereof, presented to the Secretary-Treasurer. Such request shall be presented to the Board of Directors, which shall designate a time and place for such special meeting. The Secretary-Treasurer shall give written notice of all special meetings of the Association to all members, at least seven days prior to the date of such special meeting. With the approval of the Board of Directors, special meetings of limited membership in the Association, for consideration of technical or administrative matters, may be held at times and places to be determined by the Board of Directors.

*Section C.* A simple majority of Active Members of this Association shall constitute a quorum for the transaction of business at any annual or special meeting and any actions taken at such meetings shall be by majority vote.

## Article IX. Reports and Publications

*Section A.* The annual report of the Association shall be published each year. The report may contain the proceedings, papers, and business transacted at the annual meeting. It may include any other matter deemed by the Board of Directors to be essential to the general welfare.

## Article X. Parliamentary Practices

In the absence of rules in this Constitution or in the By-laws of the Association the proceedings of the Board of Directors' meetings, as well as the Association meetings shall be conducted in accordance with established parliamentary procedure.

### Article XI. Amendments

This Constitution may be amended at any regular business meeting of the Association at which there is a quorum, by a two-thirds vote of the members present, provided the Board of Directors has previously considered the merits of the amendment.

## BY-LAWS

### No. I Dues

Dues for all classes of membership in the Association shall be payable on or before the date of the annual meeting or at such time as the Board of Directors may determine.

### No. II Committees

*Section A.* The following standing committees will be appointed each year by the President subject to the approval of the Board of Directors.

1. The Membership Committee shall consist of not less than three Active Members. This committee shall investigate and promote membership in the Association.

2. Education and Publicity Committee shall consist of not less than three Active Members. The duties of this committee shall be such as assigned by the Board of Directors.

3. Legislative Committee shall consist of not less than three Active Members whose duties shall be such as assigned by the Board of Directors.

4. Program Committee shall consist of not less than three Active Members. Their duties shall be to provide programs and direct events at each annual and special meeting.

5. Publication Committee shall consist of not less than five Active Members whose duties shall include organizing, editing and publication of the proceedings of the annual meeting and such other matters as the Board of Directors may determine.

*Section B.* The following special committees may be appointed by the President subject to the approval of the Board of Directors.

1. Nominating Committee shall consist of not less than five Active Members who shall recommend to the Association candidates for election to the several offices.

2. Auditing Committee shall consist of three Active Members whose duties shall be to examine and audit the books of the Association and report their findings at the annual meeting.

3. Resolutions Committee shall consist of not less than three Active Members.

### No. III Commercial Exhibits

All commercial and other exhibits to be displayed at the various meetings of the Association shall be approved by the Board of Directors. The Board shall also determine the fee to be charged such exhibits.

### No. IV Financial Responsibility

Except by specific direction of the Active Members at an annual or special meeting no debt or other financial obligation shall be incurred beyond the amounts of the funds (over and above all liabilities) then in the hand of the Secretary-Treasurer.

### No. V. Amendments

The By-Laws may be amended at any regular business meeting of the Association at which there is a quorum of Active Members, by a two-thirds vote of the members present, provided the Board of Directors has previously considered the merits of the amendment.

# CHAPTER 14

## MOSQUITO ABATEMENT DISTRICTS



**26-14-1. Organization authorized.**—Mosquito abatement districts may be organized, incorporated and managed as herein provided, and may exercise the powers herein expressly granted or necessarily implied.

**History: L. 1923, ch. 90, § 1; R. S. 1933 & C. 1943, 56-0-1.**

**Comparable Provision.**

Deering's Cal. Health and Safety Code, § 2205 (mosquito abatement district may be "organized and managed" as provided in statute and may exercise powers expressly granted or necessarily implied therein).

**Collateral References.**

Health⇐27.
39 C.J.S. Health § 21.
Subjects of health regulations, 25 Am. Jur. 302, Health § 24 et seq.

**26-14-2. May include cities, towns or counties or portions thereof.**—Any city, town or county, or portion of a city, town or county having a population of not less than one hundred inhabitants, whether such portion includes incorporated territory or not, may be created a mosquito abatement district under the provisions of this title.

**History: L. 1923, ch. 90, § 2; R. S. 1933 & C. 1943, 56-0-2.**

**Comparable Provision.**

Deering's Cal. Health and Safety Code, § 2202 ("city" as including a city and county); § 2203 (each city in proposed district regarded as a "unit"; likewise as to all unincorporated territory in proposed district and in one county only); § 2210 (any territory in one or more counties, having population of not less than 100 inhabitants, may be organized as mosquito abatement district).

**26-14-3. Petition for—Signers—Contents—Publication.**—A petition, which may consist of any number of separate instruments, shall be presented to the board of commissioners of the county in which the proposed mosquito abatement district is located at a regular meeting thereof, signed by registered voters within the boundaries of the proposed district, equal in number to at least ten per cent of the number of votes cast in such proposed district for the office of governor at the last general election prior to the presenting of the petition; provided, that where all or part of one or more municipal corporations is included in such proposed mosquito abatement district, such petition must be signed by at least ten per cent of the qualified electors of such municipal corporations, or parts thereof, and of the unincorporated territory included in such proposed district, and in addition thereto the governing body of each such

municipality shall by resolution request the inclusion of such incorporated territory in such district. Such petition shall set forth and describe the proposed boundaries of the district, and shall pray that the same be created, a mosquito abatement district. The text of such petition shall be published, for at least two weeks before the time when the same is to be presented, in a newspaper published in such county, and also in a newspaper published in each municipal corporation or part thereof included in such proposed district, or if there is no newspaper published in such county or municipal corporation, the text of such petition shall be posted for the same length of time in three public places within the county and within each municipal corporation or part thereof included in such proposed district. When contained in more than one instrument, one copy only of such petition need be published and posted. Not more than five of the names attached to the petition need appear in such publication or posting, but the number of signers shall be stated.

**History: L. 1923, ch. 90, § 3; R. S. 1933 & C. 1943, 56-0-3.**

**Comparable Provision.**

Deering's Cal. Health and Safety Code, §§ 2211, 2212, 2213 and 2214 (similar, except as to proviso herein).

**Collateral References.**

Health⊜27.
39 C.J.S. Health § 21.

**26-14-4. Petition—Hearing—Notice.**—With such petition there shall also be published, and, if posted, there shall also be posted, a notice of the time of the meeting of the board of county commissioners when such petition will be considered, and that all persons interested therein may then appear and be heard. At such time the board shall hear the petition and all protests and objections to the same, and may adjourn such hearing from time to time, not exceeding two months in all. No defect in the contents of the petition or in the title to or form of the notice or signatures, or lack of signatures thereto, shall vitiate any proceedings thereon, provided such petition has a sufficient number of qualified signatures attached thereto. On the final hearing the board shall make such changes in the proposed boundaries as may be deemed advisable, and shall define and establish such boundaries; provided, that if the board deems it proper to include therein any territory not included within the proposed boundaries, they shall first cause notice of their intention so to do to be mailed to each owner of land within the territory proposed to be included whose name appears as such on the last completed assessment roll of the county, addressed to such owner at his address given on such assessment roll, or, if no address is so given, then to his last known address, or, if it is not known, then at the county seat of the county in which his land lies; which notice shall describe the territory so proposed to be included, and shall fix a time, not less than two weeks from the date of mailing thereof, when all persons interested may appear before the board and be heard; provided further, that the boundaries lying within a municipal corporation shall not be altered unless the governing body of such municipal corporation shall, by resolution, assent to the alterations of such boundaries therein.

**History:** L. 1923, ch. 90, § 3; R. S. 1933 & C. 1943, 56-0-4.

**Comparable Provision.**

Deering's Cal. Health and Safety Code, §§ 2215, 2216, 2217, 2218, 2219 and 2220 (substantially identical).

**26-14-5. Findings—Order thereon—Name—When incorporation complete.**—Upon the hearing of such petition the board shall determine whether or not public necessity, or welfare of the proposed territory and of the inhabitants thereof, requires the formation of such district, and shall also determine whether or not the petition complies with the provisions of this title. A finding of the board of commissioners in favor of the genuineness and sufficiency of the petition and notice shall be final and conclusive against all persons except the state. If it appears to the board that public necessity or welfare requires the formation of such district, it shall, by an order entered on its minutes, declare such to be its finding, and shall further declare and order that the territory within the boundaries so fixed and determined be created a mosquito abatement district under an appropriate name to be selected by the board, which name shall contain the words "mosquito abatement district." The county clerk shall immediately cause to be filed with the secretary of state a certified copy of such order of the board of commissioners, and thereafter the district named therein shall be deemed incorporated as a mosquito abatement district, with all the rights, privileges and powers set forth in this title and necessarily incident thereto.

**History:** L. 1923, ch. 90, § 3; R. S. 1933 & C. 1943, 56-0-5.

**Comparable Provision.**

Deering's Cal. Health and Safety Code, §§ 2221, 2222, 2223 and 2224 (substantially the same).

**Collateral References.**

Health⇐27.
39 C.J.S. Health § 21.

**26-14-6. Board of trustees—Appointment—Number—Term.**—Within thirty days after the filing with the secretary of state of the certificate of incorporation of the district a governing board of trustees therefor shall be appointed. Such board shall consist of one trustee to be appointed from the district at large by the board of county commissioners, and of one trustee to be appointed from each municipality therein by the governing body of such municipality; provided, that if the board of trustees so created shall consist of less than five members, the board of county commissioners shall appoint from such district at large enough additional members to make a board of five trustees; provided further, that if seventy-five per cent or more of the lands in the district are wholly within the boundaries of a city or town, all five members of the board of trustees shall be appointed by the governing board of such municipality. The governing board of such district shall be known as "The board of trustees of ..... mosquito abatement district." Each trustee appointed by the governing body of a municipality shall be an elector of the municipality from which he is appointed and each appointee of the board of county commissioners shall be an elector of the district. All trustees shall hold office for a term of two years from and after the 2nd day of January following their appointment; provided, however, that the

first board of trustees appointed under the provisions of this title shall at their first meeting so classify themselves by lot that one-half of their number, if the total membership is an even number, and if uneven, that a bare majority of their number, shall go out of office at the expiration of one year and the remainder, at the expiration of two years, from the 2nd day of January following their appointment.

**History:** L. 1923, ch. 90, § 4; 1931, ch. 52, § 1; R. S. 1933 & C. 1943, 56-0-6.

**26-14-7. Board of trustees—Organization—Meetings—Vacancies—Quorum.**—The members of the board of trustees shall meet on the first Monday subsequent to thirty days after the filing with the secretary of state of the certificate of incorporation of the district, and shall organize by electing one of their members as president and one thereof as secretary. The members of the board shall serve without compensation, except that the necessary expenses of each member for actual traveling expenses on meetings or business connected with the board shall be allowed and paid. In event of the resignation, death or disability of any trustee his successor shall be appointed by the board of county commissioners, if such board originally made such appointment, or by the governing body of the appropriate municipality, if such appointment was originally made by the latter. The board of trustees shall provide for the time and place of holding its regular meetings, and the manner of calling the same, and shall establish rules for its proceedings; special meetings may be called by three trustees, and notice of the holding thereof shall be given to each member at least three hours before the meeting. All of its sessions, whether regular or special, shall be open to the public and a majority of the members of the board shall constitute a quorum for the transaction of business.

**History:** L. 1923, ch. 90, § 5; R. S. 1933 & C. 1943, 56-0-7.

**Collateral References.**
Health⇨27.
39 C.J.S. Health § 21.

**26-14-8. Powers of board of trustees—Interference with, a crime.**—The board of trustees of such district shall have power to take all necessary and proper steps for the extermination of mosquitoes, flies and other insects within the district and, subject to the paramount control of the municipal or other public authorities, to abate as nuisances all stagnant pools of water and other breeding places for mosquitoes, flies or other insects within the district or in territory located in any city or county in the state so situated with respect to such district that mosquitoes therefrom may migrate into the district, to enter upon such territory for the purpose of inspection and examination of the same, and to remove therefrom without notice, stagnant water or other breeding places for mosquitoes, flies or other insects; to purchase such supplies and materials and to employ such labor as may be necessary or proper in furtherance of the objects of this title, and, if necessary or proper in the furtherance of the same, to build, construct and thereafter repair and maintain necessary levees, cuts, canals or channels upon any land within the district, and to acquire by purchase, condemnation or other lawful means in the name of the district

any necessary lands, rights-of-way, easements, property or materials requisite or necessary for any of such purposes; to make contracts to indemnify or compensate any owner of land or other property for any injury or damage necessarily caused by the exercise of its powers by this title conferred or arising out of the use, taking or damage of property for any such purposes and generally to do any and all things necessary or incident to the powers hereby granted and to carry out the objects specified herein. It is a misdemeanor for any person to prevent, hinder, delay or interfere with said board in the exercise of its powers or duties, and cities, towns and counties shall have the power by ordinance to declare such acts to be a misdemeanor and prescribe punishment therefor.

**History: L. 1923, ch. 90, § 6; 1931, ch. 52, § 1; R. S. 1933, 56-0-8; L. 1937, ch. 64, § 1; C. 1943, 56-0-8.**

**Compiler's Note.**

The 1937 amendment inserted "or in territory * * * into the district" after "district" in seventh line, changed "any land" to "such territory" in ninth line, inserted "and counties" after "towns" in next to last line, and made various minor changes in phraseology and punctuation.

**Cross-Reference.**

Eminent domain, 78-34-1 et seq.

**26-14-9. Taxation—Limit of levy.**—The board of trustees of each mosquito abatement district shall furnish to the board of county commissioners and to the county auditor, respectively, of the county in which such district is situated, in writing, an estimate of the amount of money necessary for all purposes required under the provisions of this title during the next ensuing fiscal year. Such estimate shall be furnished at least fifteen days before the first day of the month in which the board of county commissioners is required by law to levy the taxes required for county purposes. The board of county commissioners shall thereafter, at the time and in the manner of levying other county or city and county taxes, but without additional compensation for assessing and collecting, levy upon all of the taxable property within the district and cause to be collected a tax, to be known as the "..... mosquito abatement district tax." The maximum rate of such tax must not be greater than sufficient to raise as nearly as may be the amount estimated to be necessary by the board of trustees of the district, and in no event shall such tax exceed ten cents on each one hundred dollars of taxable property in such district.

**History: L. 1923, ch. 90, § 7; R. S. 1933 & C. 1943, 56-0-9.**

**Collateral References.**

Health⇐27.
39 C.J.S. Health § 21.

**26-14-10. Taxation—Additional levy—Election.**—Whenever it appears to the board of trustees of any such district that the amount of funds required during the next ensuing fiscal year will exceed the maximum amount which the county commissioners are authorized to levy for the annual district tax, the board of trustees may in its discretion call an election and submit to the electors of the district the question of whether a tax shall be voted for raising the necessary additional funds, and notice thereof shall be published for at least four weeks prior to such election in a newspaper published in such district; provided, that no particular form of ballot shall be required and no informalities in conducting such election shall invalidate the same, if the election shall have otherwise been fairly

conducted. At such election the ballots must contain the words, "Shall the district vote a tax to raise the additional sum of $.....?" The board of trustees shall canvass the votes cast at such election, and, if a majority of the votes cast are in favor of the imposition of such tax, the board of trustees must report the same to the board of county commissioners, stating the additional amount of money required to be raised. The board of county commissioners shall at the time of levying general county taxes levy an additional tax upon all of the taxable property in the district voting such additional tax.

**History:** L. 1923, ch. 90, § 7; R. S. 1933 & C. 1943, 56-0-10.

**26-14-11. Collection and disbursement.**—All taxes levied under the provisions of this title shall be computed and entered on the assessment roll, and collected at the same time and in the same manner as state and county taxes, and when collected shall be paid into the county treasury for the use of the district. Such funds shall be withdrawn from the county treasury upon the warrant of the board of trustees of the mosquito abatement district, signed by the president, or acting president, of the board and countersigned by its secretary.

**History:** L. 1923, ch. 90, § 7; R. S. 1933 & C. 1943, 56-0-11.

**Collateral References.**
Health⇐27.
39 C.J.S. Health § 21.

**26-14-12. Annexing territory—Election.**—Any territory, incorporated or unincorporated, lying adjacent and contiguous to a mosquito abatement district may be added and annexed to such district at any time upon proceedings as follows: The board of trustees of such district, upon receiving a written petition therefor, containing a description of the new territory sought to be annexed to such district, signed by the owners of more than one-half of the assessed value of such territory as shown by the last county assessment roll, must submit to the electors of the district, and also to the electors residing in the territory sought to be annexed, the proposition of whether such proposed territory shall be annexed and added to such district. The proposition to be submitted to the electors at such election, both within said district and within said territory so proposed to be annexed, shall be as follows: "For annexation," or "Against annexation," or words equivalent thereto. Such election must be called and held, and notice thereof shall be published for at least four weeks prior to such election in a newspaper published in such district, and also in a newspaper published in such territory so proposed to be annexed. The board of trustees shall canvass, separately, the votes cast within said district and the votes cast within said territory so proposed to be annexed, and, if it shall appear from such canvass that a majority of all the ballots cast in such district and a majority of all the ballots cast in such territory so proposed to be annexed are in favor of annexation, the board of trustees shall certify such facts to the secretary of state, describing the territory proposed to be annexed, and upon receipt of such last mentioned certificate the secretary of state shall issue his certificate reciting that the territory

(describing the same) has been annexed and added to the ..... mosquito abatement district (naming it), and a copy of such certificate of the secretary of state shall be transmitted to and filed with the county clerk of the county in which such mosquito abatement district is situated. From and after the date of such certificate the territory named therein shall be deemed added and annexed to and a part of such mosquito abatement district. If the property so proposed to be annexed is included within a municipality, consent to such annexation shall first be obtained from its governing body, and an authenticated copy of the resolution or order of such body so consenting to such annexation shall be attached to the petition and be made a part thereof.

**History:** L. 1923, ch. 90, § 8; **R. S. 1933 & C. 1943, 56-0-12.**

**Comparable Provision.**

Deering's Cal. Health and Safety Code, § 2330 et seq. (authorizing and prescribing manner of annexing adjacent and contiguous territory).

**Cross-Reference.**

Effect of forming new county, 17-3-5.

**26-14-13. Dissolution—Election—Apportionment of property.**—Any mosquito abatement district may at any time be dissolved upon the vote of two-thirds of the qualified electors thereof, upon an election called by its board of trustees upon the question of dissolution, and the proposition which shall be submitted to the electors at such election shall be as follows: "Shall the district be dissolved?" Notice of such election shall be published for at least four weeks prior thereto in a newspaper published in such district. If two-thirds of the votes cast at such election shall be in favor of the dissolution of the district, the board of trustees shall certify such fact to the secretary of state, and thereupon he shall issue his certificate reciting that the mosquito abatement district (naming it) has been dissolved; and a copy of such certificate of the secretary of state shall be transmitted to and filed with the county clerk of the county in which such mosquito abatement district is situated. From and after the date of such certificate the district named therein shall be deemed disincorporated, and the property of the district shall thereupon vest in the county wherein said district is situate, if the district at the time of its dissolution comprises unincorporated territory alone, and, if it comprises incorporated territory alone, or partly incorporated and partly unincorporated territory, its property shall be ratably apportioned amongst the several municipalities and the county in proportion to the assessed value of the property included within the district as shown upon the last county assessment roll; provided, that any real property, easements or rights of way belonging to the district shall in such event remain the property of the municipality wherein the same is situate, if situated within incorporated territory; otherwise, the same shall remain the property of the county.

**History:** L. 1923, ch. 90, § 9; **R. S. 1933 & C. 1943, 56-0-13.**

**Comparable Provision.**

Deering's Cal. Health and Safety Code, § 2390 et seq. (similarly prescribing method of dissolution of district).

**Collateral References.**

Health⇐27.
39 C.J.S. Health § 21.

**26-14-14. Notices—Publication and posting.**—Every notice herein required to be published may be published in a daily or weekly newspaper; and if there is no such newspaper published within the district or other territory wherein the notice is required to be published, such notice shall be posted in three public places thereof for the length of time herein required for the publication of the same.

**History:** L. 1923, ch. 90, § 10; R. S. 1933 & C. 1943, 56-0-14.

**Collateral References.**
Health⇐27.
39 C.J.S. Health § 21.

CHAPTER 14—MOSQUITO ABATEMENT DISTRICTS



**26-14-8. Powers of board of trustees—Interference with, a crime.**—The board of trustees of such district shall have power to take all necessary and proper steps for the extermination of mosquitoes, flies and other insects within the district and to abate as nuisances all stagnant pools of water and other breeding places for mosquitoes, flies or other insects within the district or in territory located in any city or county in the state so situated with respect to such district that mosquitoes therefrom may migrate into the district, to enter upon such territory for the purpose of inspection and examination of the same, and to remove therefrom without notice, stagnant water or other breeding places for mosquitoes, flies or other insects; to purchase such supplies and materials and to employ such labor as may be necessary or proper in furtherance of the objects of this title, and, if necessary or proper in the furtherance of the same, to build, construct and thereafter repair and maintain necessary levees, cuts, canals, or channels upon any land within the district, and to acquire by purchase, condemnation or other lawful means in the name of the district any necessary lands, rights-of-way, easements, property or materials requisite or necessary for any of such purposes; to make contracts to indemnify or compensate any owner of land or other property for any injury or damage necessarily caused by the exercise of its powers by this title conferred or arising out of the use, taking or damage of property for any such purposes and generally to do any and all things necessary or incident to powers hereby granted and to carry out the objects specified herein. It is a misdemeanor for any person to prevent, hinder, delay or interfere with said board in the exercise of its powers or duties.

History: L. 1923, ch. 90, § 6; 1931, ch. 52, § 1; R. S. 1933, 56-0-8; L. 1937, ch. 64, § 1; C. 1943, 56-0-8; L. 1959, ch. 42, § 1.

**Compiler's Note.**

The 1959 amendment deleted the phrase "subject to the paramount control of the municipal or other public authorities" following "within the district and" and the phrase "and cities, towns and counties shall have the power by ordinance to declare such acts to be a misdemeanor and prescribe punishment therefor" at the end of the section.