

vidual pastures by as much as 90%. It means that operators, instead of having to spray entire fields, spray only a few residual drains in the field.

The following case histories of actual cooperative drainage projects performed by the District with the tractor and ditcher are typical of the results obtained so far.

reduction of mosquitoes through drainage so far is infinitesimal compared to what is left to be done, but it is at any rate a step in the right direction. Further accomplishment in any marked degree will depend in large part on the cooperation obtainable from the farmers themselves as well as from other agencies.

	Pasture	Larviciding Cost for One Season	Cost to District for Drainage	Larviciding Cost Following Season
Case A	1,200 Acres	\$1,275	\$81	\$295
Case B	100 Acres	\$ 201	\$52	\$ 19
Case C	33 Acres	\$ 29	\$11	\$ 0

These projects obviously result in a financial saving to the district, but they also mean increased yield to the farmer and consequently increased good will for the district.

We regard our program as a long range approach and our individual projects as demonstrations of what can be done. We realize that there is more to be done by way of drainage in Merced County than any one organization without unlimited resources could ever hope to do. Any

SUMMARY: The Merced County Mosquito Abatement District is approaching the problem of reducing mosquito sources in irrigated fields by contracting with the farmers to do the necessary drainage construction and maintenance work at cost; by cooperating with and enlisting the aid of other agencies with mutual problems; and by conducting an educational program to promote the solution of drainage problems by the farmers themselves.

THE CDC PROGRAM RELATED TO WATER RESOURCES DEVELOPMENT¹

CHRIS A. HANSEN

I. Introduction. Water is a major factor in Western prosperity. To the members of this Association, water also means mosquitoes, and mosquitoes mean disease, discomfort, and economic loss. We are all interested in this national resource and its development for the greatest benefit to the greatest number of people. This afternoon, I want to tell you the reasons why we, in the Communicable Disease Center, are partici-

pating in the national water resources development activity, the problems we face, and the program we are conducting.

II. The National Water Resources Development Program. Development of the nation's water resources has been under way since early colonial times, but only during the past forty years has the magnitude of this development become significant. Federal, state, local, and private groups are all participating in this work, but often with widely divergent interests and needs. To coordinate the efforts of all, the President, in 1948, ap-

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pointed a commission to study the problem and to recommend *a water policy for the American people*. This commission (1) formulated a proposal for comprehensive water resources development involving coordinated basin-wide planning for maximum beneficial use of the nation's river systems and their watersheds. The proposed program includes 13 primary elements: (1) watershed management, (2) flood management, (3) water supply, (4) navigation, (5) hydro electric power, (6) irrigation, (7) pollution abatement, (8) drainage, (9) recreation, (10) fish and wildlife, (11) sediment control, (12) salinity control, and (13) insect control.

This comprehensive river basin development program includes large reservoirs, stock and fish ponds, canals, irrigation systems, as well as levees and soil erosion control work. Coordination of the work of all interested agencies and groups is achieved by Inter-Agency River Basin Committees. These committees consist of representatives from Federal and State agencies and include active participation by local organizations and individuals. The Communicable Disease Center works through the Federal Security Agency—Public Health Service member of this group.

III. Necessity for Health Agency Participation. The use of water for irrigation has created public health problems since pre-Biblical times. Increased knowledge and improved techniques of investigation have led to recognition of water-derived insects as factors in this connection. Expanding irrigation development and recent emphasis on water resources activities, particularly in the West, require immediate attention to the public health problems involved.

The occurrence of malaria outbreaks resulting from water impoundments in the southeastern United States is well known. Although malaria is no longer a major public health problem in the United States, I believe that it would be foolhardy to ignore the experience of the past forty years by developing water resources without regard for possible future

malaria problems. We do not need the caution of fifteen years ago, but we must not create malaria mosquito breeding areas which could not be controlled if a recurrence of the disease demanded control. *Malaria could come back!*

Encephalitis is a growing problem in this country. Equine encephalomyelitis has occurred in every state of the Union with especial concentration throughout the western and midwestern areas. Major outbreaks of encephalitis have occurred in Missouri and North Dakota. The 1933 St. Louis outbreak exceeded 1600 cases of human encephalitis with 310 deaths. In 1941 more than 1100 human cases with 139 deaths were reported in North Dakota. Smaller epidemics have occurred repeatedly throughout the western states. Many of these outbreaks had no relationship to irrigation, but they were associated with unusual natural mosquito production. The Central Valley of California is an important encephalitis area. There, however, endemic encephalitis became prevalent only after major irrigation projects were established.

Research and investigations during the St. Louis outbreak, and subsequent work by numerous investigators have established the fact that mosquitoes can transmit at least five varieties of encephalitis virus. *Culex tarsalis* mosquitoes, commonly found in irrigated areas of the West, have been incriminated repeatedly as carriers of encephalitis virus.

At the third annual Public Health Service Encephalitis Conference, attended by Public Health Service research workers in the field, together with other outstanding virus encephalitis investigators, the following resolutions were adopted:

1. Encephalitis is a public health problem and the potential public health significance of this disease is fully recognized.
2. Preventive mosquito control is justified and should be continued through intensive cooperative action with other Federal and State agencies concerned with water resources development throughout the nation, the principal justification for this program being the

public health importance of encephalitis and pest mosquitoes.

3. Studies should be undertaken on passive and active immunization procedures in man and animals for the purpose of developing means to aid in the control of epidemic outbreaks of encephalitis. An antiserum should be developed if possible, manufactured, and kept in supply for preventive treatment in times of epidemics of the disease.
4. Serologic and pathologic studies should be continued to improve the diagnosis of the encephalitides in man.
5. Continued epidemiologic and ecologic studies are essential to solve many of the unsolved problems in the realm of encephalitis.

These resolutions emphasize the importance of encephalitis to the public health and stress measures for its prevention and control.

Health and well-being are necessary to our way of life as well as a requirement for maximum productivity by our people. To accomplish this objective, mosquito control and disease prevention must be expanded in the public health program. The national policy for conservation of human, land, and water resources *demand*s the prevention and control of insects having a deleterious effect on the public health.

Aside from the health interests, mosquitoes also exert a significant detrimental effect on our economy. Beef, poultry, egg, and milk production are significantly reduced by mosquito annoyance. The Crocker-Hoffman Land & Cattle Company of California reports that animals grazed on pastures with mosquito control gained from 50 to 100 pounds each per year more than cattle grazed on pastures without mosquito control. In order to minimize these economic losses, as well as to protect human health, large sums of money are expended. For example, in the State of California, more than 2 million dollars are spent annually on mosquito control.

IV. Insect Problems of Public Health

Significance Resulting from Water Resources Development. The principal insect problems created by water development result largely from poor irrigation practices. Such procedures create pooled areas which damage the soil, decrease productivity, and provide a perfect habitat for mosquitoes.

At the present time, there are more than 21 million acres of irrigated land in the United States, mostly in the western states. A serious mosquito breeding problem exists in much of this area. Planned irrigation development is expected to increase this amount by approximately 10 million acres during the next 25 years. It is most important that mosquito breeding be minimized in these new areas.

Reservoirs and other impoundments often produce tremendous numbers of mosquitoes. However, adequate clearing of the reservoir area before impoundment helps to solve the problem. Similarly, canals and laterals are of negligible importance as mosquito breeding places if adequately constructed, operated, and maintained. Seepage from leaky canals eliminates fertile land from production and at the same time creates an excellent habitat for mosquitoes. In the Farmers Irrigation District near Scottsbluff, Nebraska, over 5,000 of 60,000 acres of good farming land have become mosquito breeding seepage areas, useless for agricultural purposes, as a result of seepage from distribution canals.

V. The CDC Program. The Communicable Disease Center has established a Water Projects Section in its Vector Control and Investigations Branch to direct the Public Health Service program for prevention and control of insect problems of public health importance associated with the water resources development. Dr. Stanton J. Ware, Chief of this Section, has established his headquarters here in Salt Lake City in order to be located more centrally with respect to the principal problem areas.

The CDC objectives for this program are: first, to prevent or minimize the creation of new mosquito problems on

water projects being developed; and second, to aid in the elimination and control of insect problems produced by water developments constructed in the past. Our primary emphasis in the immediate future is to be on prevention, and later, as time permits, we will concentrate on the second objective of eliminative and control work. The Water Projects Section of the Communicable Disease Center will not be in the pest control business in the sense of swatting and spraying mosquitoes, but rather in guiding construction agencies and groups in "building" mosquito prevention into the projects. These measures will be extended also to the operation and maintenance phases of irrigation projects. In existing problem areas, we favor a planned long-range program for eliminating the problem and using supplemental repetitive chemical control measures.

Research, investigations, and demonstrations will be conducted to delineate the problem more clearly and to develop effective preventive and control measures. Research workers at our Mitchell, Nebraska, field station are actively engaged in important ecological studies and evaluation of mosquito problems associated with water development in that area. At Angostura, South Dakota, a demonstration is being conducted in cooperation with the Bureau of Reclamation and the Soil Conservation Service to show that mosquito problems can virtually be eliminated in the construction phases. Studies under way at Bakersfield, California, in cooperation with the Hooper Foundation, are designed to broaden our knowledge of the complex virus encephalitis transmission chain. Other investigations are being conducted jointly with the California State Department of Public Health on specific operational and ecological problems. Similar studies will be increased as the need arises and funds become available.

We believe that public health insect control should be an integral part of state and local health department programs. Accordingly, we are assisting State Health departments in developing insect

vector control organizations to deal with insects of public health importance.

A definite program is under way for dissemination of technical insect vector control information to water development agencies and water users, on the need for mosquito prevention in water development programs and eliminative and control procedures for existing projects. This is accomplished by preparation and distribution of such authoritative information as brochures, films, filmstrips, and reports. The brochure "Mosquito Problems and Prevention in Irrigated Areas" has just been released.

Surveys of water projects under consideration are necessary to anticipate problem conditions during the planning stage and to outline the necessary preventive measures. We will participate in this work by supplementing, where necessary, the State Health department activities. We are now engaged in evaluating and reporting on the insect problem associated with basin-wide developments planned by various Federal, State and local agencies in the lower Mississippi, Northeast, Pacific Northwest, and Missouri River Basins. This is a part of Federal Inter-Agency River Basin Committee's plan for coordinating the interests of all concerned.

Proper planning will assure the inclusion of mosquito preventive measures in future water resources development activities. We are responsible for coordinating the vector control work of the Public Health Service in these areas. To accomplish these many objectives, we will need to train more professional and technical personnel to carry on the proposed vector control work.

Local communities will be assisted, through the State Health departments, in the organization of mosquito abatement districts in areas suffering from the plague of mosquitoes resulting from water resources development. Technical assistance is available also to existing mosquito abatement districts in similar areas.

Excellent work is now being done by mosquito abatement districts, but that

work covers only a small percentage of the total problem. Scores of additional districts are needed *now*, not only in the West but also in the rice-producing areas of the South, and in coastal problem areas.

VI. Summary. Our program is concerned with the insect problems of public health importance associated with the National Water Resources Development Program. We have two basic objectives, (1) to prevent these insect problems on water projects being developed, and (2) to promote the elimination or control of the problems on existing projects. The co-operation of the constructing agencies, the water users, the agricultural and health agencies, the mosquito abatement districts, and recreational interests will be needed to accomplish these objectives. Many additional mosquito abatement districts need to be organized now to cope with the existing mosquito problems in irrigated areas of the United States—the greatest need is in the West and the rice-growing areas of the South and Southwest. The Water Projects Section will carry out a program of:

1. Delineating the problem by research and investigations and developing

effective preventive and control measures.

2. Assisting the State Health departments in developing organizations to deal with insects of public health importance.
3. Disseminating information to water development agencies and water users on the need for insect control measures on existing projects.
4. Promoting mosquito abatement districts in areas plagued by mosquitoes resulting from water resources development.
5. Preparing surveys of projects under development to anticipate problem conditions.
6. Planning to assure the inclusion of preventive measures in future water resources development activities.
7. Coordinating vector control work of the Public Health Service in water resources development areas.
8. Training personnel to carry on vector control work in the areas under consideration.

Reference

1. 1950. U. S. President's Water Resources Policy Commission. Vol. 1: A Water Policy for the American People, U. S. Government Printing Office, Washington, D. C., 445 pages.

PHOTOGRAPHS TAKEN AT THE AMERICAN MOSQUITO CONTROL ASSOCIATION ANNUAL MEETING AT SALT LAKE CITY, UTAH, MARCH 24 to 27, 1952. These pictures are available through the Western Photo and Science Service, P. O. Box 411, Berkeley, California. 8 x 10 glossy prints are \$1.00 each. 1. AMCA Field Tour group picture at Copper Club, Magna, Utah. 2. Kennecott open pit copper mine at Bingham, Utah. 3. Group in lobby (Stutz, L. Smith, Rees, Hirst, Mulrennan, R. F. Peters, Lindquist, Carpenter, Clark, Stage, Dorer, Gray and Twinn. 4. California Group. 5. Dr. Bradley and Chris Hansen. 6. AMCA President and Past-President; Dr. Twinn and Dr. Rees at field equipment demonstrations. 7. Dr. Collins and Dr. Bradley. 8. Mulhern congratulating Raley on his new job as Executive-Secretary of the AMCA with Dr. Rees looking on. 9. President Henderson, Past President Smith and V.P. Bob Peters of the California Mosquito Control Association and their exhibit. 10. Field demonstrations of fog machines at Salt Lake M. A. D. 11. U.S.D.A. personnel at field demonstrations: Husman, Bishop, Lindquist, Gjullin, Hoffman, Stage. 12. Husman demonstrating mist sprayer. 13. T. D. Mulhern and AMCA gift clock (2 poses at Fresno home). 14. Mr. and Mrs. T. D. Mulhern and AMCA gift clock (2). 15. Demonstration of TIFA (Steinrock and Williams—2 poses). 16. TIFA exhibit booth (Schoenfeld, Steinrock, Henderson and Williams). 17. Lawrence Aero-Mist demonstration (2). 18. Weber Co. MAD Butane Fog Machine (2).