PROCEEDINGS
of the
FORTY-SECOND ANNUAL MEETING

of the
UTAH MOSQUITO ABATEMENT ASSOCIATION

Held at the
EXCELSIOR HOTEL
Provo, Utah

September 24-26, 1989

Edited by
SAMMIE DICKSON

UTAH MOSQUITO ABATEMENT ASSOCIATION
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TABLE OF CONTENTS

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RESOLUTIONS

WHEREAS, the Utah Mosquito Abatement Association has held its 42nd Annual Meeting at Excelsior Hotel, Provo, Utah, September 24, 25, and 26, 1989;

WHEREAS, Utah County Mosquito Abatement District, Lewis Marrott, Manager, has served as the host organization; and

WHEREAS, the Arrangement and Program Committees have done an outstanding job;

THEREFORE, be it resolved that the members of the UMAA extend sincere appreciation to Utah County Mosquito Abatement District and all others concerned with preparation and arrangements for this excellent convention.

WHEREAS, many of the speakers came considerable distances to participate in these meetings; and

WHEREAS, the papers presented by the speakers have been of high quality and informative for those in attendance;

THEREFORE, be it resolved that the Association extends its appreciation to all speakers and gives special thanks to those who came from out of state including Judy Hansen, President, American Mosquito Control Association and Director Cape May County Mosquito Commission, Cape May, New Jersey, and Claude Watson, President of California Mosquito and Vector Control Association and Manager of East Side MAD, Modesto, California.

WHEREAS, the Excelsior Hotel has provided excellent facilities and services; and

WHEREAS, the banquet was of excellent quality;

THEREFORE, be it resolved that the Utah Association expresses appreciation to the personnel of the Excelsior Hotel who contributed greatly to the success of these meetings.

WHEREAS, the contributing Members have provided contributions, interesting displays and informative discussions of their products;

THEREFORE, be it resolved that the Utah Association extends its appreciation to these organizations for the support and services they have provided to further mosquito control throughout the State.

WHEREAS, Reed S. Roberts has been selected to be the recipient of the Don M. Rees Award; and

WHEREAS, the Board of Directors of the Utah Mosquito Abatement Association recognize the outstanding contribution Reed S. Roberts has made to mosquito control within the State of Utah and nationally;

THEREFORE, be it resolved that the Board of Directors of the Utah Mosquito Abatement Association extend its congratulations to Reed S. Roberts on being named to receive this prestigious award.

RESOLUTIONS COMMITTEE
Elmer Kingsford

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Matthew M. Yates . . . . . Baton Rouge, Louisiana

Dr. Don M. Rees
MEMORIAL AWARD

This award was created in 1987 by the Utah Mosquito Abatement Association to acknowledge exceptional contributions to mosquito control in Utah. The award honors **Dr. Don Merrill Rees, 1901-1976**, who was often referred to as the "Father of Mosquito Abatement in Utah."

The 1989 recipient of the third **Dr. Don Merrill Rees Memorial Award** is Reed S. Roberts. Reed began his interest in insects while doing undergraduate work at Utah State Agricultural College, where he received a B. S. degree in entomology in 1942. During World War II Reed served as an entomological technician with the 40th Malaria Survey Unit in New Guinea and the Philippines. In 1948 Reed earned an M.S. degree in entomology from Utah State University. During the 1948-1949 academic year, Reed worked under the supervision of Dr. Don M. Rees while furthering his education at the University of Utah.

Reed served as the Extension Entomologist at Utah State University from 1965 through 1984. During that time Reed became a friend to all of the mosquito workers of Utah. He was involved with the establishment of several new mosquito abatement districts in Utah. As a long time member of both the Utah Mosquito Abatement Association and the American Mosquito Control Association, Reed earned the respect and admiration of mosquito workers around the country.

Reed S. Roberts is known for his unending energies as he pursues various projects. The UMAA was honored to award Reed S. Roberts with its highest award, the **Dr. Don Merrill Rees Memorial Award**.

AMERICAN MOSQUITO CONTROL ASSOCIATION UPDATE

JUDY HANSEN
Cape May County Mosquito Extermination Commission
Cape May Court House, New Jersey 08210

Thank you for inviting me to speak to you today about the American Mosquito Control Association, Inc. It is a little early to inform you of new happenings because the interim Board Meeting is to be held on October 11 in Peoria, Illinois. However, there has been a lot of committee activity that I can discuss with you.

The Board of Directors met all day Sunday in Boston prior to the meeting and on Thursday morning for several hours. A number of important decisions were made and a few new committees established. There is a committee to look into quality assurance of mosquito control programs, a committee to investigate the feasibility of establishing the position of Executive Director as a full time position, the Environmental Protection Committee, watching and waiting for the Federal Register to publish their Public Health Exemption they worked so hard on, new ideas for operational papers to be published in the newsletter, and *Tiger Tales*, the *Aedes albopictus* publication is completed for its first publication. An Operational Committee was established, and we are hoping for good things from them with ideas on how we can better serve our operational members and add more operational people to our list of members.

The Central Office has been busy working on the Directory of Mosquito Control Agencies along with many other items. They are working to prepare for the interim Board Meeting in Illinois as well as talking to the local arrangements committee in Kentucky. This brings me to our next topic, the 56th Annual Meeting of AMCA to be held in Lexington, Kentucky April 1-5, 1990, at the Hyatt Regency at downtown Lexington Center. The Hyatt Regency Lexington is the focus of the Civic Center which encompasses the Rupp Arena and the Lexington Convention Center. In addition, this complex includes three levels of galleries, boutiques and restaurants. A glass skywalk bridges Hyatt to the renovated Victorian Square and Lexington Festival Market. This sounds a little like a TV commercial, and in a way it is a commercial. We would like you all to join us in Kentucky, the Bluegrass Country - April 1-5, 1990, for a meeting that promises to be one of the best. Matt Yates is hard at work on the program with several symposia being developed as I speak. The entertainment and facilities in Kentucky appear to be top shelf. Several complete trustee sessions are planned. Make your plans now to be with us next April.

There is one item of importance I would like to call to your attention in a little more detail, and that is the Public Health Exemption contained in the Endangered Species Program that was published in June in the Federal Register. The Environmental Protection Committee chaired by Chuck Hansen worked with the California Mosquito and Vector Control Association to put together a response to the Federal Register Publication on July 3, 1989; Endangered Species Protection Program notice of proposed program. The Committee recommended to me that I use the CMVCA letter as a model in preparing AMCA's response with any modifications deemed necessary. The plan was to have the AMCA support letter sent by the end of August with follow-up letters of support from all the State Associations to follow in September. No doubt you have been contacted by now and have favorably responded. The Endangered Species Act eventually will affect all States even though only a few are involved at the present time. Your prompt response is extremely important to vector control programs throughout the states.

Briefly, the letter praises the realistic approach to the program by the changes noted in the register. However, a few points need clarification. One point, the Public Health Exemption language appears vague in the Federal Register Notice that suggests that Fish & Wildlife Service may have veto power or be able to delay the implementation of the public health exemption. It is critical that a Public Health Exemption be granted by EPA without delay, and if FWS can delay implementation, it would defeat the intention of the exemption.

The second point and a general concern is that the U. S. Public Health Service seems to be involved very little as an advisory agency. They are not among the Interagency Task Group or the Technical Task Group in spite of the fact that the goal is to insure consistency among the Federal agencies in designing and implementing an effective program that considers public health and environmental safety. Since pesticides are linked so closely to public health by way of vector control programs, the input of the USPHS is essential.

There are a few other minor concerns, but please, when your Association has a copy of this letter, act upon it immediately.

In another, but related, area, John Mulrennan, Chair of the new Pesticide Labeling standardization Committee reports that it appears that chemical companies that are interested in the mosquito control market are becoming more responsible to our concerns. He said that if nothing else, our new committee has created a national awareness which has had an impact on the way chemical companies must register insecticides for mosquito control use. The committee has been trying to get the labels amended where possible to take out language that was more applicable to agricultural applications than to mosquito control. This appears to be a bright spot on the horizon.

The American Mosquito Management Insurance Association is very active and functioning well, according to Mr. Hyde of Hyde Associates, the Agency for AMMIA. He reports that the Association has signed up 44 mosquito control districts across country with 45 considering a move to AMMIA Insurance. Mr. Hyde and his Associates will attend many of the regional meetings to explain the insurance program, so if there are any districts who would like to have he or a representative attend, please contact Tom Gillingham who will be attending this meeting.

And finally, as I have done the last three years, I am asking each of you who are AMCA members to act as ambassadors and talk to your colleagues about joining AMCA. A strong national organization with many members is a safeguard and back-up to the local agencies and associations. We are here to support mosquito control and your association if you will join us and let us. There are many benefits of joining, and I am not going to go into them all now. Any of you who would like a longer explanation, please see me after the meetings, and I will be glad to talk with you.

1989 EAST COAST MOSQUITO PROBLEMS

JUDY HANSEN
Cape May County Mosquito Extermination Commission
Cape May Court House, New Jersey 08210

The 1989 mosquito season is one that will go in the books in New Jersey and probably a good part of the Northeast, as a record year with record rainfall and numbers of mosquitoes. Budgets were stressed to the limits - and that limit was broken when a good many of us in New Jersey had to go back to the governing body requesting additional emergency funds. The State Mosquito Control Commission had to go to the legislature and request additional funds. Overtime was astronomical and compensatory time is being built so that many commissions will be understaffed this winter when all the comp time is taken. Complaints from the public were at an all time high, and public awareness of mosquito control programs reached new heights. The mosquitoes in 1989 in New Jersey gave mosquito control programs more media air time, both national, regional and local, than ever before. Many areas that had not experienced mosquito populations in any sizeable numbers before did so this year. This, then, is the 1989 season about which I will speak.

I will talk to you today about the operation of which I am Superintendent, the Cape May County Mosquito Extermination Commission. We are the southernmost peninsula that you see on the map of New Jersey. We are a tourist-oriented area with the Atlantic Ocean on the east and the Delaware Bay on the west. We have tremendous salt marshes on both the east and west and the mainland is largely forested with some farmland and many residential areas. We have 85 square miles of tidal marsh, 10 square miles of brackish marsh, 59,000 acres of woodlands, and 64,000 acres of farmland. Believe it or not, it is a nice place to live and to visit. Most people who come to Cape May County as visitors plan to spend most of their time out-of-doors camping, fishing, hiking, sunbathing, swimming, birdwatching, crabbing, shopping, and eating (many restaurants have sidewalk cafes). There are outdoor theatres, outdoor parks, lakes, hiking and biking paths, beaches, boardwalks and promenades, boat rental, canoe rental . . . I am sure you get the idea. Mosquitoes in our County are a no-no! 90% of the economy is tourism, with the remaining commercial fishing and crabbing industry, farming and resort business, and a few small businesses unrelated to the tourist industry. Cape May County is home for many retired people, and throw-off from the casino industry in Atlantic City, 10 miles north of our border, has brought numerous young families into the northern part of the county.

In 1989, mosquitoes descended on the county in large broods much to the dismay of many newcomers and visitors. Natives only said they haven't seen them like this in years. Our telephones ran continuously! Environmental pressure for no mosquito control dwindled to a trickle this summer. The environmental groups usually hit us hard in the summer time, but this year to utter the words "no mosquito control," was to bring on the threat of lynching, or at least a good tongue lashing.

It has been a good year for us, and I am sure most would not agree, as we are pretty exhausted and tired of the whole mess. I say this seriously because mosquito control came to the forefront in many people's minds without our calling attention to our programs. We were requested to do work. We had no hassles at all when we requested extra monies to do the work. Being in the public eye as we were this season brings additional responsibilities. Mosquito control personnel could not go into a residential neighborhood in marked trucks and shirts with logos without preparing to do public relations. Personnel, who had never been in public relations before, all of a sudden were ambassadors and had to answer questions intelligently and politely, even when the questioners were not so polite. They learned to control their tempers. This meant additional training, especially to seasonal personnel who were unfamiliar with all the proper answers. Many times referral to the office or personnel who could answer all the questions asked was necessary.

One problem we did not have this season was off-duty personnel wearing their uniforms (shirts) with logos when they were not working. Most of us could not wait to get home, take them off, and forget all about mosquitoes. Often, by the time we got home it was dark anyway and dark when we left in the morning, so technically we were incognito most of the time.

It was necessary for us to balance our program this year so that mosquito control was accomplished, but that we did not go overboard and spray everything in sight.

We had to set priorities and stick to them even with the pressure on. We again answered every complaint of every person that called personally or by telephone if it was a request to spray and we knew the adult counts were high in the area. I am getting ahead of myself, really, making small talk about the season and its problems. What I really want to tell you about is the program itself.

Our operating budget for 1989 was $1,206,200.00, plus $113,000.00 capital budget. Additional funds under an emergency appropriation totaled $60,000.00. The Cape May County Mosquito Extermination Commission takes an integrated approach to mosquito control which simply means you do not put all your eggs in one basket. Our primary and most expensive means of control is water management. Second comes biological, then chemical. We accomplish all these with the aid of a sophisticated surveillance program in order to determine where the mosquito breeding occurs so we may do source reduction. Source reduction in the form of water management is the long-term best way to control mosquitoes, but source reduction through larviciding is also another important method, especially this year. Our breeding areas increased tenfold this year. All known breeding areas were treated, and many new ones occurred.

New Jersey Mosquito Control Commissions are empowered through the State Statutes to "perform all acts which in its opinion will control mosquito breeding and mosquitoes." The Statute is under the Health Code and gives the Commission the right of entry and all the powers of a local Board of Health. Our budgets are state mandated but they rarely are up to the mandated amount. We have seventeen full time personnel, one part-time solicitor; and this year, **TWELVE** seasonals. Our job titles are the usual ones in mosquito control--inspectors, pilot, supervisors, heavy equipment operators, office personnel, entomologist; laborers and seasonals are pesticide applicators, laboratory and field workers.

Our projects this year in the laboratory ranged from a complete surveillance program using New Jersey light traps, pigeon traps, CDC traps, resting boxes, landing rates, collecting *Culiseta melanura* and *Aedes sollicitans* for virus sampling, to banding radio-tagging and bleeding water birds (glossy ibis, herons, night herons, etc.) in a project designed to answer more questions about the primary reservoir for Eastern Equine Encephalitis. We tested *Bacillus sphaericus*, did water samples in streams throughout the County for dissolved oxygen and pH, and did a marked release capture test on *Aedes sollicitans* using aerial markings.

Our pesticide usage increased greatly this year. To date as of September 21, we have used 96,800 pounds of Abate 2CG, treating 18,177 acres by air, using Simplex seeder gravity flow system from our Hiller UH12F helicopter. We adulticided with our other Hiller helicopter using a Beco ULV system. We used 599 gallons of Malathion (Cythion) at a rate of 3 oz./acre and sprayed 27,100 acres. Our 2 ULV Whispermists mounted on 4-wheel drive trucks sprayed 555 3/4 gallons of scourge mixed with soy bean oil (mixed 4 to 1) throughout the county wherever mosquito landing rates were high. Our land larviciding crews used 342 1/2 gallons of Golden Bear Oil for pupacide, 927 1/2 gallons of *Bacillus thuringiensis israelensis* for larvicide, and 761 3/4 pounds of Abate 2CG for larvicide on 142 acres. All the storm drains throughout the county were treated with Golden Bear Oil approximately every 10-14 days. Retention-detention stormwater facilities were included in larviciding as well as dredge spoils on the salt marsh and along the canals and intercoastal waterway. Our complaints number over 1,100. These are official complaints where people call in and leave their names and want service. We participated in the County 4-H Fair in July and had our usual exhibit with two employees on hand to answer questions. The two men who attended wanted to know before hand if they would receive combat pay for this year, for service above and beyond the call of duty.

The first horse case of Eastern Equine Encephalitis appeared in Camden County this year on August 15. We usually have viral testing and results in hand beginning in June each year, but this year the monies in the state were cut and the State Health Department denied us testing of our samples and did not provide the diluent to mosquito research and control at Rutgers as they promised so the Elisa method could be used. Our viral data was sadly lacking but the vector potential index was as high as it has ever been, so we have been proceeding along the lines that virus was present and trying to control our older population of mosquitoes. The *Culiseta melanura* have reached an all time high in our county. They are not only appearing heavily in the resting boxes, but just as heavily in the New Jersey light trap collections. This species is not attracted to light.

Eastern Equine Encephalitis did appear this year in New Jersey with eight horse cases to date and one presumptive human case, a child of four. This will probably always be presumptive as the parents would not permit an autopsy. We are very thankful we continued our control methods based on the vector potential index and assumed the virus present. We now have our virus data. To date, we have had six isolates in Cape May County, over twenty-five in the State; and, with frost in South Jersey still six

weeks away, we anticipate a long, expensive control season.

Our major pest species, of course, is *Aedes sollicitans*. We are still looking for *Aedes albopictus* in Cape May County but have not yet found it. We do not have many tire dumps as tires from the southern four counties in the state are taken to the Southern State Correctional Institution, made into reefs and sunk in the Atlantic Ocean by Fish & Game people for fishing reefs.

As far as water management is concerned, even throughout this busy period we have continued with our Salt Marsh Management (OMWM) on both the Atlantic side and Delaware Bay side of our County. The State Mosquito Control Commission is in the process of bidding a new machine for us to replace our old rotary ditcher that bit the dust this summer. This machine runs in the neighborhood of $200,000.00. We have one machine that the County purchased for us. Our fresh water management consists at this time only of hand re-cleaning ditches and removing debris, as on July 1, 1988, the New Jersey Legislature passed the Freshwater Wetlands Act, which essentially prohibits all activity in the freshwater wetlands. Mosquito control is exempt if we use "Best Management Practices," but we have not been very successful getting permits through this bureau in the Department of Environmental Protection. I plan on submitting a budget in 1990 addressing this issue and attempting to hire a person with engineering background and marsh experience to get these permits. If we let our freshwater work backslide as has happened the last year, our breeding areas will increase tremendously under normal conditions with all the growth the county is now experiencing. Our wintertime population is 90,000. Our summertime population is two to three million.

This, then, is our program. I have only touched briefly on the projects. We recently completed a new building complex (office, laboratory, conference and a caretakers house). Our employees built this themselves, entirely for $250,000.00. It took two winters to complete, and we moved in on May 1, 1988. It has been a pleasure working in such a place after the Old Prisoner of War CCC buildings we had previously.

We are a Commission on the move. We have attempted to improve our image through a positive Public Relations and Education Program and sustain that image through service. We conduct an environmentally sound, well-balanced program. I think our halo might have slipped a little this year as we rushed around trying to cover all bases, but most of the general public has been understanding. I am sure of one thing, though, we in New Jersey and especially Cape May County are going to throw one heck of a celebration the day we have our first frost.

WHO WILL SPEAK FOR PUBLIC HEALTH

BRUCE F. ELDRIDGE
Department of Entomology
University of California
Davis, CA 95616

As most of you know, I am not a specialist in pesticides. There are many in the audience, especially those of you who deal with pesticides on an everyday basis, who know much more about them than I do. All of us in the area of mosquito abatement and public health entomology have an obligation to stay abreast of current public policies and various federal, state, and local regulations so that we may best carry out our responsibilities in our various jobs. Increasingly, there are very few of us who are not affected in one way or another by public policy decisions about pesticides.

In the next few minutes I would like to review the recent developments in federal pesticide regulations as I understand them, and to attempt to interpret them from a public health viewpoint. This is necessary, I believe, because most of the decisions, and the available interpretations are structured largely to apply to traditional agricultural uses. I will end by making the argument that public health interests do not receive adequate consideration when decisions about pesticides are made, nor are there effective methods of implementing pesticide regulations in the context of public health use.

Vector-borne disease threats at home and abroad.

The argument is made by some that vector-borne diseases, especially within the United States, have become insignificant public health problems, especially when compared with such serious threats as AIDS. Let us examine this position for a moment. Vector-borne diseases are controllable through a combination of personal and wide area preventive medicine approaches, primarily vector control and personal protective measures such as vaccines, window screening and repellants. AIDS is controllable through personal protective measures and, in the future, perhaps with still other approaches. When the incidence of new AIDS cases falls to a low level, which I predict it will, will the argument be made that AIDS is an insignificant public health problem, and will research funding and public concern fall to a low level? Yes, this probably will happen.

I do not wish to minimize the importance of a disease in which there are currently more than 20,000 new cases a year showing up, and an estimated 1 to 1.5 million persons infected in the United States. However, in the case of vector-borne diseases, options available for the vector control approaches needed to keep them at low levels are being narrowed, in some cases as a matter of public policy, justified in part by the belief that vector control is no longer needed. This is circular reasoning at its worst!

Am I crying wolf?

Please, if you will, look at dengue incidence on a worldwide basis. You don't have to look far. Puerto Rico reported 10,659 cases of dengue in 1986 involving 3 different serotypes, DEN-1, DEN-2, and DEN-4. Mexico reported 21,975 that same year. But those figures represent only a fraction of the cases actually occurring worldwide. Let me quote from Duane Gubler's Charles Franklin Craig lecture delivered to the American Society of Tropical Medicine and Hygiene in 1988 (Gubler 1989): "Dengue is a rapidly expanding disease in the tropics of the world. ...it has become the most important arbovirus disease of humans. There are now over 2 billion people at risk of infection, and millions of cases occur each year. The severe form of the disease, DHF, is a leading cause of hospitalization and death among children in Southeast Asia. Incidence has continued to increase each year and in 1987 alone, over 600,000 cases of this severe form of dengue were reported in that region compared to only 2,060 in 1967, a 300-fold increase in 20 years."

I reviewed the worldwide malaria situation in my AMCA presidential address, and I will only repeat a few points here: Worldwide incidence is presently very high -- probably as high as it was before worldwide malaria eradication efforts were begun, and also drug-resistant falciparum malaria has now spread throughout the tropics, including Africa, where it first was detected in 1979. In California we have seen indigenous malaria transmission for the first time in many years. In the United States, Lyme disease has become a major public health threat, and although there have been federal initiatives aimed at research and education, there has been little or no coordination of vector control needs with other federal programs aimed at restricting pesticide use.

Pesticide registration -- where are we?

In 1988, a revision of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was passed by Congress and signed by President Reagan. Although dubbed "FIFRA Light" by Capital humorists, it actually contains significant provisions. The most important part of FIFRA 1988 is a 5-phase reregistration process for almost all pesticides. The difference is that in the past the reregistration process was not tied to firm deadlines -- this time it is. The following summarizes the first three steps and their current status:

Step 1. The Environmental Protection Agency (EPA) is required to publish lists of pesticide active ingredients subject to registration and to ask registrants if they intend to seek reregistration. These lists must be published in 4 installments within 10 months of the effective date of FIFRA 1988 (December 24, 1988). Three of the 4 lists have appeared. The first list (List A) was released on February 22, 1989, and contains active ingredients for which registration standards have been issued. Here are some of the materials included in that list: allethrin, BTI, carbaryl (sevin), chlorpyrifos (Dursban), deet, diflurbenzuron (dimilin), fenthion (Baytex), malathion, methoprene (Altosid), naled (Dibrom), resmethrin, and temephos (Abate). Please note that this list contains most of the currently used public health pesticides, including the materials generally considered environmentally safe, or biorational. List C contains the following interesting materials: cedarwood oil and Canada balsam. You'd better watch out, taxonomists.

Step 2. Registrants are required to respond within 3 months of the appearance of each list concerning their intention to seek reregistration. They must also identify missing and inadequate scientific studies required to satisfy EPA's *current* data requirements, and agree to fill these gaps. The deadline for response to List A (above) is passed. I do not have information concerning responses received by EPA, and when I've asked, I've been told to ask the registrants. There is quite a bit of information floating around as a result of a survey of registrants conducted by the National Agricultural Chemicals Association and the USDA IR-4 Program concerning intentions to reregister uses for various agricultural crops, but very little concerning public health pests.

Step 3. Registrants are required to summarize and reformat key existing studies for EPA review, to certify that they have "raw data," to flag any studies which suggest adverse effects, and to commit to generate or to share the cost of generating new data. This must be done within 1-1/2 - 2 years of the effective date of FIFRA 1988.

It is probably appropriate to mention at this time that the final review of the Good Laboratory Practices standards have been completed and have now been released by EPA. These standards apply to laboratory and field data and must be followed in the case of any data to be used to support reregistration. The copy I have consists of 30 pages of triple-column text.

EPA has released its proposed Endangered Species Protection Plan, and the public comment period ended earlier this month. I hope all of you took advantage of the comment period to express your views. The American Mosquito Control Association submitted a detailed letter of comment structured by the Environmental Protection Committee. The plan provides for a public health exemption procedure under Section 18 of FIFRA, and although it doesn't contain all of the features I would like to see, at least it now recognizes that public health agencies do not have to wait until people are actually sick and dying before asking for an emergency exemption. Those of us on the Environmental Protection Committee had hoped to avoid the Section 18 route for implementation because Section 18 requires Federal approval of exemptions on a case by case basis. We further objected to the necessity of consultation with the Fish and Wildlife Service at the Federal level for each application because under the plan consultation will already have taken place at the state level before an application will have reached EPA.

Where is Public Health?

I read an article in an airline magazine recently written by Walter Cronkite entitled *Save the Birds*. Mr. Cronkite started out by pointing out that in saving the birds we are saving ourselves. His thesis was that there are 4 major threats to the continued existence of life on earth as we know it today: (1) population growth, (2) resource depletion, (3) pollution, and (4) nuclear war. In his discussion of pollutants he mentions sulfur dioxide, nitrogen oxides, carboflurocarbons, carbon dioxide, and DDT and unspecified "chemicals used on crops." I find little to disagree with in the article. Even though he blames deformed waterfowl at Kesterson Reservoir in California on crop chemicals rather than on the concentration of selenium and other trace elements through faulty irrigation practices, he makes a persuasive case for the generally gloomy future of the earth at our present rate of fouling it. If he would permit me to add a filth threat, worldwide infectious diseases, to the list, I would make a flag symbolizing these 5 concerns and fly it in front of my house.

My objection to the present direction of public policy in the area of environmental protection and public health,

is that there are few public health implications considered when policy is established. There is no public health representation, for example, on any of the task groups formed to help EPA administer its Endangered Species Protection Plan. There is no organized special interest group for public health which effectively influences legislation. We have no counterpart to the Farm Bureau, or the Grange, or Women for Agriculture, or a number of other farm-related organizations which speak persuasively to Congress.

At the present time the major players in formulating public policy on pesticides are agriculture and the environmental movement. Even though much of the environmental movement is driven by public health concerns (air and water pollution, pesticide-free food, etc.) there is relatively little input from the public health sector of government at all levels when these problems are addressed and government regulations are developed to solve them. Let us not wait until we are in a crisis situation before we awaken to find that we can no longer protect the public from diseases transmitted by mosquitoes and other vectors.

We should take all necessary steps to insure reregistration of biorational pesticides such as methoprene, BTI, larvicidal oils, and diflurbenzuron. We should aggressively push for research to develop new materials that are environmentally safe, and then we should all push hard for their registration. We need to have current emergency plans in place, current data on pesticide susceptibility of vector populations, and sufficient stocks of materials and proper equipment for application. We need better networking of resources and information. The USDA IR-4 Program provides an excellent service to pesticide users by serving as a clearing house for registration data, and by funding small studies to obtain data for registration of pesticides for minor crop uses. Although IR-4 has on occasion funded studies for public health uses of insecticides, it is heavily oriented toward production agriculture. We would all benefit by a similar organization under the auspices of the U. S. Public Health Service. We need intensive research on non-chemical vector control methods, and some long-term large scale projects to evaluate comprehensive integrated approaches to vector control.

In closing, I will repeat what I have said before. Public sentiment is now strongly in favor of reduction, if not elimination, of conventional pesticide use. In the public's eye, large scale agriculture is probably the target, but vector control is being swept along with the tide, because we are too small an operation to buck the current. Certainly, the U. S. public fears pesticide contamination of apples and AIDS much more than it fears malaria. For our part, we must continue to innovate, to educate the public, and to work with all public agencies to solve the many serious problems we face here and abroad. Someone must stand up for public health, lest it be forgotten until the next vector-borne epidemic comes along.

"Who speaks for public health?" We do.

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IMPACT OF FEDERAL PESTICIDE REGULATIONS ON VECTOR CONTROL PROGRAMS

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Recently the Environmental Protection Agency (EPA) commented on the effects of their implementation of the pesticide reregistration requirements passed in the 1988 Federal Insecticide Fungicide and Rodenticide Act (FIFRA) Amendments which require the EPA to reregister all pesticides registered over the past 40 years.

EPA said that as many as 20,000 products of the 45,000 products they currently have registered will be dropped because of a $425 per year registration maintenance fee. Many of these products are not currently in production or are of little or no current use. Six thousand of these registrations are Special Local Need (SLN), Section 24(c) registrations. Each one of these counted as a separate product. These 20,000 products were made from 217 different active ingredients which will be discontinued. There were about 600 active ingredients used in pesticide manufacturing. The remaining active ingredients (about 344) will now be assessed reregistration fees of from $50,000 to $150,000. This will probably have additional impact on the continued registration of some of these active ingredients. Active ingredients with major uses will carry the fees of minor uses. If the active ingredient has no major use, all uses will probably be dropped. The EPA checked 30 minor crops for pesticide uses and none will lose all of their registrations. Waivers can be requested for products with only small values or minor uses, for minor nonfood use antimicrobials and small businesses. EPA estimates cost for reregistration at about $250,000,000. EPA anticipates more cost to farmers and consumers, less quality fruits and vegetables, more imported fruits and vegetables, more unregistered uses of pesticides and more farmers leaving the U. S. in order to be able to continue farming.

Tables 1 and 2 provided by the National Agricultural Chemicals Association (NACA) give a warning to pesticide users regarding potential losses during the reregistration process.

Table 1. Public Health Pesticides for Which All Current Uses Will be Supported

Acephate (Orthene)
Bacillus thuringiensis (BT)
Bendiocarb (Ficam)
Bromacil (Hyvar)
Carbaryl (Sevin)
Chlorpyrifos (Dursban, Lorsban)
Dicamba (Banvel)
Diuron (Karmex, Krovar)
Glyphosate (Round Up)
Paraquat (Gramoxone)
Picloram (Tordon)
Tebuthiuron (Spike)
Tetrachlorvinphos (Rabon)
2,4-D

Table 2. Public Health Pesticides That Will Have Some Uses Dropped Because of Reregistration Costs or Deadlines

Active Ingredient
Ammonium Sulfamate (Ammate)
Atrazine (Aatrex)
Dalapon (Dowpon, Revenge)
Diazinon
Ethyl Parathion
Fenthion (Baytex)
Methiocarb (Mesurol)
Methyl Parathion (Penncap-M)
Naled (Dibrom)
Simazine (Princep)
Trichlorfon (Dylox)

ENDANGERED SPECIES PROTECTION

Congress passed the Endangered Species Act (ESA) in 1973 to protect animals and plants that are threatened or endangered of becoming extinct and to protect the habitat in which they live. The ESA requires that Federal agencies ensure that any actions authorized by that agency, such as the registration of pesticides by the EPA, does not result in harm to any threatened or endangered species or their habitat. Because some pesticides may harm such species, the EPA has been developing an Endangered Species Protection Program to protect these species and their habitats from the effects of pesticides. EPA began to develop the program in 1982. However, EPA was not able to put the program in place as originally planned because implementation was far more complex and time-consuming than anticipated. As a result, the program was deferred.

Since deferral of the program, EPA has extensively revised the Endangered Species Protection Program. In the revised program, EPA will concentrate on the species themselves rather than on clusters of pesticide use sites. EPA is also concerned about the impact to pesticide users. To minimize these impacts, EPA developed a new approach which will emphasize lower application rates as opposed to complete prohibitions of use. The program also provides for a proposed exemption for indoor uses, but no exemption for outdoor homeowner uses. In the case of a public health emergency, a state or federal public health agency may request an emergency exemption or may qualify for a crisis exemption under Section 18 of FIFRA.

After considering a variety of different approaches, EPA believes that the best approach would be to require registrants of affected pesticide products to place a generic label statement on the label, which will instruct pesticide users to determine if any use limitations are contained in the county bulletin. The label will not list the counties in which limitations on pesticide use apply nor will it require the user to obtain a bulletin. The user simply has to find out what use limitations exist, if any, for that particular pesticide in the county in which they intend to use the product. EPA is working to determine the best way to distribute bulletins and information identifying which counties are and are not affected (Table 3).

EPA is concerned about the accuracy of the maps which describe where the threatened and endangered plants and animals live. EPA has been working closely with the Fish and Wildlife Service, U. S. Department of Agriculture, and the states in revising the maps to ensure their accuracy. EPA will rely as much as possible on revised maps submitted by the states, although the final maps ultimately will be subject to Fish and Wildlife Service approval.

EPA is providing opportunities for public involvement in the program, including a 90-day comment period on the July 3, 1989, Federal Register Notice describing the revised program. EPA is also providing opportunity for comments on the maps and bulletins.

Until an enforceable program is in place (1991), EPA is initiating a Voluntary Interim Program which will include pilot programs; requests for public, state, and regional comment; and educational efforts. Educational efforts will include distribution of draft bulletins for voluntary use. If you need additional information about the revised Endangered Species Protection Program, you may contact EPA through its Regional Offices; the telephone numbers are listed below.

Region VIII (MT, ND, SD, WY, UT, CO) Denver, CO (303) 293-1745/(800) 525-3022

Region IX (CA, NV, AZ, HI, Pacific Islands) San Francisco, CA (415) 974-8366

Region X (WA, ID, OR, AK) Seattle, WA (206) 442-4768

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U. S. Environmental Protection Agency, Office of Pesticides and Toxic Substances, Endangered Species Protection Program, June 1, 1989.

U. S. Fish and Wildlife Service, Endangered Species Office, Salt Lake City, Utah, August 9, 1989.

Table 3. Utah Counties and Endangered Species Affected by EPA Pesticide Labeling*

County	Species
Beaver	Utah Prairie Dog
	Rydberg Milk-Vetch
Cache	Maguire Primrose
Carbon	Bonytail Chub
	Humpback Chub
	Colorado Squawfish
Duchesne	Uinta Basin Hookless Cactus
	Toad-Flax Cress
Emery	San Rafael Cactus
	Wright Fishhook Cactus
	Bonytail Chub
	Jone's Cycladenia
	Maguire Daisy
	Colorado Squawfish
	Last Chance Townsendia
Garfield	Autumn Buttercup
	Humpback Chub
	Jone's Cycladenia
	Utah Prairie Dog
	Colorado Squawfish
	Rydberg Milk-Vetch
	Wright Fishhook Cactus
Grand	Bonytail Chub
	Humpback Chub
	Jone's Cycladenia
	Colorado Squawfish
Iron	Utah Prairie Dog
	Rydberg Milk-Vetch
Kane	Siler Pincushion Cactus
	Jone's Cycladenia
	Welch's Milkweed
	Utah Prairie Dog
	Colorado Squawfish
	Rydberg Milk-Vetch
Piute	Utah Prairie Dog
	Rydberg Milk-Vetch
San Juan	Spineless Hedgehog Cactus
	Humpback Chub
	Colorado Squawfish
Sanpete	Heliotrope Milkvetch
Sevier	Heliotrope Milkvetch
	Utah Prairie Dog
	Last Chance Townsendia
	Wright Fishhook Cactus
Uintah	Uinta Basin Hookless Cactus
	Bonytail Chub
	Toad-Flax Cress
	Colorado Squawfish
	Humpback Chub
Utah	Clay Phacelia
	June Sucker
Washington	Purple-spined Hedgehog Cactus
	Siler Pincushion Cactus
	Dwarf Bear-Poppy
	Desert Tortoise
	Woundfin
	Wayne Wright Fishhook
	Utah Prairie Dog
	Colorado Squawfish

*Seventeen of Utah's 29 counties will be affected plus the entire state for the black footed ferret. Restrictions will include virtually all rodenticides intended for rangeland and forest use. Requirements before use of rodenticides will include surveying for the presence of black footed ferrets and reporting the survey results to the U. S. Fish & Wildlife Service.

GENERAL OVERVIEW OF 1989 MOSQUITO ABATEMENT OPERATIONS AND OTHER VECTOR SITUATIONS IN THE GREAT STATE OF IDAHO

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Former Vector Control Specialist (VCS) Wayne Heskari retired June 1988, after 15 years and Robert S. Hays was hired in mid-October, 1988.

DISCUSSION

Vector control in Idaho has slowly evolved as the state becomes more populated and recreational opportunities are utilized at a higher frequency. The Gem County Mosquito Abatement District (MAD), formed in 1953, is the oldest formal district. Over the years, 13 additional operations have been formed, including 2 districts in the Cascade Reservoir area (Central Idaho) this year, and 2 other districts in their first year of operation. Of the 14 operations, 2 are city operations without formal districting format. The districts operate in these areas of the State: north Idaho (1); southwest Idaho (2); central Idaho (2); eastern Idaho (8); and south central Idaho (1). The climate and topography of these districts vary considerably, as do the species of mosquitoes.

As the State VCS, I consult with the various operations on integrated pest management techniques and provide ultra low volume droplet analysis on their spray equipment (approximately 16 Leco ground foggers and one aerial applicator). During the droplet evaluations, it was discovered that approximately 80% of the ground foggers were malfunctioning or inoperable due to poor maintenance. It is my plan to provide training to the MAD operators to reduce the downtime or misapplication created by poorly maintained equipment. This mechanical training plus training for new field staff members should insure proper pesticide application and an overall professional approach to mosquito control. The training for field staff members will include identification (breeding sites, species, instars, etc.), control methods (physical, chemical, and biological), record keeping (trap counts, application locations, phone log), and public relations.

Lyme Disease: Nine cases of Lyme Disease have been diagnosed and recognized as being contracted in Idaho in the first 8 months of 1989. The distribution of cases indicates that there is no general focus of Lyme disease in Idaho. We are also considering what tick may be vectoring this disease since the implicated *Ixodes pacificus* has not been found in Idaho since a single female was identified in Pocatello in 1970.

Rats: Two rat populations in the State have been identified and control programs are in the planning stage. The communities involved are trying to minimize the negative connotations associated with their rat problems.

Black flies: Both Bear Lake and Twin Falls Counties have black fly problems that affect livestock operations and pester humans that happen to be in their way. Bear Lake County's problem is fed by small streams in the area and possibly migration out of the Salt River Drainage in Wyoming. Until the breeding sites can be located, control efforts will be hit or miss in Bear River county. Twin Falls County's problem has its origin in a large transfer canal. The hatches then migrate into the hills and feed heavily on grazing sheep. The rise in chemical cost and environmental concerns have limited the control efforts by the livestock owners, and they have requested additional control information. Two possibilities would be increased use of Bti or a nematode that parasitizes black fly larvae. Both options will require increased funding, and possibly a pest control program can be established by the county.

MOSQUITOES AND VIRUSES FROM WESTERN UTAH IN 1985

ROBERT E. ELBEL,[1] GEORGE T. CRANE,[2]
and D. BRUCE FRANCY[3]

The 1983-1984 survey in western Utah was discussed at these meetings by Crane et al. (1985) and summarized with our previous studies by Elbel (1986). Mosquitoes were collected once a month during the summers of 1983-1985 by Crane and Dugway, Utah Environmental and Ecology Branch personnel, mainly John S. Allan in 1985 who helped with the preparation of this paper. Specimens were collected with CDC miniature light traps and dry ice attractant, sealed in vials, frozen on dry ice and transported to the Dugway laboratory where mosquitoes were pooled visually by Crane and Elbel by species, date and area on a CDC chill table on which verifications were made under a stereo microscope by Elbel. In 1983 mosquitoes were collected only at Blue Lake but collections in 1984-1985 were at Fish Springs National Wildlife Refuge, Callao and Blue Lake on the southern and western boundaries of the Great Salt Lake Desert. Callao is east of the Deep Creek Mountains and Blue Lake is 17 miles south of Wendover, Utah. Dominants near light traps were: for Fish Springs saltgrass (*Distichlis stricta*), bulrushes (*Scirpus* sp.) and reed grass (*Phragmitis communis*) along a road separating marshland from a canal, for Callao Russian olive (*Elaeagnus angustifolia*), willows (*Salix* spp.) and wild rose (*Rosa* spp.) along a fence in an irrigated meadow of *Carex* spp. and other grasses, for Blue Lake saltgrass, bulrushes and pickleweed (*Allenrolfea occidentalis*) at the lake margin.

Under Dugway contract to the Fort Collins Centers for Disease Control, virus assay in 1985 was performed by Francy with the help of Larry Kirk and Christine Happ using 1% Bovine albumin as diluent and monolayer cultures of vero cells. Isolates were identified by indirect immunofluorescence and confirmed by plaque-reduction neutralization tests.

From 171 trap nights, 86,853 mosquitoes were collected in 1985 (Table 1); the trap night average was 2,058 at Blue Lake compared to 327 and 324 at Fish Springs and Callao so mosquitoes were over 6 times more abundant at Blue Lake. The most mosquitoes and the highest trap night averages were obtained in August at Fish Springs and Blue Lake but in September at Callao. At Fish Springs *Aedes dorsalis* decreased steadily from about 4,500 in June to about 50 in September but the reverse was true for *Culex erythrothorax*. Of the total mosquitoes, 47% were *Ae. dorsalis*, 18% were *Cx. tarsalis* and 12% were *Cx. erythrothorax*. For *Ae. dorsalis*, 52% were from Blue Lake and 31% were from Callao; for *Cx. tarsalis*, 85% were distributed about equally between Fish Springs and Callao; for *Cx. erythrothorax*, 92% were from Fish Springs. Similarly, in 1984 most *Ae. dorsalis* were from Blue Lake and most *Cx. erythrothorax* were from Fish Springs but more *Cx. tarsalis* were obtained in 1985 than in the preceding 2 years. In 1983-1984 from *Ae. dorsalis*, there were 68 virus isolations, from Blue Lake in 1983 was California serogroup (CAL) virus and 67 of which 85% were from Blue Lake in 1984 were mainly CAL viruses. In 1985 from *Ae. dorsalis* at Blue Lake, there were 27 isolations of CAL viruses of which 16 were from June collections. The difference in CAL virus abundance at Blue Lake each year is of interest. During the spring months for western Utah in 1983-1984, June was cool and wet, as was also July in 1984, but in 1985 May, the wet month, was hot which was also the condition for July (Climatological Data, Utah 1983-1985). As shown previously, CAL viruses are not affected by climate, particularly at Blue Lake where CAL viruses and *Ae. dorsalis* are abundant in the flooded salt grass. Since we have shown at Fish Springs that redirection of water from a canal to a marshland apparently controlled CAL viruses by changing the mosquito dominance from *Ae. dorsalis* to *Cx. erythrothorax* from which there were no CAL virus isolations, why can't something similar be done at Blue Lake? Can the lake margin be dried to get rid of the flooded saltgrass, *Ae. dorsalis* and CAL viruses? Would this create, instead, permanent or semi-permanent brackish ponds more productive of *Culiseta inornata* which, we have shown, is a better vector of CAL viruses?

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Table 1. Arbovirus isolations from mosquitoes collected by light traps in western Utah in 1985. Number of pooled insects and (California serogroup viruses, C)

Area	*Aedes dorsalis*	*Culex tarsalis*	*Culex erythrothorax*	Others* Pooled	Total Pooled	Trap nights	Averages/ trap night
Fish Springs	7,091	6,743	9,270	2,737**	25,841	79	327
Callao	12,835	6,790	119	4,220**	23,964	74	324
Blue Lake	21,202 (27 C)	2,364	713	12,769**	37,048	18	2,058
Totals	41,128 (27 C)	15,897	10,102	19,726	86,853	171	508

* Others Pooled: specimens with no virus isolations mainly *Ae. campestris* at Blue Lake and *Cs. inornata* at Callao and mosquitoes included here that were not assayed for virus.

** Specimens that were not pooled for virus assay, ca. 2000 at Fish Springs and Callao, 12,000 at Blue Lake.

FIELD TRIALS WITH SEVERAL LARVICIDING AGENTS AGAINST THE SOUTHERN HOUSE MOSQUITO *(CULEX P. QUINQUEFASCIATUS)* IN EAST BATON ROUGE PARISH, LOUISIANA

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Four separate trials were conducted with various larviciding agents against *Culex pipiens quinquefasciatus* larvae in highly polluted, heavily vegetated roadside ditches in East Baton Rouge Parish, Louisiana between June 20, 1989 and September 26, 1989. The ditches were each approximately 30 feet long and 2-3 feet wide. Water depth in the roadside ditches ranged from 2-9 inches. Bottom sediment was from 1-2 inches in most ditches. No effort was made to limit water input from rainfall or effluent from adjacent residences. Vegetation in the ditches was predominantly Alligator weed and/or Dollar weed. On several occasions the sites were flushed by rainfall. Each site received varying amounts of effluent, high in organic matter, from nearby residences. The type and amount of effluent was not monitored.

Each ditch was measured and the roadside marked with paint to indicate the beginning and end of the test area. Liquid larvicides were applied with hand-held compressed air sprayers. The "wand," or applicator, was held beneath the surface of the vegetation during application to insure that all the larvicide reached the water surface. Each sprayer was calibrated prior to treatment to deliver the appropriate amount of larvicide to the site.

Granules were applied to the sites by hand. The amount of granular material needed to treat each site was determined and measured into a 1 pint paper "ice cream" cup. The bottom of the cup was perforated with several holes large enough to allow the material to fall through when the cup was inverted. The granules were applied to the site by inverting the cup and "shaking" the material from the cup into the site.

On June 20, 1989, 10 roadside ditches were treated with either Vectobac-G (*B.t.i.* granules manufactured by Abbott Laboratories) or ABC 6185 (Abbott Laboratories granular *Bacillus sphaericus*). Vectobac-G was used to treat 5 sites each with a differing concentration 2.5, 5.0, 7.5, 10, and 15 lbs/Ac. ABC 6185 was used to treat 5 sites each with differing concentration 2.5, 5.0, 7.5, 10 and 15 lbs./Ac. Three roadside ditches were untreated and monitored as checks. Three dips were taken at each of the sites immediately prior to treatment and the total number of larvae recorded. Each site was sampled again at 1 day (24 hours) and 3 days (72 hours) post-treatment. The results are given in Table 1. Vectobac G gave good control at the 5.0, 7.5 and 10.0 lb./Ac rates, but failed to give control at the 15 lb/Ac rate. The degree of control with ABG 6185 was relatively good but did not relate directly to application rate. There were 41% more larvae in the check sites on day 1 and 5% fewer on day 3. The test was terminated on day 4 as the sites were flushed by heavy rainfall.

Two roadside ditches were treated on July 24, 1989 with GB 1356 larviciding oil (Golden Bear, Witco Chemical Corp.) and 2 sites were treated with BVA-A oil (B V A Associates). Two nearby ditches were monitored and served as checks. All sites were sampled prior to treatment and at 1 day (24 hours) and 4 days (96 hours) post-treatment. The GB 1356 larviciding oil gave fairly good results in these 2 treatments but the BVA-A oil did not (Table 2). Fewer larvae in the check sites on days 1 and 4 suggests that there might have been a natural decline in the populations in the area. These observations are consistent with rainfall patterns as repeated heavy precipitation in the area for several weeks prior to the applications kept the ditches flushed.

Four ditches were treated on July 31, 1989. One of the sites was treated with Diesel/Triton (1 gal Diesel/0.67 oz. Triton) at 10 gal/Ac and one at 15 gal/Ac. One of the 2 remaining sites was treated with GB 1356 at 10 gal/Ac and the other at 15 gal/Ac. Two additional sites were untreated and served as checks. The GB 1356 worked well at 15 gal/Ac (Table 3), but did not give good control at the 10 gal/Ac rate. The cost of this material was quite expensive ($75.00/Ac at the 15 gal/Ac rate). The number of larvae in the check sites at 1 and 4 days increased 730% and 49%, respectively.

Nine roadside ditches were treated with either Diesel/Triton, ABG 6185 or Vectorbac-G on August 28, 1989. Three ditches were treated with Diesel/Triton at 12 gal/Ac, three with 10 lbs/Ac ABC 6185 and three with 12.5 lb/Ac Vectobac-G. Two untreated roadside ditches served as checks. All sites were sampled at 1, 4 and 8 days post-

generator is ultimately responsible. This responsibility in the industry is commonly referred to as "Cradle to Grave."

If you find yourself in a situation where you are responsible for, such as aged or outdated insecticide or pesticide, you have basically four options:

1. Do nothing at all - which could lead to potential environmental problems and possible fines by the government.

2. Do it yourself - which is inexpensive at first, but in the long run could be the most expensive in terms of time and potential liability.

3. Hire a contractor - This may remove the problem, but not the liability.

4. Find a company who will take the job and responsibility and reduce your chances of liability.

Although the majority of our profit is made from dealing with large contracts of large companies, USPCI has a Small Quantity Generator division that deals with the special requirements of the little guys. We must remember that the small generator carries the same legal liability as a large chemical company because the consequences of poor disposal are the same.

USPCI has a small quantity generator representative that will walk you through the entire process step-by-step. But I emphasize that he tells all of his customers to BE PREPARED FOR ONE OF THE MOST FRUSTRATING EXPERIENCES OF YOUR LIFE. The process requires a pile of paper work, a stream of red tape, and dozens of hoops to jump through. Briefly summarized, here is what you can expect.

1. Consultation - including regulatory guidance and "how the game is played."

2. Characterization - which includes taking samples of the waste and assist in profiling and shipping the sample to a qualified laboratory.

   The required paper work can be frustrating and time consuming, but is necessary to ensure that all federal and state laws are met.

3. Determining Treatment and Disposal - There are many ways to treat and dispose of waste, including incineration or stabilizing and solidification prior to disposal in an EPA-permitted landfill. Choosing the right option depends on the type of waste involved. Generally, insecticides and pesticides must be incinerated.

4. Removal and Transportation - including preparation for shipment to the appropriate facility for treatment or disposal.

Most generators of less than 100 kilograms (220 pounds) per month of hazardous waste are exempt under federal law.

Costs - The costs for disposal varies depending on the type of waste and transportation. Remember it costs as much to transport a quart from Price, Moab, or Tremonton as it does forty 55-gallon drums.

Lab Fee - Generator is responsible for determining what the waste is. If the waste is in its original container and has a MSDS (Material Safety Data Sheet), the lab fee can be avoided. Otherwise, an independent lab must make the determination of the waste. Fee will be a minimum of $500.

EPA I.D. # - This must be obtained from the Utah Bureau of Solid and Hazardous Waste.

Acceptance - $75 Profile sample (show sample). All waste must be sampled and approved for disposal before a pickup can be made. A sample verifies what the generator determines the waste to be.

Transportation - The generator will be assigned a G. M. Number and given a firm quote on the price. Transportation costs for those within a 100-mile radius of Salt Lake City is $200.

Disposal - The price begins at $100 but varies depending on the required treatment or disposal method used.

Whether we work for a large chemical firm, a mosquito abatement district, drain oil every other month from our car, or apply a fresh coat of enamel paint to the bedroom furniture, we deal directly with hazardous waste in some form or another. It is our responsibility to be environmentally aware and strictly follow laws which regulate the industry. Afterall, a better environment is everyone's responsibility. Thank you.

HAZARDOUS WASTE MANAGEMENT

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Delivering a 15-minute speech on "Hazardous Waste Management" reminds me of a college exam I once took in a Philosophy 111 class. On my desk was an 8 1/2 x 11-inch paper with this question: Describe life. Be specific.

This afternoon I would like to give a brief overview of the hazardous waste industry, discuss the step-by-step process that a generator must follow to legally and properly dispose of hazardous waste and give some rough estimates of disposal costs.

The hazardous waste management industry is one of the most strictly regulated businesses in our country. Because of the environmental and public health consequences of illegal disposal, every action taken by those who generate, transport, treat and dispose of hazardous waste should be scrutinized by the government and public. As our society becomes more environmentally conscientious, the industry becomes more complex.

I represent United States Pollution Control, Inc. (USPCI), a company which has been in the industry since 1968. We specialize in the transportation, treatment and disposal of wastes generated by industry. USPCI, which employees 1,200 workers and has company headquarters in Houston, is a subsidiary of Union Pacific.

In Utah, we have 170 employees at our three facilities in Tooele County. The majority of these people work at our Grassy Mountain Facility, which is our EPA permitted treatment, storage and disposal site located 85 miles west of Salt Lake City. The others work as drivers, mechanics, sales, engineers or administrative personnel from our Western Regional Office in Lake Point. We also operate the Marblehead Lime Plant west of Grantsville. USPCI has applied for permits to build and operate a thermal incinerator in Utah's West Desert.

One of the most frequent questions asked about the industry is simply, "What is hazardous waste?"

The EPA estimates that somewhere between 10 and 15 percent of all waste generated in the United States - including trash from our homes and businesses, sewage, and industrial wastes - is classified as "hazardous waste."

Hazardous waste is a legal term, but in general, any used or spilled material which could pose a threat to people or the environment if not handled properly is called "hazardous waste." It can be in the form of a solid, liquid or gas. It usually has one of the four following characteristics.

Ignitable - easily ignited (used oils, paint thinners, used solvents)

Corrosive - causes materials to be destroyed by chemical breakdown (acids, photographic chemicals, drain cleaners)

Reactive - extremely unstable and may explode if not handled properly (cyanide and sulphide)

Toxic - may cause injury or death upon ingestion, absorption or inhalation (heavy metals, pesticides, insecticides)

In addition, the EPA has listed about 460 specific by-products from industry and chemical manufacturing sources which are classified as hazardous waste.

The overwhelming majority of hazardous waste (about 99 percent) is generated by large quantity generators. These are businesses or government agencies which produce 1,000 kilograms (2,200 pounds) of this waste per month. This includes large industries such as automobile, petroleum and military installations. It also includes manufacturers of consumer goods such as computers, television sets, medicines, clothing, plastics and thousands of other products that we depend on every day.

About 96 percent of hazardous waste is managed at the facility where it is generated. The remaining four percent is managed by companies like USPCI at off-site commercial treatment and disposal facilities.

Once hazardous waste is generated, it must be managed in accordance with laws under the Resource Conservation and Recovery Act, commonly referred to as RCRA. Even if a generator hires an EPA approved contractor to transport, treat and dispose of the waste, the

FISHES AND MOSQUITO CONTROL IN UTAH

ABSTRACT

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Since its introduction to Utah about 60 years ago, the mosquito fish (*Gambusia affinis*) has been widely employed in repressing the numbers of mosquito larvae in both natural and man-made water bodies. Attention must be paid to the potential of negative impacts by the mosquito fish on the native aquatic fauna prior to its use in any locality. This species has been partly responsible through both predation and competition for eliminating some native fishes from major parts of their range. Most notably, the least chub (*Iotichthys phlegethontis*) has vanished from all areas in which naturally-reproducing mosquito fish now occur. The least chub is now found only in Snake Valley in the western Great Salt Desert but was once abundant along the Wasatch Front. The rainwater killifish (*Lucania parva*), a salt tolerant species accidentally introduced to Utah in a shipment of bass from Texas, first entered the Great Salt Lake from springs in Skull Valley during the mesic early 1980s. Since then, it has spread along 70+ km of shoreline and may have reached the Jordan River estuary. This fish preferentially feeds upon mosquito larvae. As it gains access to the Great Salt Lake marshes, it may become a significant factor in controlling larval numbers. Several of the native fishes are insectivorous. They may have potential as controlling agents and, at the same time, the stocking of these fishes might assist in their preservation.

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occur in interpretating serologies in animals as they do in humans.

There is no doubt that pets (especially dogs) get Lyme disease in high prevalence areas. Cases have been documented in dogs in northern California (Piesman 1989). They would be more appropriately labeled victims than reservoirs. Infected dogs are probably not a risk for humans, since the tick would be unlikely to feed again on a human being (Piesman 1989).

Deer and migratory birds can serve as sporadic hosts. Deer probably serve as dead-end hosts; their major role is that of a mating platform for ticks. A better understanding on the role that birds play in the transmission of this disease is needed. Raccoons, skunks, opossums, and possibly rabbits can serve as a secondary reservoir (Piesman 1989).

Testing

The present technology for Lyme disease can test for 3 components: total antibody (both IgG and IgM), IgG alone or IgM alone. There are about 10 different test brands on the market. Unfortunately, even in test kits from the same manufacturer, there is sometimes no correlation among the three components. Two test methodologies are not marketed: Enzyme - Linked Immunosorbent Assay (ELISA), which is interpreted by machine, and indirect fluorescent antibody (IFA), which is interpreted by human judgment. Both types of tests suffer from false negatives and false positives. Reasons for false negatives include: 1) testing too early (under 3 weeks), 2) early antibiotic therapy which may abort immune response, and 3) in some tests, if ECM is the only manifestation, the level of diagnostic significance may not be reached. Reasons for false positives include: 1) infectious mononucleosis, 2) systemic lupus erythematosus, and 3) spirochetal diseases, such as syphilis, yaws, pinta, leptospirosis and relapsing fever. As in most other diseases, results should be evaluated in conjunction with other data such as clinical symptoms, epidemiologic information and exposure in endemic areas (Craft et al. 1984, Harold et al. 1984, and Andrews 1989).

Treatment

The organism that causes Lyme disease is generally sensitive to penicillins, tetracyclines and erythromycin. Doxycycline and Ceftriaxone have joined the list of recommended drugs; however, more controlled trials comparing different regimens on all drugs are needed (Anonymous 1989).

Prevention

The traditional recommendations of protective clothing, repellant, and checking for ticks still apply. More recently, a product called Damminix has been developed by researchers at the Harvard School of Public Health. It includes cardboard tubes filled with an insecticide-impregnated cotton. The idea is for mice to take the cotton back to their burrows thus eliminating the ticks. Further studies are needed to evaluate this product (Anonymous 1989).

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LYME DISEASE UPDATE

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Clinical Symptoms

Lyme disease symptoms can be divided into 3 stages. Stage 1 can include fatigue, stiff neck, headache, chills, fever and muscle aches and an expanding skin lesion called erythema chronicum migrans (ECM). Stage 2 may involve cardiac and nervous systems involvement. Stage 3 involves arthritis and chronic neurological syndromes (Steere et al. 1983).

Media Attention/Public Concern

During the preceding year increased media attention has been given to Lyme disease, which has led to an increase of concern on the part of the general public. This is probably due to several factors. First, the attention focused on AIDS is now starting to dissipate, and other health issues are coming to the forefront. Second, the reported number of cases has increased, with over 5,000 cases reported in 1987 and 1988 (Hamilton 1989 and Anonymous 1989). Third, the popularity of outdoor activities, such as hiking and camping, has increased over the last decade. With more people engaging in these activities there has been a corresponding increase in concern over vector-borne diseases. Concern for Lyme disease has intensified with increased awareness of the serious complications of the disease and awareness of the occurrence of asymptomatic and atypical infections.

Vectors

The usual vectors recognized for Lyme disease have been the *Ixodes* ticks (*I. dammini, I. pacificus, I. scapularis, I. ricinus, I. persulcatus*). Recently, renewed interest in other vectors and vehicles have been shown (Anonymous 1987; Daniels and Falco 1989; Hamilton 1989; Lane and Loye 1989; Magnarelli and Barbour 1986; Piesman 1989). These include mosquitoes and flies, animal urine, cat fleas, and ticks other than the *Ixodes*:

Magnarelli and Barbour (1986) (Connecticut) report recovering a spirochete from mosquitoes, horse flies and deer flies that reacts with monoclonal antibodies to *Borrelia burgdorferi*. They describe the survival as "ephemeral." No documented transmission has occurred (Hamilton 1989 and Piesman 1989).

Elizabeth Burgess (Wisconsin) reports recovering the spirochete from animal urine. Her work has not been duplicated (Hamilton 1989, Piesman 1989).

Julia Rawlings (Texas) reports recovering the spirochete from cat fleas. Her work has not been duplicated (Piesman 1989).

Dermacentor occidentalis has been infected in northern California. No transmission has been documented (Piesman 1989).

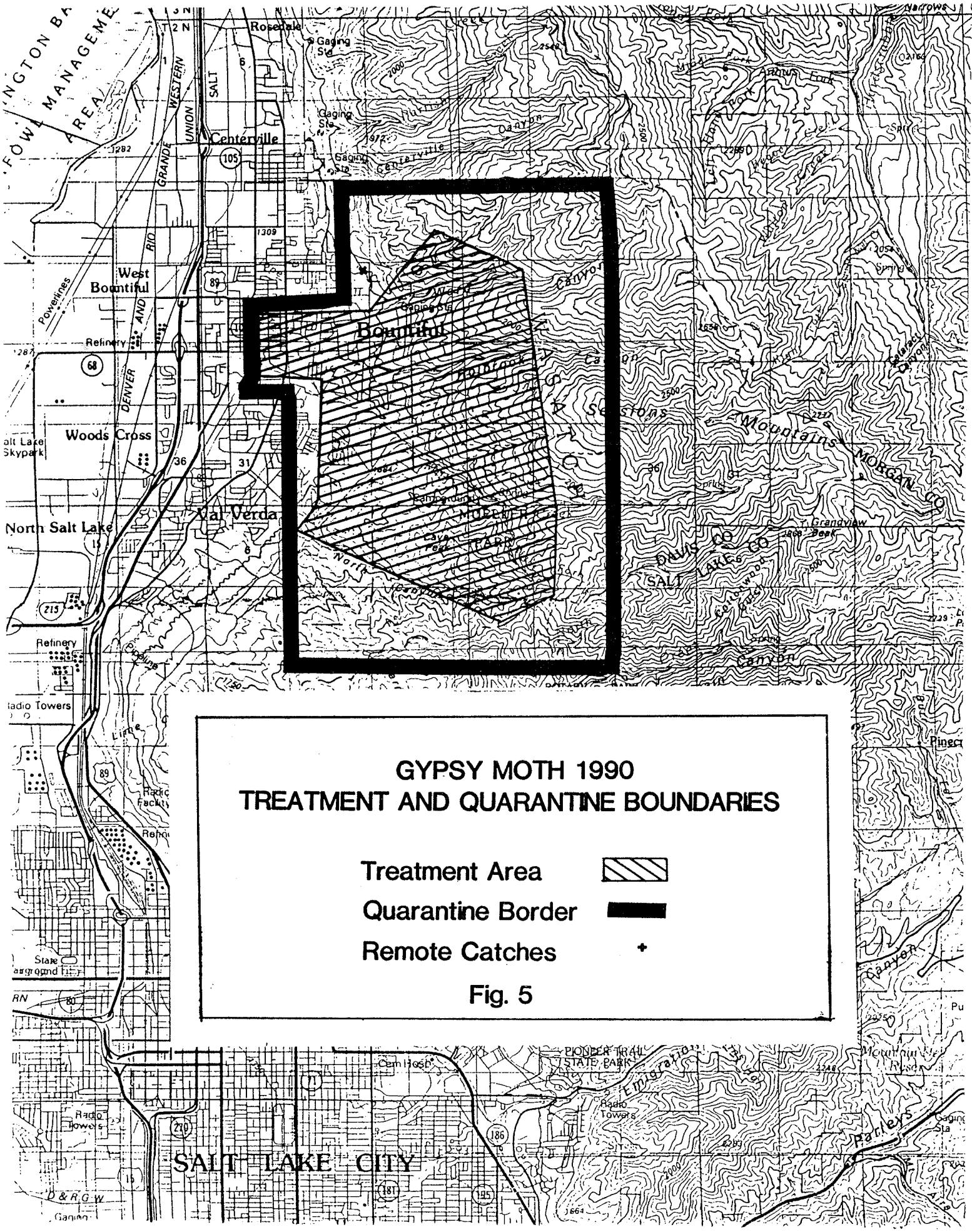
The current consensus of opinion from the Centers for Disease Control suggests Lyme disease is transmitted to humans only by the *Ixodes* tick; however, some have questioned this conclusion (Piesman 1989).

In the West, the primary vector appears to be *I. pacificus*. No recent work on tick populations in Utah has been done. Old data show *I. pacificus* in Utah in small numbers (Allred et al. 1960).

Reservoir

The triad of the deer tick, the white-footed mouse and the white-tailed deer has long been established as necessary to maintain the reservoir of Lyme disease (Daniels 1989). Recently, Lane and Loye (1989) described work done on lizards. Lizards are an important host for the immature *I. pacificus*. However, since there has been no detection of spirochetes in lizards, it's believed that they may serve as a dead-end host for the organism. Lane and Loye (1989) also note that the lizard may serve as a "zooprophylaxis" or protective factor for the rodent population, by providing an acceptable host for the immature tick population and thus preventing rodents from becoming infected.

Jackrabbits have demonstrated high rates of seropositivity (Piesman 1989). Unfortunately, the same pitfalls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North Salt Lake
Val Verda
Rosedale
SALT LAKE CITY
Mountains
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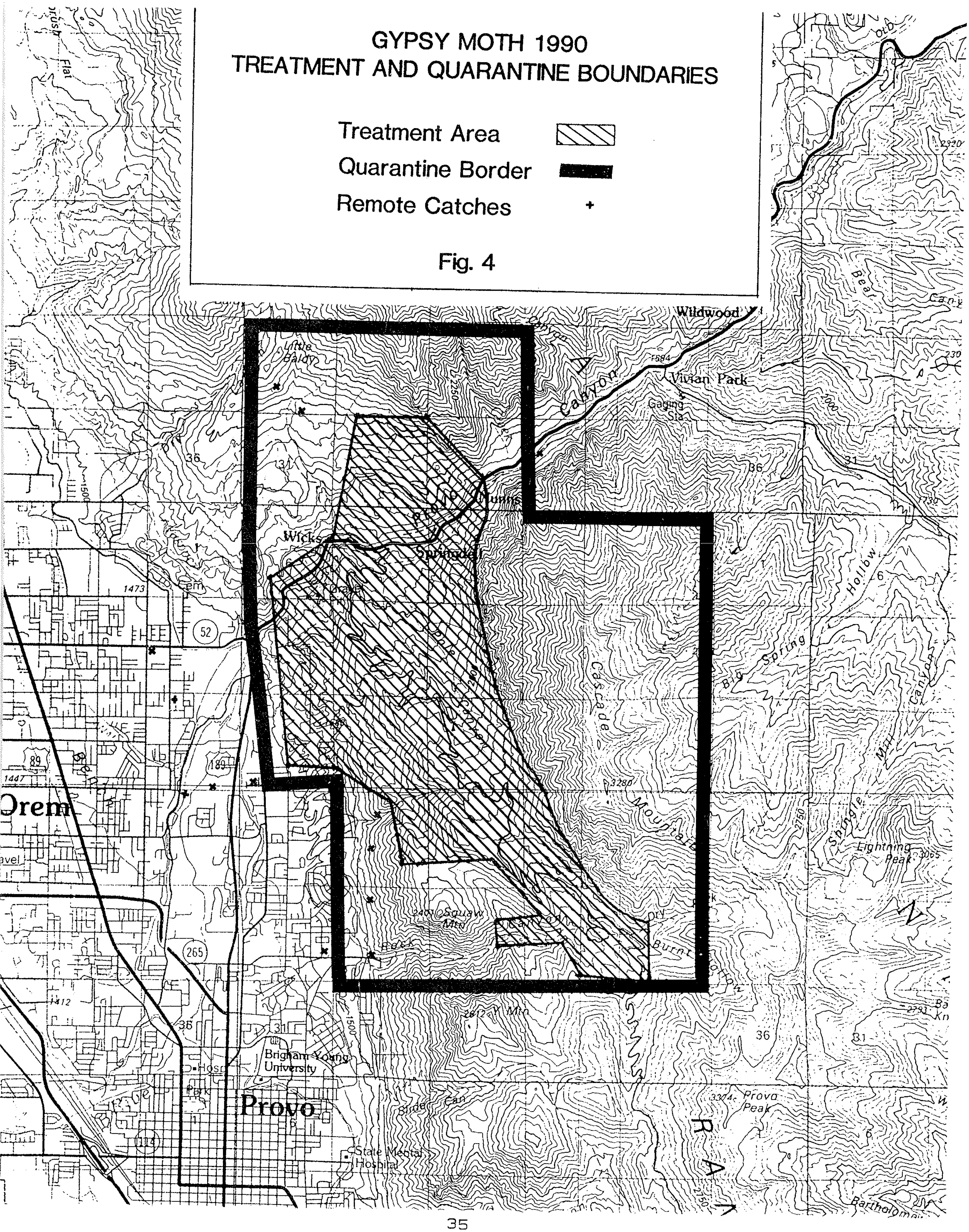
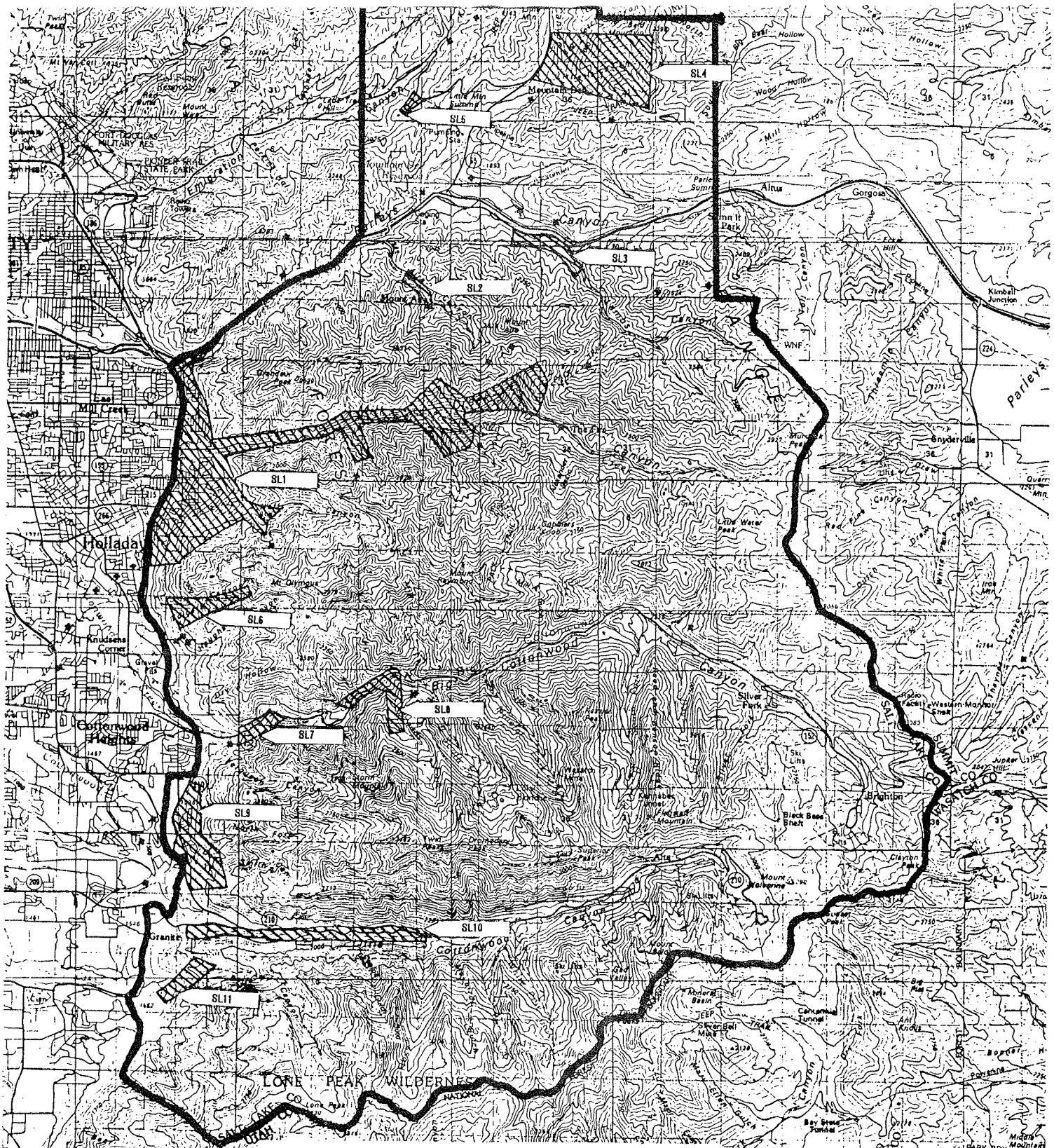
DAVIS CO
SALT LAKE CO
Refinery
Radio Towers
PIONEER TRAIL STATE PARK
Parleys
Canyon
GYPSY MOTH 1990
TREATMENT AND QUARANTINE BOUNDARIES
Treatment Area
Quarantine Border
Remote Catches

Fig. 5



GYPSY MOTH 1990
TREATMENT AND QUARANTINE BOUNDARIES

Fig. 4



GYPSY MOTH 1990
TREATMENT AND QUARANTINE BOUNDARIES

Treatment Area
Quarantine Border
Remote Catches
Treatment Block # SL11

Fig. 3

Larval count reductions
1989

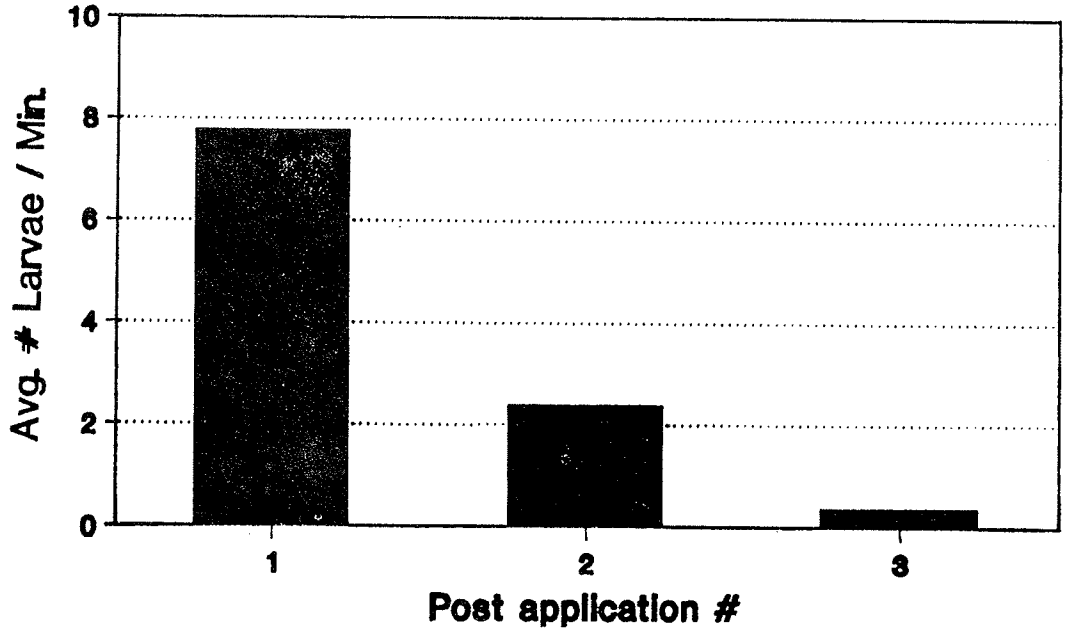


Fig. 1

Egg mass reductions
1989

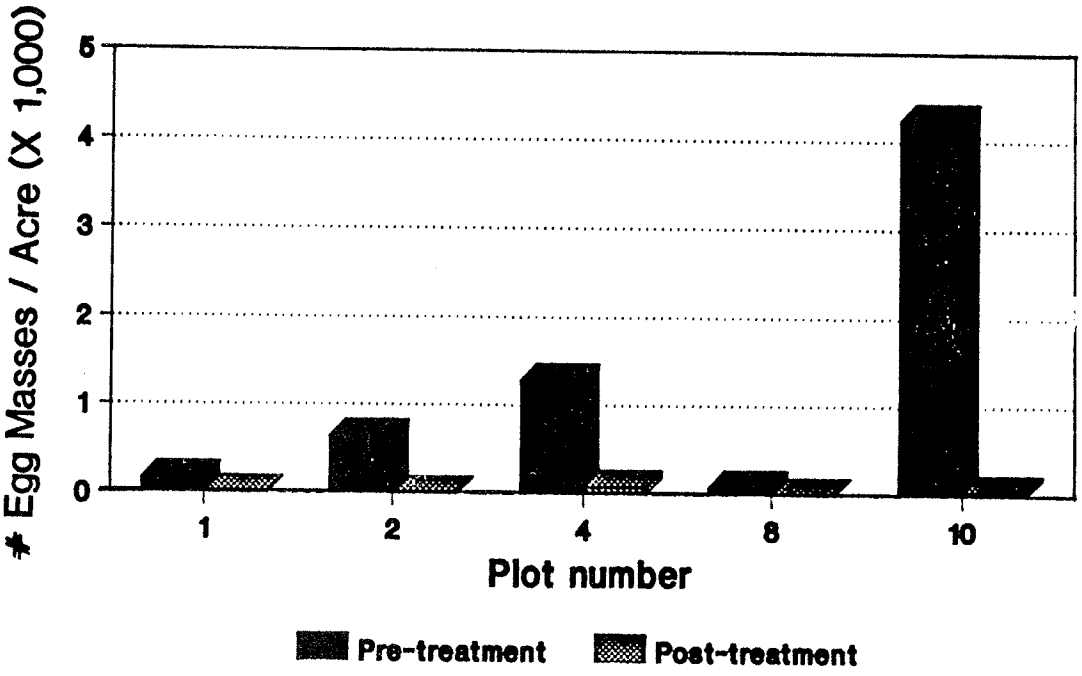


Fig. 2

Table 2. 1990 SPRAY BLOCKS

Block #	Private < 500 ac.	Private > 500 ac.	Public & Municipal	Total Non-Fed	U. S. F. S. Forest	U. S. F. S. Wilderness	BLM	Total Federal	Total Block
DA1	4,048	0	997	5,045	2,317	0	0	2,317	7,362
SL1	1,891	0	45	1,936	1,124	483	0	1,607	3,543
SL2	72	0	0	72	0	0	0	0	72
SL3	0	0	102	102	79	0	0	79	181
SL4	366	0	600	966	320	0	0	320	1,286
SL5	41	0	0	41	10	0	0	10	51
SL6	0	0	0	0	0	287	0	287	287
SL7	6	0	0	6	95	18	0	113	119
SL8	66	0	16	82	29	164	0	193	275
SL9	478	0	0	478	148	0	0	148	626
SL10	167	0	0	167	328	60	0	388	555
SL11	208	0	5	213	0	5	0	5	218
UT1	828	0	975	1,803	3,686	0	0	3,686	5,489
TOTAL	8,171	0	2,740	10,911	8,136	1,017	0	9,153	20,064

Table 1. 1989 TRAPPING DATA

County	# TRAPS PLACED					CATCH SUMMARY			
	USDANFS	BLM	Nonfed	Total Fed	Total	# Multiples	# Singles	Trp/Catch	Total
DAVIS	44	0	345	44	389	61	16	77	764
MORGAN	4	0	2	4	6	0	0	0	0
SALT LAKE	394	0	2,836	394	3,230	88	86	174	822
SUMMIT	2	1	247	3	250	0	3	3	3
UTAH	74	0	357	74	431	49	26	75	684
WASATCH	0	0	22	0	22	0	1	1	1
TOTAL	518	1	3,809	519	4,328	198	312	330	2,274

violations reported were for untarped vehicles leaving the quarantine area carrying trash. The affected community was very supportive of these efforts. This quarantine subcommittee was co-chaired by Ed Bianco, UDOA and Tom Crowe, APHIS.

THE 1990 PROGRAM

Following a successful delimitation and detection trapping survey, the Decision and Action Committee felt all treatment efforts in the 1990 program would be based on 1989 trap results. The first Decision and Action Committee meeting following the 1989 trapping season reviewed survey results.

Also, Wayne Whaley, Ph.D. summarized the detection survey he conducted along the Wasatch Front on non-target lepidoptera populations that may be at risk if treated in the 1990 eradication program. The Decision and Action Committee made the following subcommittee assignments for the 1990 eradication program:

Steve Munson, USFS-FPM - Chairman/Spray Block Committee. This group has met and proposed 13 blocks encompassing 20,064 acres for the 1990 Eradication Program (Table 2);

Joe Beckstrand, UDOA-Pesticide Supervisor - Chairman/Pesticide Selection Committee;

Ed Bianco, UDOA and Tom Crowe, APHIS - Co-Chairmen/Quarantine Committee;

Jim Cook, USFS-Wasatch/Cache NF and Leon LaMadeleine,USFS-FPM-Co-Chairmen/Environmental Assessment Committee;

Mark Quilter, UDOA - Chairman/Trapping and Survey Committee;

Larry Sagars, USU Extension Service and El Shaffer, UDOA-Information Office - Co-Chairmen/Public Relations Committee.

The 1990 Utah Gypsy Moth Eradication is already underway. The goal of the Decision and Action Committee is to reduce gypsy moth numbers to small isolated populations within the next 4 years. Ultimately, the committee hopes to completely eradicate all gypsy moth populations in the State of Utah. Using the present trapping system, the committee hopes to detect new infestations at endemic levels. The Decision and Action Committee is dedicated to preventing the spread of this insect pest and protecting the State's natural resources.

BOUNTIFUL AND PROVO

As a result of increased public awareness of the gypsy moth in Utah, a number of inquiries and larval samples were sent to various state and federal agencies for confirmation of identification. This type of community response led to the discovery of 2 isolated populations in Bountiful and Provo, Utah. Recreation personnel in cooperation with Utah Department of Agriculture (UDOA), conducted a survey of the infested sites to determine infestation boundaries. Following this survey, each city contracted with commercial applicators to treat the infested areas. Ground application equipment was used to apply the Orthene formulation. Orthene was selected as the insecticide because of its effectiveness on late, 4th and 5th instar larvae. Approximately 30 acres were treated at both sites, in Provo this included 30 residential sites and in Bountiful 85 residential sites. In both areas, the program encountered good public support.

TRAPPING AND SURVEY

Delimit Survey

Delimit trapping began in early May within the urban areas of Salt Lake City. Ten survey crews (2 people/crew) were employed by the UDOA and USDA Forest Service. Using a 1,000 foot grid, over 3,800 traps were placed in the urban areas of Provo, Salt Lake City and Bountiful. Trapping of these residential sites was completed within a 2 week period. Within the mountainous areas, traps were placed using a 2,000 foot grid whenever possible. Because of rough terrain, only 519 traps were placed within a 2 month period. In mid-August the trapping crews began to collect the delimitation traps within the urban areas. Urban area trap collection took approximately 2 weeks. Trap collection began in the mountains in early September, with the last traps collected during the 3rd week of October (Figures 3 and 4).

Detection Survey

Over 570 detection traps were placed statewide under the direction of Dawn Holzer, Animal, Plant, Health Inspection Service - Plant Protection and Quarantine (APHIS-PPQ). She developed a statewide system using APHIS guidelines that will monitor all potential gypsy moth habitats over a 4 year period. Trap placement was conducted using UDOA District Inspectors and a Forest Service-FPM trapping crew.

Trap Results

The UDOA cooperated with the Utah Automated Geographic Reference Center (AGR) automating the data storage and mapping system used by the gypsy moth program. Data compilation was conducted using existing phone lines to the AGR computer where analysis files were downloaded. Maps were produced using an RC-INFO geographic information system. Map products were used to plan the 1990 treatment program. Male gypsy moths were collected in 6 counties, Davis (764), Salt Lake (822), and Utah (684). The other 3 counties catching male moths border these counties, and only isolated single moth catches were found. Within the 6 county area, 2,274 moths were collected from the gypsy moth delimitation traps. Only 4 moths were collected in the detection survey. Within the detection survey, one multiple catch was recorded near the Provo infestation; the other 3 traps were single male moth catches. Delimitation trapping will be conducted near these positive catch sites in 1990 (Table 1).

Milk Cartons

Milk carton pheromone traps were placed within the 3 treatment areas at 4-8 traps/acre, depending on vegetation types occupying the site. Approximately 500 traps were placed in each of the 3 treatment areas. The milk carton traps averaged 2 moths/trap. On the treatment borders, trap catches ranged from 6 to over 100 moths/trap. In Provo, only a few isolated trap catches were recorded within the treatment block boundary. However, multiple catches were recorded on adjoining untreated Forest Service land.

QUARANTINE

The Utah Department of Agriculture established an internal and external quarantine to restrict the movement of gypsy moth life stages from the infested areas. The quarantine boundaries, which became effective in April 1989, encompassed the Olympus Cove area of Salt Lake City. Enforcement of the quarantine was a cooperative effort between UDOA, APHIS and the Salt Lake County Sheriff's Department. Roads leaving the quarantine area were posted, and mailings outlining the quarantine efforts were distributed to all residents within the quarantine boundary. Self inspection forms were available to residents at local libraries. UDOA, APHIS and the Sheriff's Department established periodic roadblocks near the quarantine boundary. They conducted 1,246 inspections of vehicles and material leaving the infested area. The only

A SUMMARY OF THE 1989 UTAH GYPSY MOTH PROGRAM (Lepidoptera: Lymantriidae)

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and

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The 1989 Utah Gypsy Moth Program officially began in the fall of 1988 with the formation of a Decision and Action Committee. The Committee represents a variety of local, state and federal agencies and also includes representation from the private sector. The Committee assigned duties to various subcommittees whose responsibilities were to organize and implement project activities. Each subcommittee reported directly to the Decision and Action Committee before implementing any of their proposed action items. This paper summarizes the responsibilities of each subcommittee and review activities for the 1990 program.

PUBLIC RELATIONS

The public relations subcommittee was chaired by Larry Sagars, U.S.U. Extension Service. This committee provided weekly news releases, organized speakers for various agenda, distributed gypsy moth (*Lymantria despair* (L.)) literature, organized and staffed booths at malls and fairs, and provided speakers for weekly radio talk shows. The committee administered an effective public meeting in February of 1989, for individuals interested in the treatment program. During the spray program, the committee worked with survey staff providing verbal assistance to the general public. As a result of their efforts, many newspaper, television and radio stations commented favorably on the progress of the gypsy moth program. Thanks to the efforts of this committee, the project Environmental Assessment was approved and the area successfully treated with only minor public complaints.

TREATMENT PROGRAM

The treatment committee was chaired by Steve Munson, United States Forest Service - Forest Pest Management (USFS-FPM). Dipel 8L, applied at 16 BIU's/acre in 3 treatments spaced 7 days apart was recommended by committee members. The formulation consisted of a 1:2 mixture, 1 part Dipel to 2 parts water applied at 96 ounces/acre with 2% plyac sticker. The application aircraft was a Bell 206 L3 equipped with a Simplex spray unit and 6 Beecomist nozzles. Each nozzle had a D6 orifice operating at 50 psi. Application of the formulation was made 50 feet above the canopy with a swath width of 100 feet at an airspeed of 80 mph. The spray block consisted of 1200 acres, 1100 private and 100 federal lands, in the Olympus Cove area of Salt Lake City. The first application was made on May 11, 1989. Four hours after the final load was deposited, a thunderstorm dropped 1.5 inches of rain over the spray block. Much of this moisture was in the form of hail. The second application was made May 18, 1989; no application or weather problems occurred during or after treatment. The final application was conducted May 25, 1989, and no operational difficulties were encountered.

Pre and post spray larval and eggmass counts were made by Dawn Cameron, Entomologist (USFS-FPM), to determine spray effectiveness. Seven days following the last application, larval counts indicated a 95% reduction in larval number. Eggmass (EM) counts conducted in the fall of 1989, indicated a 98% reduction in eggmass numbers within the 10 sites surveyed. Pre-spray counts within the 10 sites had eggmass numbers ranging from 0-4240 EM's/acre and post-spray eggmass counts of 0-80 EM's/-acre (Figures 1 and 2). However, a skip did occur within the block near Millcreek Canyon, eggmass numbers are estimated at 200 EM's/acre within this 2 acre area. A treatment summary was prepared following project completion in September 1989 containing detailed information on operational phases of the program.

Culicidae) in three regions of central California, USA. Journal of Medical Entomology 19(5):558-68.

Shemanchuk, J. A. 1965. On the hibernation of *Culex tarsalis* Coquillet, *Culiseta inornata* (Willison), and *Anopheles earlei* Vargas (Diptera: Culicidae), in Alberta. Mosquito News 25(4):456-62.

Shelton, R.M. 1973. The effect of temperature on development of eight mosquito species. Mosquito News 33(1):1-12.

found an upper threshold for daily temperatures of 18°C, and Meyer (1981) found lessened flight below 9°C.

Two characteristics of the species may be advantageous under unfavorable temperatures. Meyer (1981) found autogeny correlated with reduced flight due to temperature extremes. He felt autogeny would maintain egg production during unfavorable times. Also, *Cs. inornata* mates immediately upon emergence using locator pheromones and does not swarm (Kliewer et al. 1966, 1967). Downes (1969) indicated lack of swarming implies occupation of a marginal habitat.

Temperature causes mortality in ways that vary geographically. Hudson (1977) observed that for *Cs. inornata* around Alberta, "overwintering may be achieved at the cost of very high mortality" and "the preference of the mosquito for feeding on cattle, and their wide powers of dispersal . . . may be responsible for the high populations observed." However, Meyer et al. (1982) concluded that in California, abundance of *Cs. inornata* in salt marsh habitats was related to 2 principal factors: (1) the extent of colonizable production sources . . . and (2) high larval productivity. Similarly in Utah, the lack of larval habitat, inversely correlated with precipitation, is probably a larger source of mortality than overwintering mortality or inability to find hosts.

This supports Graham and Bradley's 1965 hypothesis that *Cs. inornata* abundance in Utah is a function of the amount of larval habitat of suitable temperature range. *Culiseta inornata* larvae have optimal growth near 20°C (Shelton 1973). Aestivation and hibernation of adults enable the species to survive temperature extremes when the larvae cannot. Population dynamics of *Cs. inornata* are apparently structured around the occurrence of 20°C and cooler water pools which provide the larvae with greatest survival.

ACKNOWLEDGEMENTS

This research was part of a thesis at the University of Oklahoma. Thanks go to my major professor, C.E. Hopla; committee members, A. P. Covich and F. J. Sonleitner; G. C. Collett, who generously allowed me access to Salt Lake City Mosquito Abatement District records; and S. L. Dickson, R. E. Elbel, J. E. Alexander, and K. L. Gage for helpful discussions.

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POPULATION DYNAMICS OF *CULISETA INORNATA*

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Culiseta inornata (Williston), 1893, the "snow mosquito," is a widely distributed bivoltine mosquito, though it may have more than 2 generations per year in the south (Horsfall 1955). This study compares light trap data from Utah and Oklahoma and discusses previous studies from California and Canada.

In Oklahoma, the 2 generations are well separated, with larvae and adults collected in the spring (April and May) and fall (September and October) and is not collected in July and August (Loving 1973). Larvae are found in water of around 15°C and lower (pers. obs). In Utah, all life stages can be collected throughout the summer months, with the greatest number of larvae in June and September, followed by an increase in adult abundance (Collett et al. 1964). Larvae are usually found in shaded, cooler pools at temperatures 21°C and lower, particularly as temperatures rise seasonally (Graham and Bradley 1965). Adult activity in central California peaks in November, while most larvae are collected in January (Chew and Gunstream 1970, Apperson et al. 1974). Fanar and Mulla (1974) concluded "high temperatures were the limiting factor mitigating against a resurgence of *Cs. inornata* after reflooding." Adults aestivate during high temperatures (Barnard 1977).

In Alberta, Canada, larval and adult populations peak in July and August with two peaks of larvae that overlap (Hudson 1977). The adults hibernate in mammal burrows (Shemanchuk 1965), avoiding supercooling which they survive poorly (Hudson 1977). Emergence from temperature refuges occurs when soil temperature profiles invert during the California fall (Barnard 1977) and Canadian spring (Hudson 1977).

MATERIALS AND METHODS

Comparisons of *Cs. inornata* abundances between Utah and Oklahoma were made from New Jersey light trap (NJLT) data collected by the Salt Lake City Mosquito Abatement District (SLCMAD) and the Norman Mosquito Surveillance (NMS). This equaled the sum of the weekly totals for a month divided by the number of weeks in that month having data. These monthly average collections were linearly regressed against average monthly temperatures from National Oceanic and Atmospheric Administration Climatological records.

To estimate yearly yields of *Cs. inornata* in Salt Lake City, weekly collections of the species from the first week in June until the last week in September from 1972 to 1982 were summed for each year. These yields were correlated against average temperature for the year, total yearly precipitation, snowfall preceding that summer, various cumulations of monthly precipitations from January to September, number of heating and cooling days of the year, and the number of larvae and adults collected that season and the previous season.

RESULTS

Regressions of monthly average *Cs. inornata* collections against monthly average temperatures were significant for both Utah ($p=.0001$) and Oklahoma ($p=.04$):

$$c = -1.1(t) + 35,\ r^2 = .19 \text{ (Salt Lake)}$$
$$c = -15\ (t) + 406,\ r^2 = .18 \text{ (Norman)}$$

(where c = monthly average collection of *Cs. inornata* and t = average monthly temperature in centigrade).

The x-intercept, the temperature at which flight activity would be zero, is 32°C for Utah and 27°C for Oklahoma.

Cumulative precipitation from January to September and total *Cs. inornata* larvae collected the previous year were best correlated with the yearly totals of SLCMAD trap counts. When combined in a multiple regression equation:

$$y = 8.48(p) + .652\ (1) - 280,\ p = .001$$

(where y = total annual yield of *Cs. inornata*, summed weekly totals from June to September, p = summed precipitation from January to September in centimeters, and 1 = total *Cs. inornata* larvae collected the previous year from May to September). The equation explains 80% of the variance from 1972-1982; however, it has not been checked against data not used to construct the regression equation.

DISCUSSION

The temperatures that *Cs. inornata* fly in are similar in both Utah and Oklahoma with an upper threshold for average monthly temperatures of 30°C. Barnard (1977)

Table 4. Bti Sand Granule Formulation Cost.

Fixed Cost		
Vectobac[r] Technical powder $13.50/lb. at 4.3 lbs./100 lbs. sand		.54/lb.
#4 sandblasting grit $3.00/100 lb. bag		.03/lb.
Oil (Golden Bear 1356[f]) $3.81/gal. at 37 oz./100 lbs. sand		.01/lb.
	Subtotal	$0.58/lb.
Adjusted Cost		
Labor 10 man-hrs. @ $5.00/hr./1000 lbs.		.05/lb.
Cement Mixer $20.00/day making 1000 lbs.		.02/lb.
	Total cost	$0.65/lb.

* Container Cost
$2.67 ea. + .60/lid = $3.27

Table 3. Field Trials of Bti Sand Granules at 6 lbs./acre.

# of Weeks Post-Treatment	Habitat* Type	Plot Size (Acres)	Pre-Treatment Larvae/Dip	24 Hr. Post-Treatment Larvae/Dip	% Mortality
2	SM	5	10	0.35	97
	SM	5	1	0.1	90
	SM	1	2	0.1	95
3	P	2	2	0.2	90
	P	5	3	0.8	73
5	SG	0.5	2	0.05	98
	SM	5	15	2**	87
	SM	3	5	1.5**	70
6	SG	0.25	2	0.1	95
	SM	1	15	5.0	67
	SM	0.75	15	0.25	98
	SM	1	15	3.0	80
7	SG	2	2.5	0.05	98
	P	1	2	0.05	98
	P	2	1	0.15	85
8	SG	1.5	1	0.1	90
	SG	0.25	1	0.0	100

* P = irrigated pasture; SM = salt grass and marsh; SG = salt grass swale

** 48 - 72 hour total used

Table 2. Laboratory Bioassay of Granules.

# of Weeks Post-Formulation	Percent Mortality			
	Control		Treated	
	4 hr.	24 hr.	4 hr.	24 hr.
(Batch 1)				
1	0	0	--	100
2	0	12	70	100
3	20	92	100	100
4	2	6	100	100
5	2	20	98	100
6	0	46	66	100
7	0	8	74	100
8	0	6	86	100
9	0	2	78	100
(Batch 2)				
14	0	36	84	100
15	0	0	96	100
16	4	64	100	100
17	0	54	60	100
18	0	0	56	96
19	4	8	46	100
20	0	46	50	100

Dip counts were taken 24 hours post-treatment from the same flagged area as the pre-treatment. Results were noted, and 48-hour visits made when necessary.

Results

All laboratory trials for both batch 1 and 2 had a 100% mortality 24 hours post-treatment, with control groups averaging over 75% survival after 24 hours. The main difference noted between the two granule batches was in the 4 hour reading, batch 1 usually had a lower mortality than batch 2, with the 4 hour mortality decreasing in both batches as the 9 weeks passed (Table 2).

Field trial results were only collected for batch 2. The data collected from the 17 sites showed a variation from 70%-100% mortality after 24 hours, with a mean of 90.4% (Table 3).

Discussion

The mortality rates and effective shelf life shown in the laboratory and field trial testing suggests that this formulation and storage of Bti sand granules will be an excellent operational control tool. The lowest percentage mortalities, as expected, occurred in the salt grass marshes where the organic matter in the water was high and dip counts were the greatest.

The tests showed that the Bti sand granule has a longer shelf life than had been originally anticipated. The shelf life appears to be enhanced by the use of the reseal-able plastic containers (after 20 weeks granules were still moist). When the granules are left in an open container, they dry out within 48 hours. The effects this has on the viability and shelf life of the granules has still yet to be fully studied. The buckets offered good protection and carrying capacity with a minimum of storage space.

The cost of the production of the Bti sand granules was $0.65 per lb. (Table 4). This cost can be reduced by: buying larger quantities of Bti technical powder and bidding it out, increasing production amounts and efficiency, and buying sand in bulk.

The cost of the container was not added in; however, assuming 5 uses/container, it will only add $0.01/lb. of granules.

At the Salt Lake City Mosquito Abatement, we are excited about our results in the field trial test and feel that with improvements in application our mortality average will increase. The shelf life is much longer than expected, and in the laboratory the granules were effective for 20 weeks post-formulation. We are looking forward to further testing and manufacturing next year and are optimistic for continued success.

Table 1. Bti Sand Granule Formula.

Materials	% By Weight	Based on 100Lbs. Sand
VECTOBAC[r] - Technical Powder	4.00	4.3 lbs.
Golden Bear 1356[r]	2.00	37.0 fl. oz. (2.3 lbs.)
Sand (washed/dry)	94.00	100.0 lbs.
	100.00%	106.6 lbs.

Bti SAND GRANULES

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The Salt Lake City Mosquito Abatement District (SLCMAD) has made a transition from the use of organophosphate to bacterial agents as mosquito larvicides because of resistance to organophosphates. *Bacillus thuringiensis var. israelensis* (Bti) coated corncob granule has been the pesticide of choice. However, three operational drawbacks to the use of Bti corncob granules have been observed: 1) wind makes application difficult, because of the granules light weight, by causing windrowing and uneven distribution on the water surface, which results in poor kills; 2) traditional hand application techniques used with sand granules do not work with corncob granules; 3) corncob granules are bulky and require twice as much storage area as sand granules. To overcome these obstacles the SLCMAD formulated Bti sand granules. The purpose of this paper is to report the formulation technique, as well as laboratory test and field trail results on the effectiveness and shelf life of the Bti sand granules.

Mixing procedure

The method of granule formulation was modified from the instructions provided with Vectobac Bti technical powder, and is based on 100 lbs. of sand for the formulation of 4% granules (Table 1). Clean #4 regular sandblasting grit was placed into a rotary mixer. While the mixer was rotating, Golden Bear 1356 larviciding oil was sprayed into the sand using a hand-held or a back pack sprayer unit. The mixer was allowed to run 5-10 minutes to assure a uniform coating of oil on the sand. With the mixer off, the Vectobac technical powder was added. Before the mixer was turned on, a plastic lid was placed over the opening of the mixer to prevent the escape of the technical powder. The mixer was allowed to run for 15-30 minutes to ensure full coverage of the sand granules. The Bti sand granules were then transferred into plastic buckets of 50 lbs. each and sealed for storage.

We found that 300-400 pound batches were the most efficient for the mixing process and the use of time. A rotary mixer is recommended because a mortar mixer was unable to produce as large of batches.

Mixing problems and precautions

The production of the sand granules is a relatively simple process; however, there are definite problems and precautions that are inherent in the mixing procedure. During the measuring, adding to the mixer, and when the mixer is turned on the Bti tends to billow out; therefore, respiratory and eye protection should be worn during the mixing process.

Testing Procedure

Two 1000 lb. batches of granules were formulated. One was produced on April 27, 1989 (batch 1) and the other on July 12, 1989 (batch 2). Both batches were tested in the laboratory. The testing started 1 week post formulation of batch 2, and continued weekly for 9 weeks, which was 21 weeks post formulation of batch 1.

The laboratory tests were conducted at the SLCMAD office. The test consisted of the use of 4 trays; two used as controls and one each for batch 1 and 2 granules. The water in the trays had a surface area of 1.66 sq. ft. An effective application rate of 6 lbs. per acre was used in all trials, which equals 0.1 gram or on the average 25 grains of sand per tray. Larvae were collected in pesticide free containers from various sources and brought to the laboratory. Larvae were allowed to climatize to room temperature before being transferred into the trays. The pans were filled with about an inch of distilled water. Then 50 larvae were transferred into each pan. Third instar larvae were used for the test. Larvae were checked at 4 and 24 hours post treatment for mortality.

The field tests were conducted for 8 weeks post formulation of batch 2 within the SLCMAD area. For the field trials 17 sights were used. The sights varied from salt grass marsh to pastures and ranged in size from 200 sq. ft. to 10 acres, with larval densities of 1-15/dip. The dip counts were determined by taking the average of 20 dips from a flagged region in the sight. All larval instars were tested, but sights with third instar larvae were used whenever possible. The 5 species treated with the Bti sand granules were *Aedes dorsalis, Aedes vexans, Culex pipiens, Culex tarsalis,* and *Culiseta inornata*. The test sights were treated with an application rate of 6 lbs./acre.

Table 3. Tests of Selected Larvicides Against *Cx. p. quinquefasciatus*, July 31, 1989 - August 4, 1989.

LARVICIDE	Application Rate (Gals/Ac)	Avg. % Reduction (1/4 Days)	Cost Per Acre
Diesel/Triton	10	93/81	$ 7.00
Diesel/Triton	15	80/74	$10.50
GB 1356	10	-57/-49*	$50.00
GB 1356	15	99/100	$75.00
Control		-730/-49*	

* Negative number indicates an increase in the number of larvae.

Table 4. Tests of Selected Larvicides Against *Cx. p. quinquefasciatus*, August 28, 1989 - September 5, 1989.

LARVICIDE	Application Rate	Avg. % Reduction (1/4/8 Days)	Cost Per Acre[b]
Diesel/Triton	12 Gal/Ac	84/89/74	$ 8.40
ABG 6185	10 lb/Ac	59/59/66	
Vectobac	12.5 lb/Ac	89/-13[a]/-17[a]	$13.75
Control		-46[a]/0/6	

[a] Negative number indicates an increase in number of larvae.

[b] Cost information for ABG 6185 is not available.

Table 1. Tests of Selected Larvicides Against Cx. *p. quinquefasciatus*, June 20, 1989 - June 23, 1989.

	LARVICIDE	Application Rate (lbs/Ac)	Avg. % Reduction (1/3 Days)	Cost Per Acre[d]
	Vectobac	2.5	32/31	$ 2.75
	Vectobac	5.0	96/98	$ 5.50
	Vectobac	7.5	100/100	$ 8.25
[a]	Vectobac	10.0	97/91	$11.00
[a,b]	Vectobac	15.0	5/-173[c]	$16.50
	ABG 6185	2.5	69/78	
	ABG 6185	5.0	100/100	
	ABG 6185	7.5	100/91	
	ABG 6185	10.0	78/85	
	ABG 6185	15.0	99/98	
	Control		-41[c]/5	

[a] Heavy flooding occurred at 4 days post-treatment

[b] Many 1st instar larvae

[c] Negative number indicates an increase in the number of larvae.

[d] Cost for ABG 6185 is not available.

Table 2. Tests of Selected Larvicides Against Cx. *p. quinquefasciatus*, July 24, 1989 - July 28, 1989

LARVICIDE	Application Rate (Gals/Ac)	Avg. % Reduction (1/4 Days)	Cost Per Acre
GB 1356	5	81/93	$25.00
GB 1356	10	85/63	$50.00
BVA-A	5	35/76	$14.75
BVA-A	10	43/63	$29.50
Control		7/40	

treatment (Table 4). There was a 46% increase in the number of larvae at the control site 1 day (24 hours) after treatment (Table 4). The number of larvae present at the control site 4 days post-treatment was the same as for the pre-treatment sampling and there were 6% fewer larvae in the control site at 8 days post-treatment. The Diesel/Triton gave moderately good control at 1, 4 and 8 days post-treatment. ABG 6185 was less effective during the same period. Since the active ingredient in ABG 6185 was *Bacillus sphaericus* these sites were sampled again at 21 days post-treatment to determine if there had been any residual control. The number of larvae in the 3 sites treated with ABG 6185 had increased to 579% of pre-treatment levels at 21 days post treatment. The check site had increased to 319% of pre-treatment counts at 21 days. Vectobac-G gave good control (89% reduction) at 1 day post-treatment but the number of larvae in the treated area increased by 13% and 17%, respectively, at 4 and 8 days post-treatment.

In general, all of the materials tested gave some control of *Culex pipiens quinquefasciatus* in these highly polluted, heavily vegetated roadside ditches. However, none of the materials gave exceptionally good results at economically acceptable rates. Diesel/Triton, which is no longer used by most mosquito abatement districts, was the most economical (Tables 3 & 4). In some of the sites the number of larvae increased following treatments with GB 1356 and Vectobac-G (Tables 1, 3 and 4). The BVA-A oil did not work well in either of the sites where it was used (Table 2).

The high organic content, the intermittent addition of new nutrients and water from nearby residences and the heavy vegetation in the study sites present a great challenge to any larvicide. We plan to run trials again during 1990 to attempt to find a larvicide that will give consistent results at economically affordable rates. Some of the materials tested in East Baton Rouge Parish during 1989 will be tested again during 1990 to determine if the results are consistent from year to year. We also plan to test additional materials in these study sites during 1990.