SECTION 22

PUBLIC HEALTH APPLICATIONS OF REMOTE SENSING

by

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INTRODUCTION

Since August 1970, a small staff from the Medical Research and Operations Directorate working with the Science & Applications Directorate at the Manned Spacecraft Center has studied the feasibility of using remote sensing in public health applications. Technical assistance to this Public Health Ecology group has been received from the University of Texas School of Public Health at Houston, and from municipal, county, state, and regional government officials. Theoretical evaluations, and practical applications of remote-sensor data have been discussed with representatives from the above groups in addition to those from the U.S. Public Health Service, the Pan American Health Organization, the World Health Organization, and the Food and Agriculture Organization of the United Nations. All discussions have been directed toward potential applications on a pilot study scale.

This Public Health Ecology group has embarked on a three-fold program of research and development. This overall program entails:

First, a program designed to develop and increase awareness in the Public Health Sector of the potential of NASA's remote sensing capabilities for the solutions of public health problems currently engaging these agencies.

Second, a program designed to develop and increase a university and public health sector applied research program into those public health problems which might be most amenable to solution by the application of remote sensing technology.

And third, a program designed to develop and increase an in-house capability to examine, develop and apply remote sensing applications to the solutions of public health problems.

PROGRAM OBJECTIVES

The Public Health Ecology group is encouraged that it will find significant scientific correlations between disease, water, air and urban degradation, and natural disasters as they show relationships to other observed phenomenon such as indicator species, crown signatures of trees, and evidence of other reliable symbiotic relationships.

Of these four areas of endeavor, animal or insect-borne diseases have received the greatest emphasis. These diseases are caused by organisms whose life cycles depend on insect vectors or animal hosts that have a unique and often critical dependency on specific components of the biosphere for their perpetuation and transmission.

Primary reasons for the stubborn persistence of these diseases in our society lies in our lack of understanding and our inability to deal effectively with the interrelationships between man and his physical and biological environment. Remote sensing can provide the investigator with the unique perspective and a different kind of knowledge needed to deal more effectively with these diseases.

The key to this sought after new capability is to determine those highly reliable sensor detectable characteristics which are to a high degree mutually exclusive, all inclusive and replicable when addressing vector-borne disease phenomenon or medical zoology problems.

SUPPORTING RESEARCH AND TECHNOLOGY

Contracts to assist in the accomplishment of this work, as seen in Figure 1, have been awarded to the University of Texas School of Public Health at Houston. This graduate school, one of eighteen in the nation that provides Masters and Ph.D. level training to physicians, veterinarians, dentists, bioenvironmental engineers and other graduate level paramedical people, has also received a contract to assist the Public Health Ecology group in a study of respirable and suspended air-borne particulates.

The basic technique is dependent on contrast imagery. Since suspended particulates scatter light waves of a wavelength equal to that of the suspended particulate diameter the image contrast at that wavelength is reduced. Furthermore, the amount of reduction of that contrast has been successfully correlated to the size, size distribution and total weight of suspended particulates in the air environment. Thus, the method requires a passive detector system which will measure the amount of scattered light at a particular wavelength or family of wavelengths and a ground truth capability with which to correlate results.

The particulate itself may be harmful to the body or may act as a carrier of substances absorbed upon their surface. The capability to monitor such a hazard would represent a real contribution to community health.

Another study to evaluate the capability of remote sensing in delimiting regions meaningful to urban public health investigators has been initiated at the University of Texas.

This program requires the use of remote sensing to examine the capability for prediction and assessment of socio-economic spatial distribution and those related ecological facets which exert a marked influence on health and health-related activities.

Another contract was just awarded to the University of Texas School of Public Health to investigate the usefulness of remote sensing imagery to identify and quantify specific water pollution parameters that will contribute to the resolution of water degradation problems of public health importance.

Another contract was recently awarded to the Office of Environmental studies, The University of West Florida to conduct an investigation of those botanic species or vegetative communities which have a strong relationship with certain diseases.

PUBLIC HEALTH ECOLOGY PROJECTS

The following specific projects resulting from situations of opportunity have been initiated in the last seven months.

As the epidemic of Venezuelan equine encephalitis crossed the Mexican border and spread through Texas counties in July and August, 1971, as seen in Figure 2, NASA provided low and high altitude aerial photography and health experts trained in remote sensing to a cooperative program with the Public Health Service Center for Disease Control and the University of Texas School of Public Health at Houston.

Currently, detailed research is underway to determine the habitat of Culex quinquefasciatus, as seen in Figure 3, the mosquito vector of St. Louis encephalitis virus in the Houston area. Studies of this mosquito are indicative that in most cases, as seen in Figure 4, the habitat can be associated with effluent from septic tank overflow into collection ditches that are common in the Houston area because of the high water table and the soil conditions. These collecting ditches as seen in Figure 5, constitute 1600 miles of collecting ditches in Harris County which run into larger ditches as seen in Figure 6, which all run into Galveston Bay.

NASA aircraft provided thermal scanner data, color infrared, color and multiband camera coverage over approximately 12 miles of these ditches containing septic water along Little York Road in north Houston.

As seen in Figure 7, ten test sites were surveyed for physical, chemical, microbiological and entomological characteristics at the time of the flight. This study is still underway.

A project in support of the U.S. Public Health Service Center for Disease Control, Atlanta, Georgia, was initiated in mid-July 1971. An explosive outbreak of anthrax caused the death of more than 500 cattle and numerous other animals in Ascension Parish, Louisiana. This applied research project uses remote sensing to determine the environmental conditions that are conducive to this soil-borne disease outbreak. NASA remote-sensing aircraft have been flown on missions over areas that are highly endemic for the disease.

Final spatial and numerical mortality data concerning the Ascension Parish Anthrax Project in Louisiana has just been received from the Public Health Service Center for Disease Control in Atlanta. This will be transferred as overlay information to color coded soils type map overlays as seen in Figure 8, to the special purpose semi-controlled color infrared mosaic being prepared by the Mapping Sciences Branch. The study has already revealed that essentially no deaths due to anthrax were observed in soil type 7, seen in orange at the northern part of the parish.

This investigation will permit correlative interpretation of NASA remote-sensing data of farms where anthrax exists. Color and color-infrared aerial photography of the epidemic area is now being analyzed in a retrospective epidemiologic study of this test site. The objective is to learn what determinants of anthrax infection can be detected and measured from the air so that aircraft may be used to rapidly evaluate potential for an anthrax outbreak or to determine the natural geographic or physical barriers of an epidemic.

High altitude color infrared aerial photography has been useful to scientists studying the habitat of endemic strains of Venezuelan encephalitis virus as seen in Figure 9, along the southern coast of Florida. It has been particularly difficult from the ground to determine the salt-water/fresh-water interface as seen in Figure 10, that provides the proper environment for vegetation hammocks in which encephalitis vector mosquitoes (Culex atratus) commonly breed.

Late in September a low altitude mission was conducted with the NP3A over a 200 acre test plot as seen in Figure 11, between Lakes Pontchartrain and St. Catherine northeast of New Orleans with color,

color infrared and multiband sensor and film combinations in a joint investigation of the feasibility of using remote sensing to recognize the ecological set necessary to produce salt marsh mosquito populations.

The New Orleans Mosquito Control Districts three years of baseline entomological, vegetative, aquatic, and meteorological data has shown certain heterogeneous vegetative communities to be empirically but strongly related to salt marsh mosquito populations. Heterogeneous vegetative communities are even difficult to assess using color infrared photography as seen in Figure 12.

Major botanical communities in the New Orleans Mosquito Control District Test Site area have been identified and inventoried and are now being compared with multiband photography which has been subjected to edge and color enhancement as a function of emulsion density.

The results of the mission are now being processed by several interpretive means. One of these methods is by simultaneously processing by electronic means three photographic negatives of the same view which records different wavelength portions of visible light. The process enhances the ease of identifying the different vegetative communities and very sharply delineates edge effects and community interfaces by assigning false colors to differentiate subtle density differences. Figure 13 shows the test site frame in the green band, Figure 14 in the red band, and Figure 15, in the near infrared band. As seen in Figure 16, only when the red band and the near infrared band are combined with decreasing density slices are the most subtle differences markedly observed which reveal even the most minor vegetative communities and interface differences.

The importance of this capability is recognized when one observes that approximately 90 percent of the production of Aedes sollicitans mosquito is dependent on the same ecological set that provides support for the Bacopa vegetative community in the New Orleans area.

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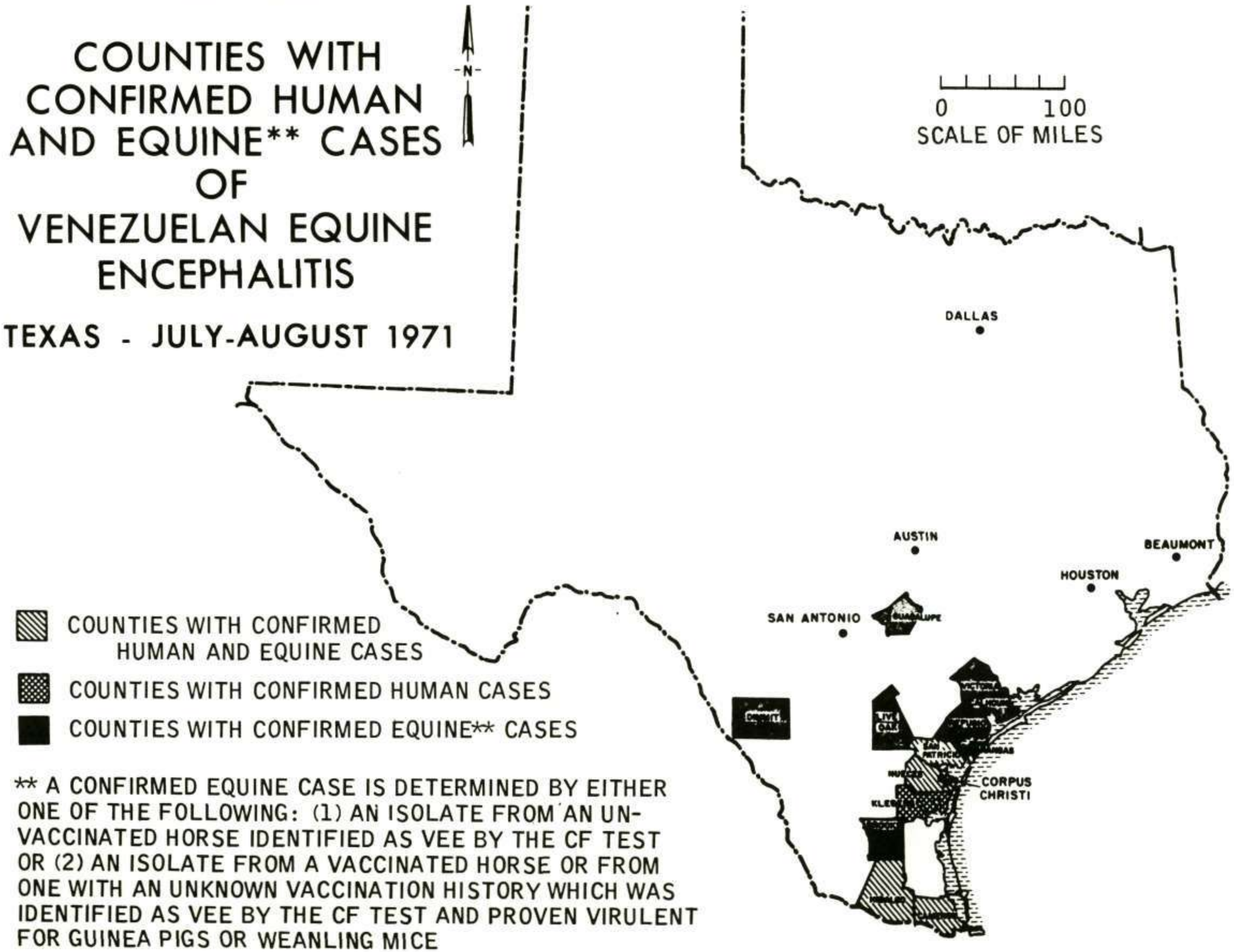
SUPPORTING RESEARCH AND TECHNOLOGY

PUBLIC HEALTH ECOLOGY

VECTOR BORNE DISEASES --------	UNIV OF TEXAS SCHOOL OF PUBLIC HEALTH
PUBLIC HEALTH ASPECTS OF WATER DEGRADATION -----	UNIV OF TEXAS SCHOOL OF PUBLIC HEALTH
PUBLIC HEALTH ASPECTS OF AIR POLLUTION ---------	UNIV OF TEXAS SCHOOL OF PUBLIC HEALTH
BIOENVIRONMENTAL FACTORS OF DISEASE AND HEALTH CONDITIONS ---	UNIV OF WEST FLORIDA

Figure 1.- Effort to develop a university sector applied research program into those public health problems which might be most amenable to solution by the application of remote sensing technology has resulted in the contracts in the above areas.

Figure 2.- As the epidemic of Venezuelan equine encephalitis crossed the Mexican border and spread through Texas counties in July and August, 1971, NASA provided low and high altitude aerial photography over a test site in the Flour Bluff section of Corpus Christi, Texas. This activity supported a cooperative program with the Public Health Service Center for Disease Control and the University of Texas School of Public Health at Houston.



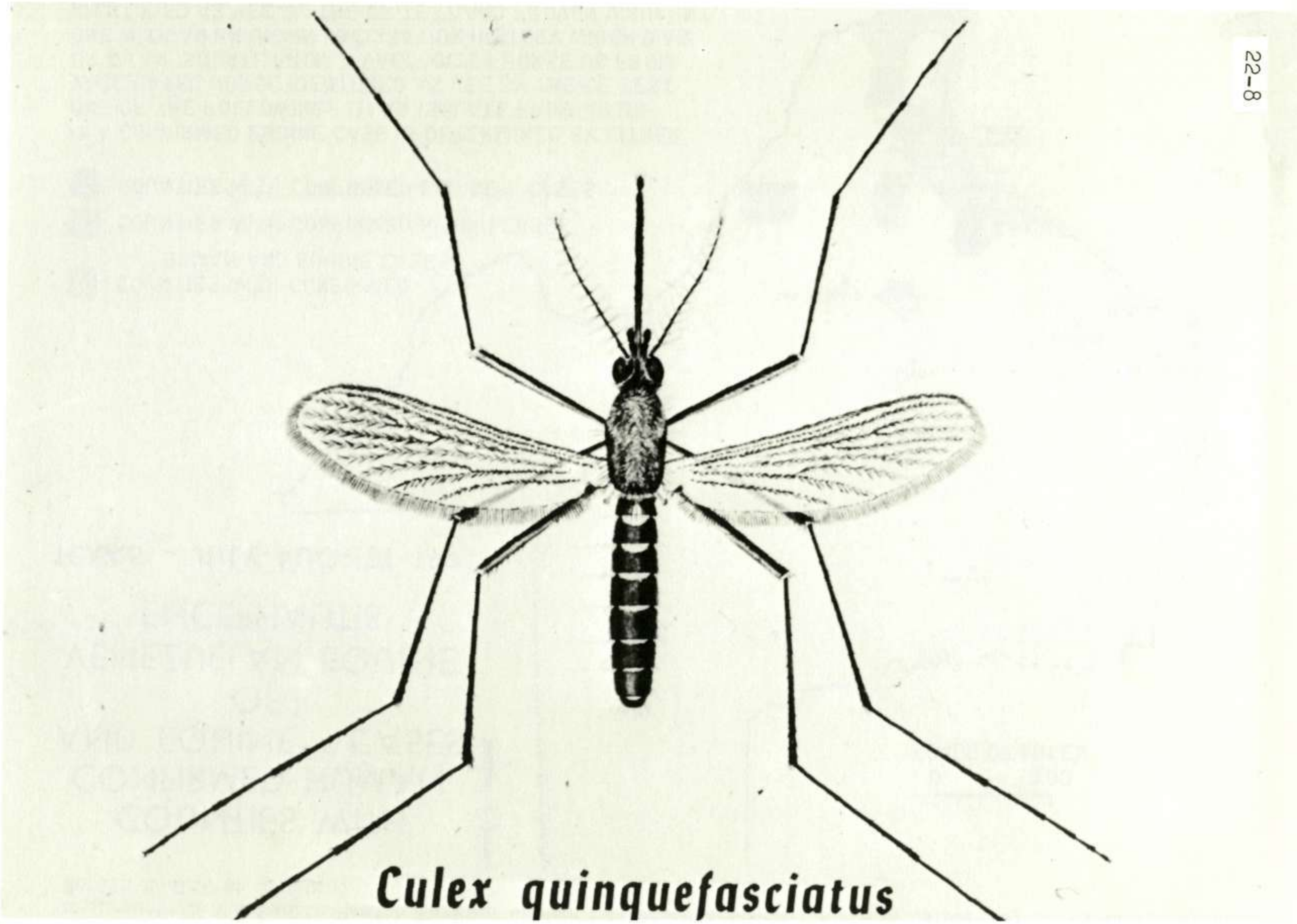


Figure 3.- Culex quinquefasciatus is the mosquito vector of St. Louis encephalitis virus in the Houston area. This mosquito which breeds almost entirely in ditches which contain effluent from septic tanks in the Houston area, caused an epidemic of St. Louis encephalitis in 1964. Control of this disease vector is mandatory.

NASA
S-71-25437

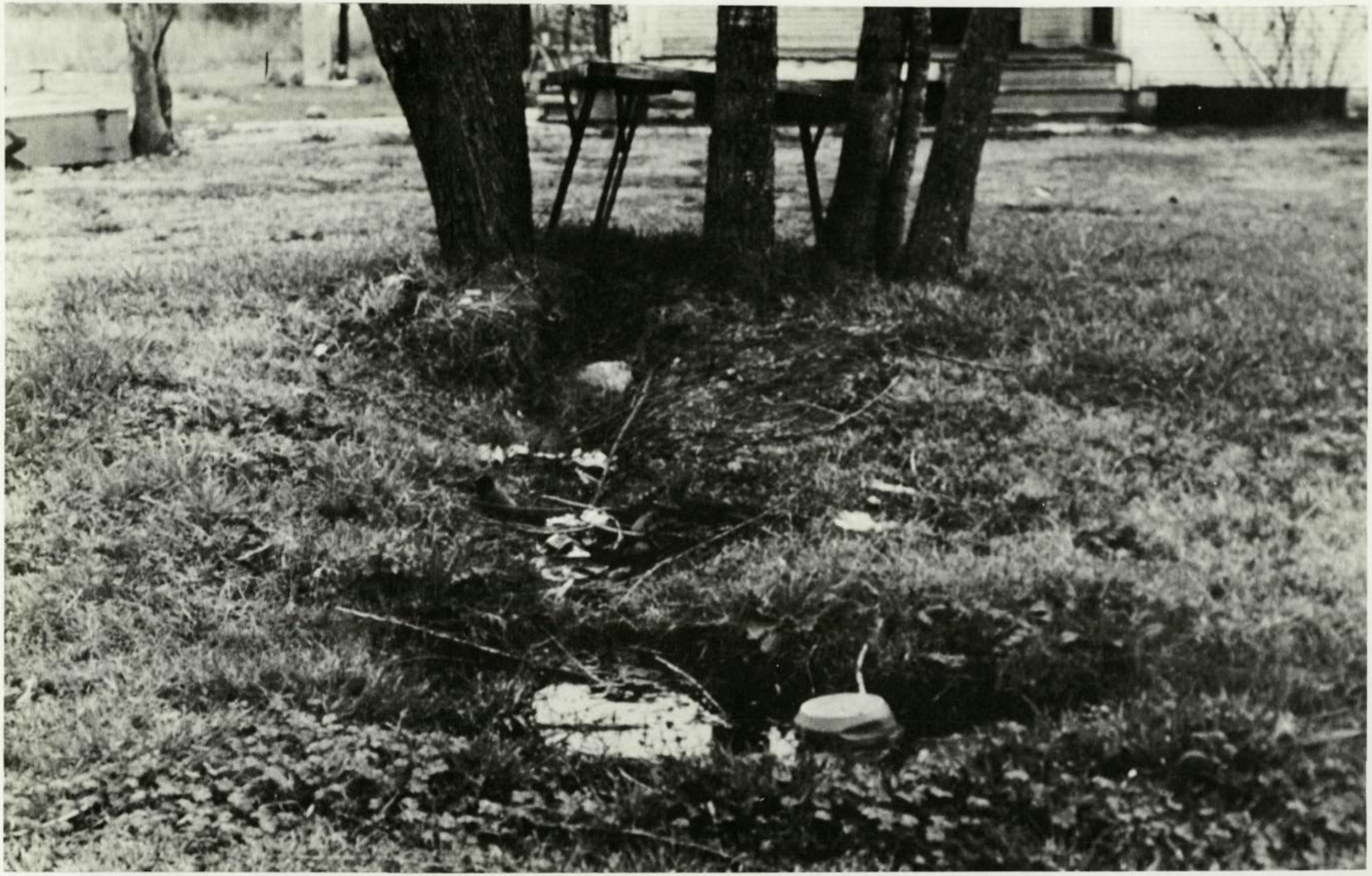


Figure 4.- The effluent from septic tanks in thousands of adjacent homes, unable to percolate thru the hard pan, flows thru pipes to openings near these collecting ditches. In this figure we see septic tank effluent running from a pipe opening in front of the trees in the front yard of this house.

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S-71-38225

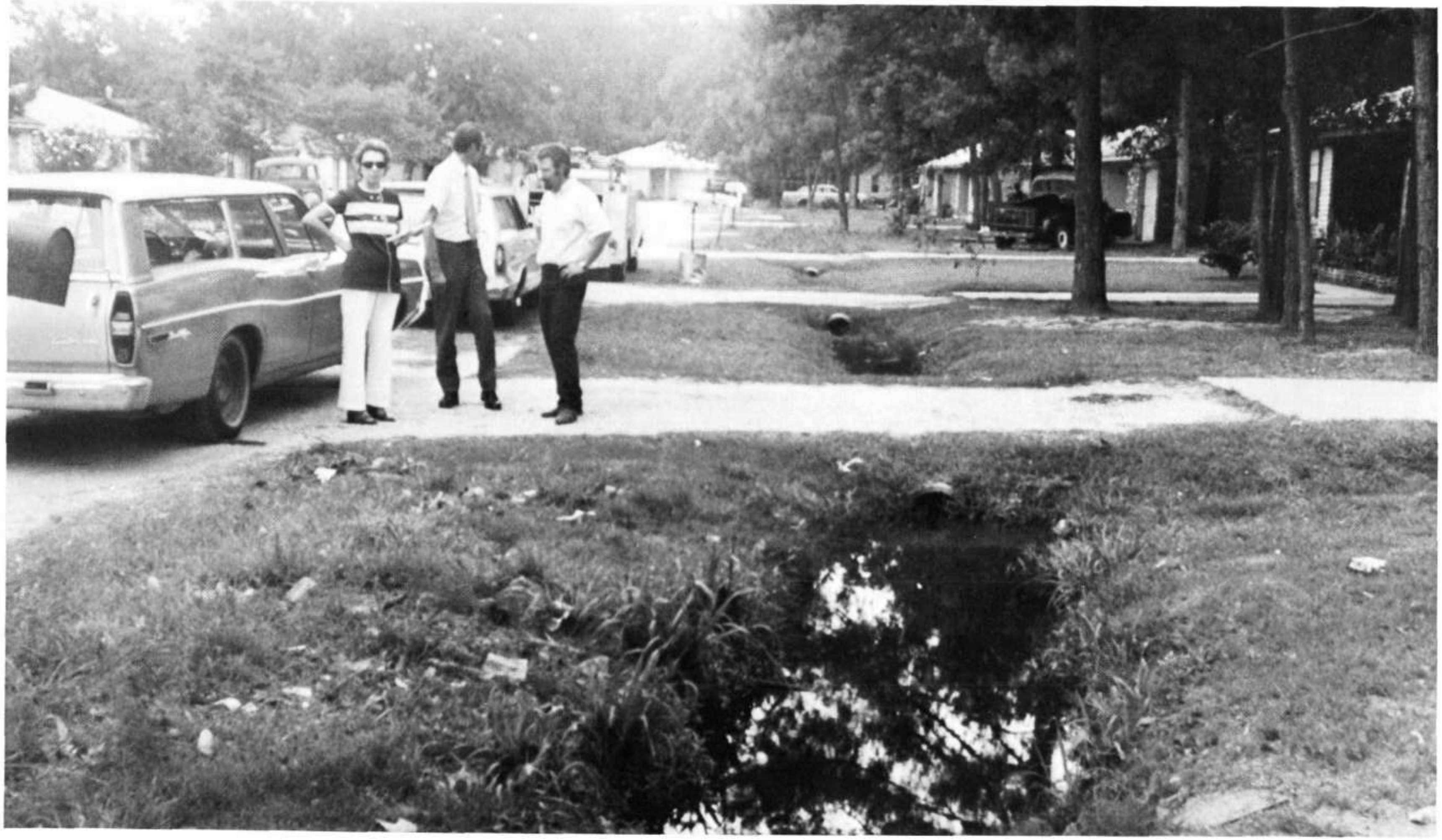
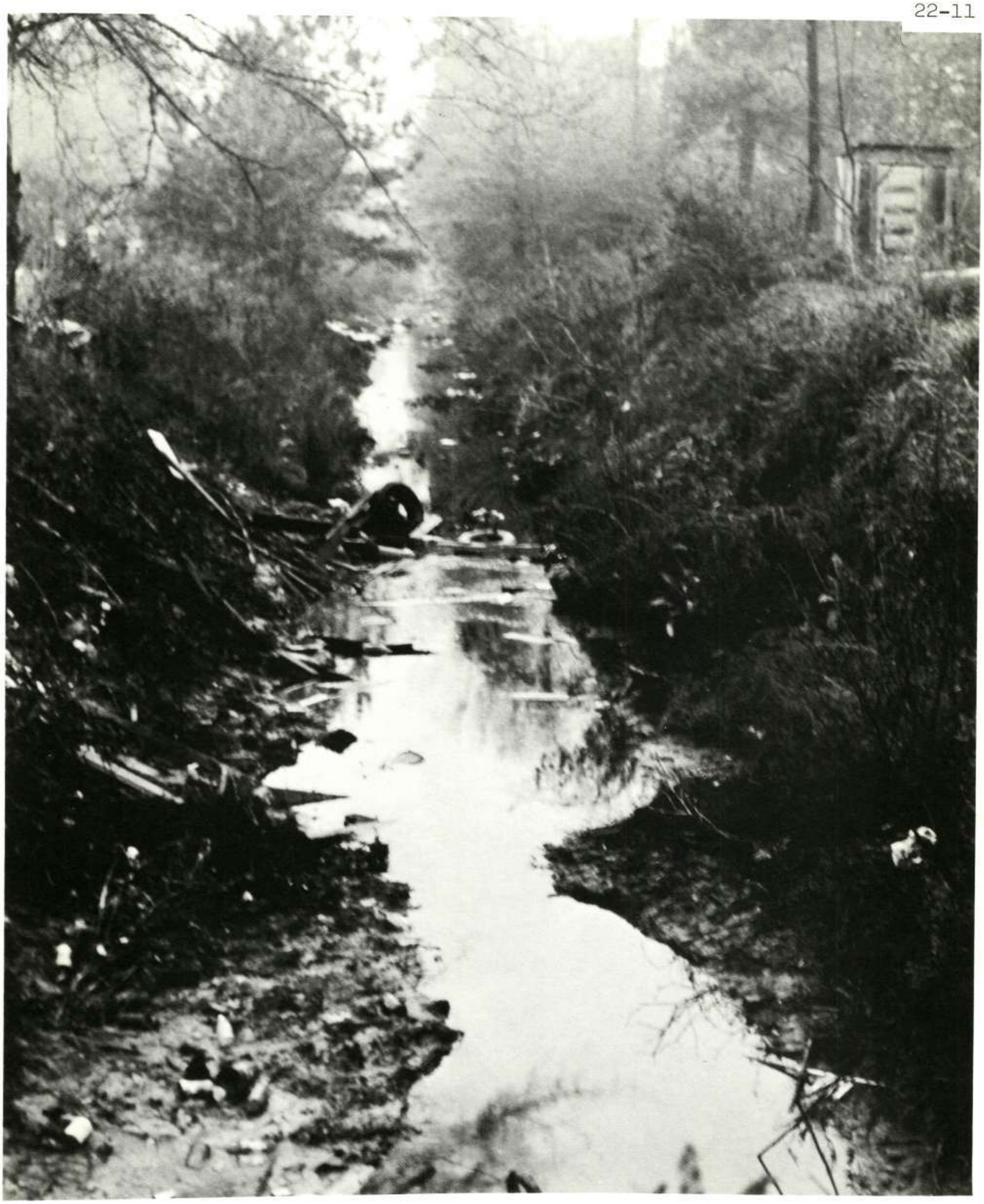


Figure 5.- This collecting ditch is representative of some 1,600 miles of collecting ditches in Harris County. Approximately $900,000 are required each year to find and control <u>Culex quinquefasciatus</u> larvae in Harris County, Houston, Texas.



NASA
S-71-25435

Figure 6.- Large ditches such as seen here collect the run off from ditches seen in Figure 5, and channel it to courses which eventually reach Galveston Bay. Culex mosquitoes breed in these larger courses as well as smaller ones provided they contain organic wastes.

NASA
S-71-38217

Figure 7.- A laboratory technician is seen collecting water samples from one of ten test sites near Little York Road in north Houston, Texas. These samples taken at the time of overflight were surveyed for physical, chemical, microbiological and entomological characteristics.

Figure 8.- Color coded soils type map overlays of Ascension Parish, Louisiana, as seen here, as well as mortality, morbidity, soil pH, and soil anthrax organism identification data, will be compared with special purpose semi-controlled infrared mosaics being prepared from data obtained in September 1971, by the NASA NP3A aircraft. This investigation will permit correlative interpretation of NASA remote sensing data with epidemiologic data.

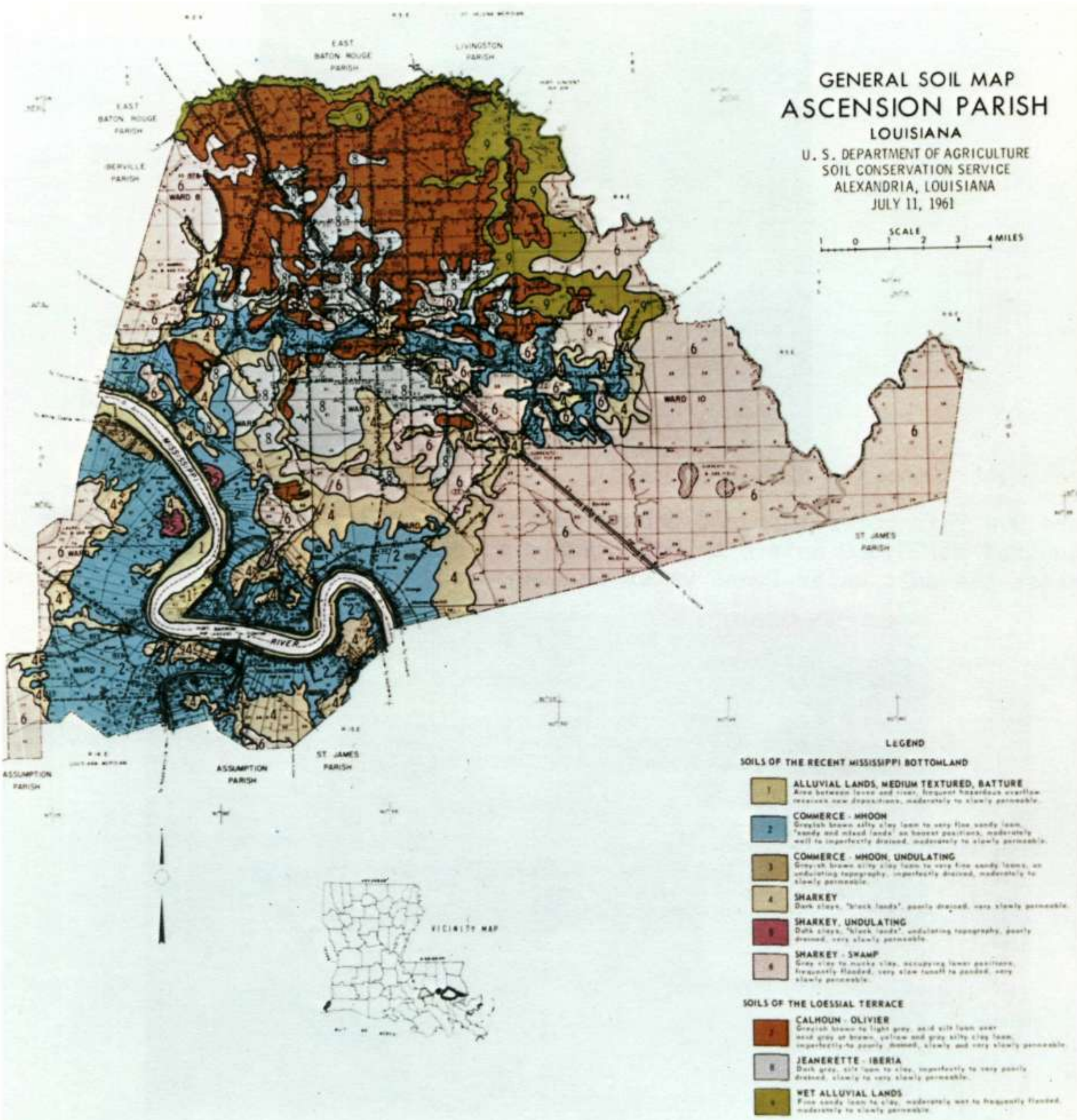


Figure 9.- This color infrared photograph of the south Florida littoral zone acquired at 20,000 meters by NASA remote sensing aircraft readily illustrates the salt water-fresh water influence and interface.

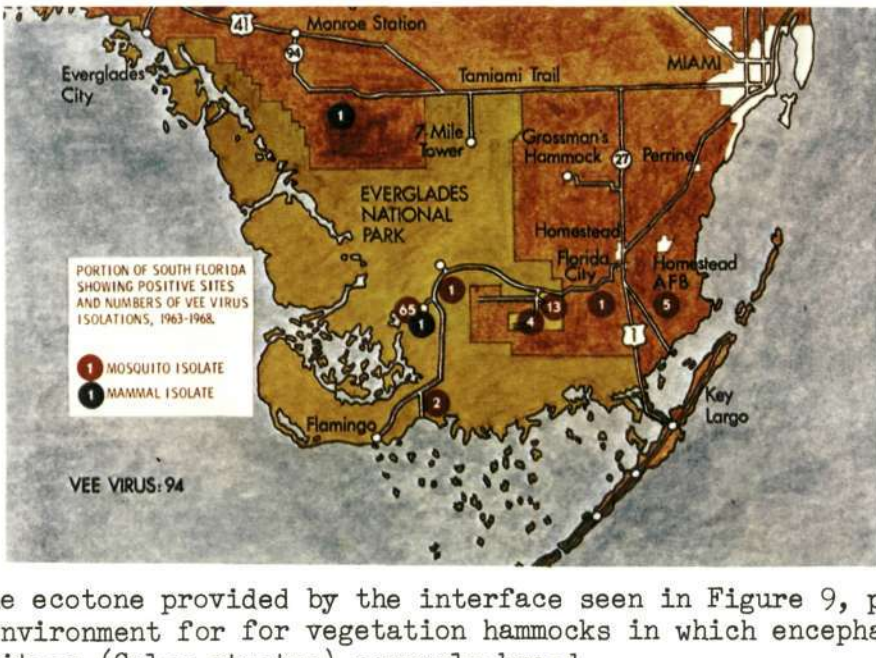


Figure 10.- The ecotone provided by the interface seen in Figure 9, provides the proper environment for for vegetation hammocks in which encephalitis vector mosquitoes (Culex atratus) commonly breed.

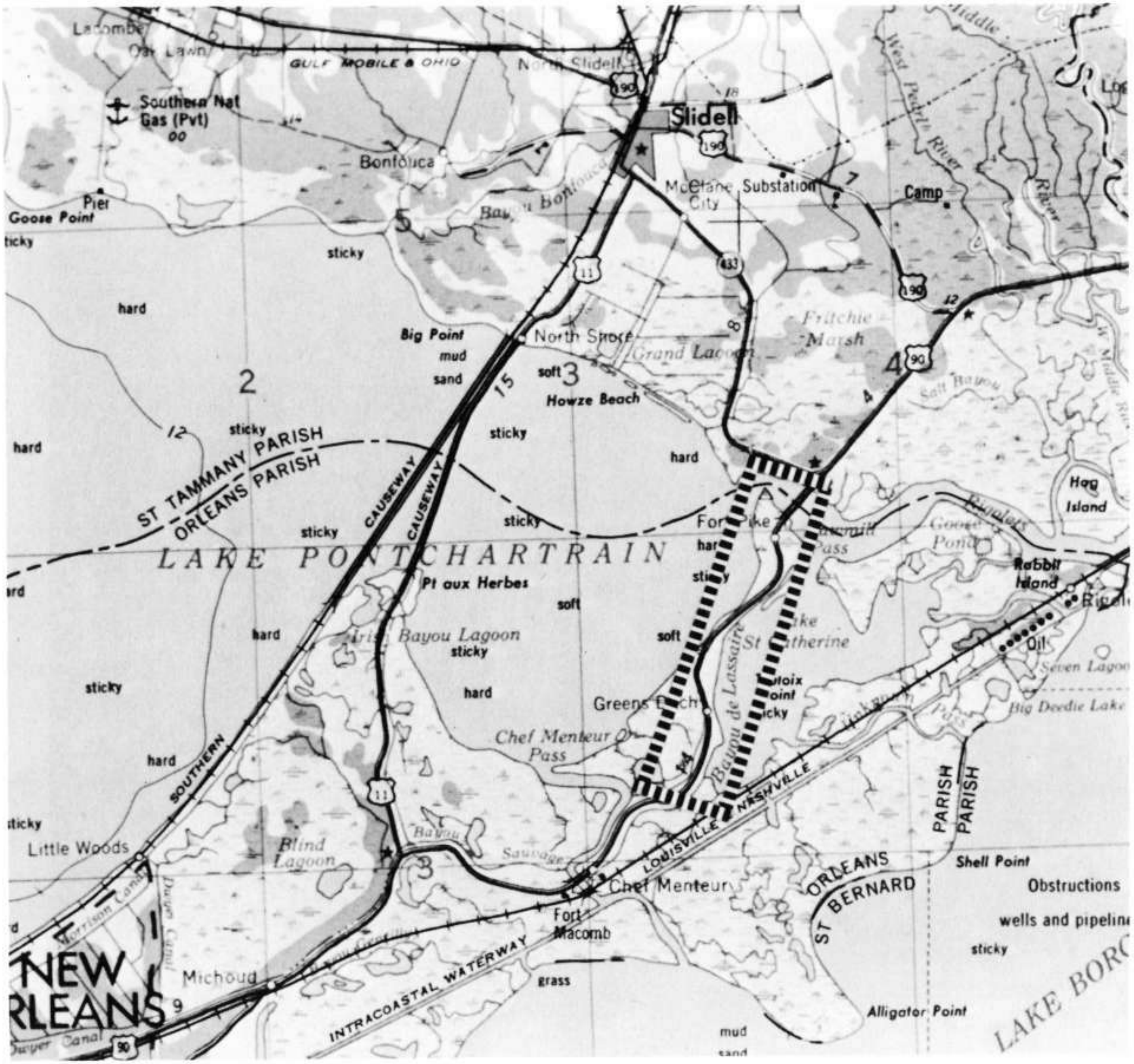


Figure 11.- The area outlined between Lakes Pontchartrain and St. Catherine includes a 200 acre test site of the New Orleans Mosquito Control District. Three years of baseline entomological, vegetative, aquatic and meteorlogical data has been acquired by that group.

Figure 12.- This color infrared photograph acquired from ektachrome color infrared 2443 film from 770 meters with the NASA NP3A aircraft, illustrates approximately 100 acres of the 200 acre New Orleans Mosquito Control District test site. Several vegetation types can be observed.

Figure 13.- This photograph was acquired from the display of the I^2S Multiband Camera Film Viewer (MCFV) which electronically processed the 2402 black and white film exposed by the KA-62 multiband cameras of the test site. This particular camera recorded the green band. False color assignment and edge enhancement have been accomplished for this band as seen here.

Figure 14.- This photograph, acquired by the same means as that seen in Figure 13, was derived from the KA-62 multiband camera that exposed the 2402 film in the red band.

Figure 15.- This photograph acquired by the same means as that seen in Figures 13 and 14, was derived from the multiband camera that exposed the 2402 film in the near infrared band.

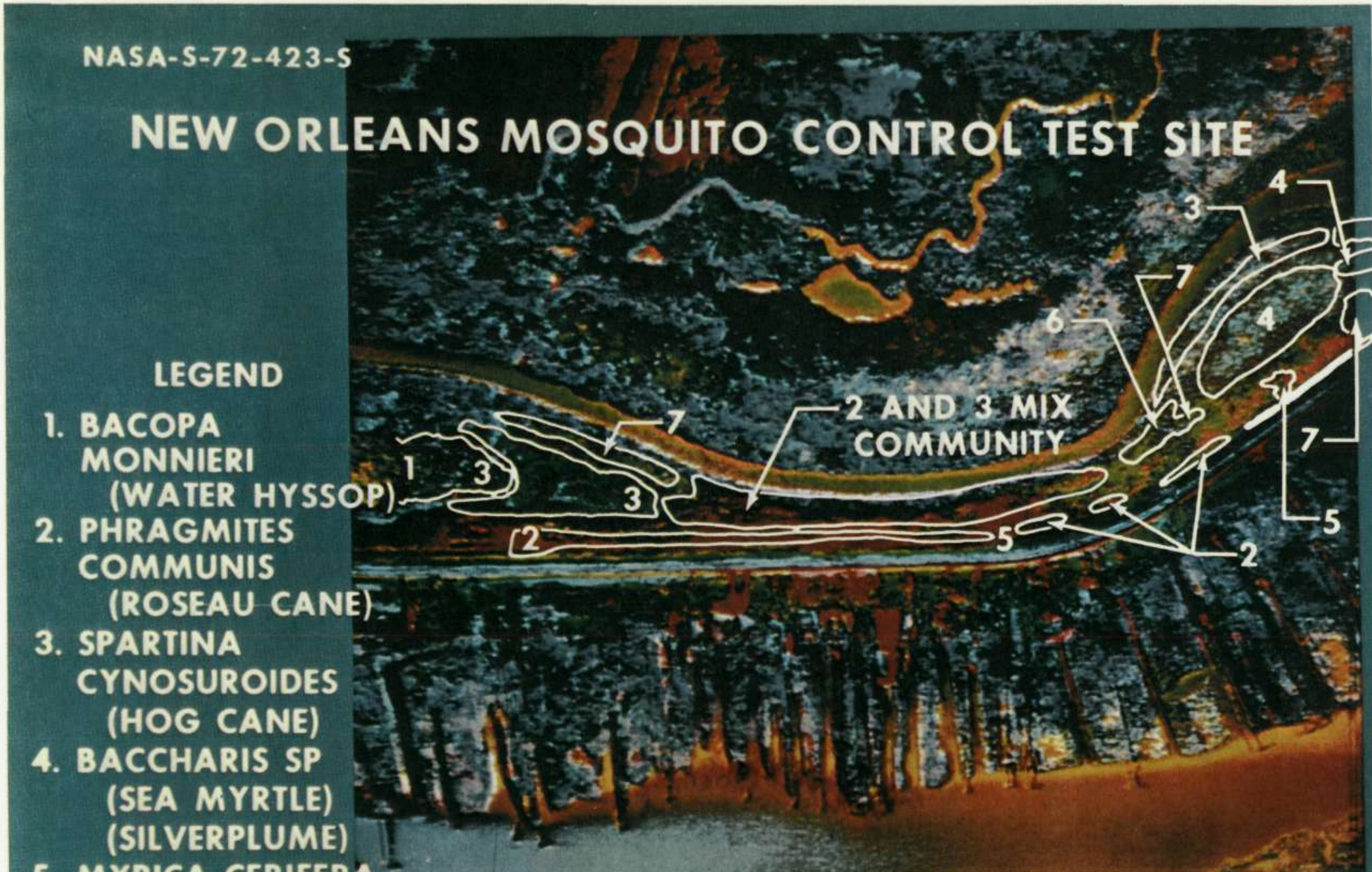


Figure 16.- This photograph acquired by the same means as the preceeding three, was derived by adding the red and near infrared bands. This process enhances the ease of identifying the different vegetative communities and sharply delineates edge effects and community interfaces by assigning false colors to differentiate subtle density differences.