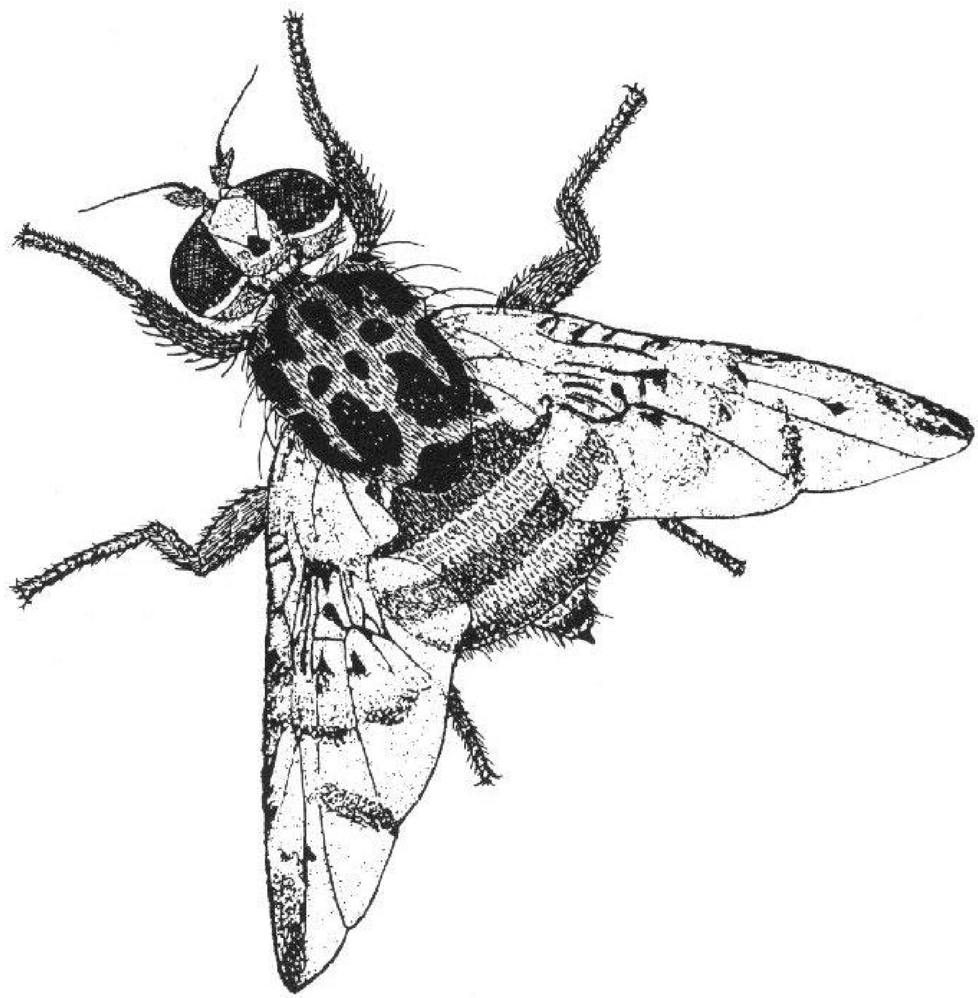
United States Department of Agriculture

Marketing and Regulatory Programs

Animal and Plant Health Inspection Service

Fruit Fly Cooperative Control Program

Final Environmental Impact Statement 2001



United States Department of Agriculture

Marketing and Regulatory Programs

Animal and Plant Health Inspection Service

In cooperation with:

United States Department of Agriculture, Agricultural Research Service

United States Environmental Protection Agency

California Department of Food and Agriculture

Florida Department of Agriculture and Consumer Services

Texas Department of Agriculture

Washington State Department of Agriculture

Fruit Fly Cooperative Control Program

Final Environmental Impact Statement 2001

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Executive Summary

Many fruit fly species are serious pests of agriculture throughout the world and represent a threat to the agriculture and ecology of the United States. In particular, six genera of fruit flies–*Anastrepha*, *Bactrocera*, *Ceratitis*, *Dacus*, *Rhagoletis*, and *Toxotrypana*–represent a major threat to United States resources. The U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), in cooperation with other Federal and State organizations, is proposing a national program (a broad strategy) to respond to the threat of these invasive alien pest species. APHIS has prepared this environmental impact statement (EIS) of the Fruit Fly Cooperative Control Program in accordance with the National Environmental Policy Act of 1969 (NEPA) and the Council on Environmental Quality's Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act.

APHIS and its cooperators analyzed a range of alternatives (no action, a nonchemical program, and an integrated program) and their component methods in this EIS. The alternatives are broad in scope and reflect the major choices that must be made for the program. The alternatives' associated components (exclusion, detection and prevention, and control) are the specific techniques used in insect control or eradication. They are limited in scope and may vary in their applicability to different fruit fly species. This EIS focuses principally on the potential environmental effects of the control measures, but maintains a secondary focus on the identification of strategies for the reduction of risk in fruit fly programs.

Each alternative (including no action) has the potential for adverse environmental consequences. Those consequences are related principally to the use or the nonuse of control methods. The no action alternative's substantial indirect adverse impacts would be the result of an infested agricultural environment, and increasing and uncoordinated use of pesticides by the States and the private sector. The nonchemical program alternative also could have substantial indirect adverse impacts if it were implemented for all species of fruit flies, but it could be applied efficiently for some species. The integrated program alternative would offer the greatest flexibility for responding to fruit fly pests and would have the least indirect (and long-range) adverse impacts, but it could have greater direct adverse impacts.

The preferred alternative, an integrated program, offers the greatest flexibility in responding to fruit fly pest outbreaks. With an integrated program, nonchemical and chemical controls would be available to program managers, based upon the exigencies of the outbreak. Nonchemical methods, including sterile insect technique (SIT), can be used in coordination with chemical methods in emergency eradication programs, or may be used as the principal method in some suppression programs. The preferred alternative, thus, accommodates eradication or suppression programs, and allows the use of nonchemical controls, chemical controls, or both.

The geographical scope of the program was based on factors such as climate, host availability, avenues of introduction, and past introductions. One or more of the fruit fly species named in this EIS has the potential to be introduced into or infest areas in each of the United States. The scope of this EIS, therefore, is the entire United States. However, past experience and knowledge suggests that certain coastal States (especially California, Florida, Texas, and Washington) are at greater risk. This EIS examined seven ecoregions that included those States. Those ecoregions, adapted from several classification systems in use, included: California Central Valley and Coastal, Southwestern Basin and Range, Lower Rio Grande Valley, Southeastern and Gulf Coastal Plain, Mississippi Delta, Floridian, and Marine Pacific Forest. The physical environment, biological resources, human population, cultural, and visual resources were all discussed in relation to those ecoregions.

This EIS examined comprehensively the environmental consequences associated with the programs' use of control methods (especially chemical control methods). Contemporary risk assessment methodology and computer modeling were used for qualitative and quantitative determination of environmental risk. Human health and nontarget species risk assessments were completed separately and are incorporated by reference in this EIS. Although this EIS focuses on the chemical control methods, it analyzes effects of both chemical and nonchemical control methods on the physical environment, human health and safety, socioeconomics, cultural and visual resources, and biological resources. The effects of the control methods are analyzed individually; cumulative impacts of program and nonprogram controls are also analyzed.

Standard operational procedures and program mitigative measures serve to negate or reduce environmental impacts of fruit fly control programs. Standard operational procedures are routine procedures required of the programs and their employees to safeguard human health and the natural environment; they are generic in nature and may be substantially the same as those developed for other APHIS cooperative pest control programs.

Program mitigative measures are measures developed for the purpose of avoiding, reducing, or rectifying environmental impact; they were developed specifically for fruit fly control programs. In addition, this EIS identifies optional risk reduction strategies that may substantially reduce risk to humans and the natural environment, but that may not be universally applicable for all fruit fly species.

APHIS and its cooperators will monitor programs to determine the environmental consequences and the efficacy of their program operations. Site-specific monitoring plans will be developed and followed for individual programs. Those plans may vary, depending on the site-specific characteristics of the program area and on issues that may arise for individual programs. Procedures for efficacy monitoring and procedures for handling accidental spills are outlined in guidelines, policies, and manuals of APHIS and its cooperators.

In the planning and implementation of program actions, APHIS and its cooperators comply with a variety of environmental laws and policies. This EIS has been prepared specifically to meet the requirements of the National Environmental Policy Act of 1969. The Endangered Species Act of 1973 also provides for biological assessment of potentially affected endangered and threatened species in a process that is separate from, yet parallel in many respects to, that of this EIS. APHIS will rely on its cooperators to identify applicable State environmental regulations, take the lead for their procedures, and facilitate full compliance with State laws.

In conclusion, APHIS determined that each alternative has potential for adverse environmental consequences. The preferred alternative (the integrated program) would use exclusion, detection and prevention, and control methods to achieve program objectives. It would rely on nonchemical and/or chemical control methods, based upon the site-specific characteristics of the program areas. The integrated program appears to offer the best combination of short-term risk and long-term benefit to agricultural resources and the environment, when compared to no action or a nonchemical program. In general, standard operational procedures and recommended mitigative measures will negate or reduce environmental risks; optional risk reduction methods may further reduce risk for specific conditions.

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I. Introduction

A. The Proposed Action

There are many fruit fly species which are serious pests of agriculture throughout the world. Six genera of fruit flies in particular–*Anastrepha*, *Bactrocera*, *Ceratitis*, *Dacus*, *Rhagoletis*, and *Toxotrypana*–represent a major threat to the agricultural resources of the United States. Because of their wide host ranges, their abilities to become established or more widespread, their potential economic impacts, and their potential ecological impacts (direct and indirect), those species have been the subject of strict quarantines and comprehensive control programs.

The U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) has cooperated with several State departments of agriculture in eradication programs for exotic fruit fly species. In many instances, those programs have taken the form of emergency actions that were expensive, complex, and sometimes controversial. Fruit fly programs may have a number of characteristics in common, including: their recurrent nature, their broad scope, their shared (although not universally shared) control strategies, and their potential environmental impacts.

APHIS now proposes to conduct a cooperative national program to combat invasive and destructive fruit fly pests. APHIS, in cooperation with other government agencies (refer to table 1–1), has prepared this programmatic environmental impact statement (EIS) to analyze, in a combined and holistic fashion, that proposed program. Alternatives and components of this proposed program are analyzed within this EIS, which focuses principally on the potential environmental impacts of control methods. In addition, the EIS maintains a secondary focus on the identification of strategies for the reduction of risk within cooperative fruit fly control programs.

Table 1–1. Federal and State Organizations Cooperating in Development of the Fruit Fly Cooperative Control Program EIS

Federal
USDA, Animal and Plant Health Inspection Service (Lead Agency)
USDA, Agricultural Research Service
U.S. Environmental Protection Agency
State
California Department of Food and Agriculture
Florida Department of Agriculture and Consumer Services
Texas Department of Agriculture
Washington State Department of Agriculture

B. Fruit Fly Species of Concern

There are at least 80 species of fruit fly pests belonging to the dipteran genera *Anastrepha*, *Bactrocera*, *Ceratitis*, *Dacus*, *Rhagoletis*, and *Toxotrypana* that are of concern to agricultural officials. Table 1–2 lists those species, their representative ranges, and their principle hosts. The list contains tropical, sub-tropical, and temperate species of fruit flies. All 50 States are subject to repeated introductions of one or more of these species, and the Southern States are threatened by multiple species.

Figure 1–1. The Mexican fruit fly is one of many damaging fruit fly pests of agriculture. (Photo credit USDA, APHIS)

C. Scope and Focus of the Environmental Impact Statement

The geographical scope of the Fruit Fly Cooperative Control Program and of this EIS is based on factors relating to climate, host availability, potential avenues of introduction, and past introductions. APHIS officials have determined that one or more fruit fly species has the potential to be introduced into or infest areas in each of the 50 States. The geographical scope of the Fruit Fly Cooperative Control Program, therefore, is the entire United States.

Table I–2. Fruit Flies Subject to Control Action

Scientific Name	Common Name	Representative Ranges	Principle Host(s)
***Anastrepha* spp.**			
Anastrepha antunesi		Costa Rica, Panama, Brazil, Peru, Venezuela	Common guava, hog plum
Anastrepha bistrigata		Brazil	Common guava
Anastrepha distincta	Inga fruit fly	Costa Rica, Guatemala, Mexico, Panama, Brazil, Guyana, Columbia, Peru, Venezuela	Mango, star-apple
Anastrepha fraterculus biotype: Mexican South American	South American fruit fly	Central America, South America	Citrus, common guava, apple, mango, pear, peach, tropical fruits & nuts
Anastrepha grandis	South American cucurbit fruit fly	Argentina, Bolivia, Brazil, Colombia, Ecuador, Paraguay, Peru, Venezuela	Cucumber, pumpkin, watermelon
Anastrepha leptozona		Guatemala, Mexico, Panama, Bolivia, Belize, Guyana, Venezuela	Star-apple, Sapotaceae
Anastrepha ludens	Mexican fruit fly	Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Texas	Citrus, mango, peach, apple, avocado
Anastrepha macrura		Argentina, Brazil, Paraguay, Venezuela	Sapotaceae
Anastrepha obliqua	West Indian fruit fly, Antillean fruit fly	Central and South America, West Indies	Mango, citrus, pear, tropical fruits & nuts
Anastrepha ornata		Ecuador	Common guava, pear
Anastrepha pseudoparallela		Argentina, Brazil, Peru	Passion fruit, mango
Anastrepha serpentina	Sapote fruit fly, Serpentine fruit fly	Costa Rica, Guatemala, Mexico, Panama, South America, Dominica, Trinidad	Citrus, apple, avocado, tropical fruits
Anastrepha sororcula		Brazil	Common guava
Anastrepha striata	Guava fruit fly	Central and South America, Trinidad	Common guava, mango, citrus, avocado, tropical fruits
Anastrepha suspensa	Caribbean fruit fly, Carib fly	Florida, Puerto Rico, Bahamas, Cuba, Dominican Republic, Haiti, Jamaica	Citrus, apple, guava, loquat, Suriname cherry, tropical fruits & nuts
***Bactrocera* spp.**			
Bactrocera albistrigata		Indonesia, Malaysia, Thailand	*Syzygium* spp., tropical almond
Bactrocera aquilonis		Australia	Apple, mango, avocado, citrus, peach, tropical fruits
Bactrocera atrisetosa		Papua New Guinea	Cucumber, pumpkin, tomato, watermelon

Table I–2, continued.

Scientific Name	Common Name	Representative Ranges	Principle Host(s)
Bactrocera carambolae	Carambola fruit fly	French Guiana, Suriname, Brazil, Indonesia, Malaysia, Thailand	Carambola, mango, chili pepper, banana, tropical fruit
Bactrocera caryeae		Southern India	Citrus, common guava, mango
Bactrocera caudata		Oriental Asia	Pumpkin, cucumber, gourds
Bactrocera correcta	Guava fruit fly	India, Nepal, Pakistan, Sri Lanka, Thailand	Citrus, mango, common guava
Bactrocera cucumis	Cucumber fruit fly	Australia	Cucurbits, tomato, papaya
Bactrocera cucurbitae	Melon fly, melon fruit fly	New Guinea area, Oriental Asia	Cucurbit crops, avocado, papaya, peach, citrus
Bactrocera curvipennis		New Caledonia, Vanuatu	Citrus
Bactrocera decipiens		New Britain	Pumpkin, cucurbits
Bactrocera depressa		Japan, Taiwan	Pumpkin, cucurbits
Bactrocera distincta		American and Western Samoa, Fiji, Tonga	Breadfruit, star-apple
Bactrocera diversa		China, India, Sri Lanka, Thailand	Cucurbits, pumpkin, gourd
Bactrocera dorsalis	Oriental fruit fly	Guam, Hawaii, Bhutan, China, India, Myanmar, Thailand	Apple, mango, pear, peach, banana, papaya, tomato, citrus, tropical fruits
Bactrocera facialis		Tonga	Avocado, citrus, mango, peach, pepper, tomato, tropical fruit
Bactrocera frauenfeldi		Queensland, New Guinea area, South Pacific	Common guava, tropical almond, mango
Bactrocera jarvisi		Australia	Common guava, mango, pear, peach, papaya, citrus, banana
Bactrocera kirki		South Pacific	Citrus, mango, peach, pineapple, peppers, tropical fruit
Bactrocera latifons	Solanum fruit fly	China, India, Laos, Malaysia, Pakistan, Sri Lanka, Taiwan, Thailand, Hawaii	Solanaceous crops, eggplant, tomato
Bactrocera melanota		Cook Islands	Citrus, mango, common guava
Bactrocera minax	Chinese citrus fly	Bhutan, China, India	Citrus
Bactrocera musae	Banana fruit fly	Australia, New Guinea area	Banana, common guava

Table I–2, continued.

Scientific Name	Common Name	Representative Ranges	Principle Host(s)
Bactrocera neohumeralis		Australia, Papua New Guinea	Apple, citrus, mango, peach, raspberry, plum, tomato, tropical fruit
Bactrocera occipitalis		Philippines	Mango
Bactrocera oleae	Olive fruit fly	Mediterranean Africa	Olive
Bactrocera papayae		Thailand, Malaysia, Indonesia, Singapore	Guava, mango, citrus, starfruit
Bactrocera passiflorae	Fijian fruit fly	Fiji, Niue Island, Tonga	Avocado, cocoa citrus, mango, papaya
Bactrocera philippiensis		Philippines	Papaya, mango, other tropical fruit
Bactrocera psidi		New Caledonia	Citrus, common guava, mango
Bactrocera pyrifoliae		North Thailand	Guava, peach
Bactrocera tau		Oriental Asia	Cucurbits
Bactrocera trivialis		Torres Strait Islands, Indonesia, Papua New Guinea	Common guava, peach, pepper, citrus
Bactrocera tryoni	Queensland fruit fly	Australia	Apple, avocado, berries, grape, citrus, papaya, peach, pear, pepper, tomato, tropical fruit
Bactrocera tsuneonis	Japanese orange fly	China, Japan	Citrus
Bactrocera tuberculata		Myanmar, Thailand, Vietnam	Peach, mango
Bactrocera umbrosa		New Guinea area, Oriental Asia, South Pacific	Breadfruit
Bactrocera xanthodes		South Pacific	Bell pepper, papaya, pineapple, tomato, watermelon, common guava
Bactrocera zonata	Peach fruit fly	India, Indonesia, Laos, Sri Lanka, Thailand, Vietnam	Peach, apple, papaya, citrus, common guava
***Ceratitis* spp.**			
Ceratitis anonae		Africa	Mango, coffee, tropical almond, avocado, guava
Ceratitis capitata	Mediterranean fruit fly	Africa, Australia, Mediterranean Europe, Middle East, Central and South America, Hawaii	Tropical and temperate fruits and nuts
Ceratitis catoarii	Mascarene fruit fly	Mauritius, Reunion, Seychelles	Avocado, peppers, mango, peach, tomato, other tropical fruits

Table I–2, continued.

Scientific Name	Common Name	Representative Ranges	Principle Host(s)
Ceratitis colae		Cameroun, Ghana, Cote d'Ivoire, Nigeria, Sierra Leone, Zaire	Cola
Ceratitis cosyra	Mango fruit fly, Marula fruit fly, Marula fly	Africa	Mango, sour orange guava, avocado, peaches
Ceratitis malgassa	Madagascan fruit fly	Madagascar	Citrus, common guava
Ceratitis pedestris	Strychnos fruit fly	Angola, South Africa, Zambia, Zimbabwe	Tomato
Ceratitis punctata		Africa	Cocoa, tropical fruits
Ceratitis quinaria	Five spotted fruit fly, Rhodesian fruit fly, Zimbabwean fruit fly	Africa, Yemen	Apricot, citrus, guava, peach
Ceratitis rosa	Natal fruit fly, Natal fly	Africa	Apple, common guava, pear, papaya, mango, peach, citrus, grape
Ceratitis rubivora	Blackberry fruit fly	Cameroun, Kenya, Malawi, South Africa, Uganda, Zimbabwe	Rubus spp.
***Dacus* spp.**			
Dacus axanus		Australia, New Guinea area	Cucurbits
Dacus bivittatus	Pumpkin fly, greater pumpkin fly, two-spotted pumpkin fly	Central and southern Africa	Melons, cucumber, squash, pumpkin
Dacus ciliatus	Ethiopian fruit fly, lesser pumpkin fly, cucurbit fly	Africa, Middle East, Indian Ocean, Oriental Asia	Melons, cucumber, squash, pumpkin
Dacus demmerezi		Madagascar, Mauritius, Reunion	Cucumber, pumpkin, watermelon
Dacus frontalis		Africa, Cape Verde Islands, Saudi Arabia, Yemen, Arab Republic	Cucumber, pumpkin, melons
Dacus lownsburyii		Angola, South Africa, Zimbabwe	Cucurbits
Dacus punctatifrons		Central and southern Africa	Cucurbits
Dacus smiroides		Brunei, Indonesia, Malaysia	Cucurbits
Dacus solomonensis		New Guinea area	Cucumber, pumpkin
Dacus telfaireae		Kenya, Malawi, Tanzania, Zimbabwe	Cucurbits
Dacus vertebratus	Jointed pumpkin fly, melon fly	Africa, Madagascar, Saudi Arabia, Yemen, Arab Republic	Melons, cucumber, squash
***Rhagoletis* spp.**			
Rhagoletis cerasi	European cherry fruit fly	Europe	Cherries
Rhagoletis conversa		Chile	Solanaceous crops
Rhagoletis lycopersella		Peru	Tomato

Table I–2, continued.

Scientific Name	Common Name	Representative Ranges	Principle Host(s)
Rhagoletis nova		Chile	Pepino
Rhagoletis pomonella	Apple maggot fly	Eastern and Western U.S.	Apple, sour cherry, peach
Rhagoletis tomatis		Chile, S Peru	Tomato
***Toxotrypana* sp.**			
Toxotrypana curvicauda	Papaya fruit fly	Costa Rica, Guatemala, Mexico, Panama, Brazil, Columbia, West Indies	Papaya

This list is based on current available information and does not identify all fruit fly species present in, or of concern to, the United States. Regulatory decisions for a specific commodity will be based on a complete risk analysis that considers the commodity or host (species and variety), known pests and their distribution, origin of host material, and all other factors affecting risk.

The organizational scope of the EIS includes the analysis of all reasonable alternatives for the program, with component technologies. Refer to chapter 3, Alternatives, for a discussion of alternatives, component technologies, and associated impacts. Issues identified at the outset by APHIS for comprehensive consideration within the EIS included: improving risk reduction strategies, emergency communication strategies, selection of program control components, exploitation of new or evolving technologies, environmental justice considerations, (refer to section 8.E), and environmental monitoring.

APHIS conducted scoping for the EIS between the period January 1, 1998, to March 31, 1998. A draft EIS was prepared and submitted to the public for comment on July 30, 1999 (refer to appendix A). Comments received during scoping and on the draft were considered fully by APHIS in the planning of the EIS. Issues and concerns identified by the public included: potential human health impacts, chemical hypersensitivity, and potential pollution. The comments received from the public helped APHIS to determine the principal focus of the EIS and to refine the discussion that was contained in the draft. From the history of past programs and the results of the scoping process, APHIS and its cooperators recognize fully the public's concern about the potential impacts of program chemicals on human health, biological resources, and the physical environment.

Figure 1–2. The larva of the Medfly is a slender, cream-colored maggot. (Photo credit USDA, APHIS)

D. Programmatic Analysis and Site-specific Review

This EIS is a broad, programmatic analysis of the alternatives for fruit fly programs that collectively make up the Fruit Fly Cooperative Control Program. It focuses on available program control methods and their potential environmental consequences, and is not intended to serve as an encyclopedic compendium of information about specific fruit fly programs. Instead, it provides an overview of the programs and incorporates by reference detailed information that may be found in documents like the "Medfly Cooperative Eradication Program, Final Environmental Impact Statement—1993," and "Oriental Fruit Fly Regulatory Program, Environmental Assessment, November 1991."

In addition to providing a broad overview, this EIS also conveys the specific procedures which APHIS will follow prior to implementation of a program, to ensure that site-specific characteristics of the program area are considered. For example, prior to implementing a program, APHIS will consider site-specific characteristics such as: (1) unique and sensitive aspects of the proposed program area; (2) applicable environmental documentation, including the programmatic EIS; and (3) applicable new developments in environmental science or control technologies. To the extent possible, when separate Federal and State site-specific environmental reviews are prepared, they will be coordinated. Such site-specific environmental reviews will summarize and incorporate by reference all programmatic analyses contained in the EIS.

Site-specific review of the program areas will consider such things as: land usage patterns (including agricultural cropping), unique or sensitive areas, water bodies and their drainage, endangered and threatened species, human population density, cultural factors, and unique human health issues (such as homeless people, people with special medical conditions, or ethnic groups that require special notification procedures). APHIS will review existing environmental documentation, including the EIS, risk analyses, biological assessments, and any site-specific tiered environmental assessments, to ensure that program procedures and protective measures are appropriate. Also, after the publication of the EIS, APHIS will consider new developments in environmental science (new findings or requirements related to potential risk to humans or other nontarget species) and in scientifically and operationally proven control technologies (new, more efficacious, and more environmentally sound controls).

The site-specific review will be appropriate, based upon the circumstances, issues, and timeframe of need for the program. Generally, the site-specific assessment prepared for a program will be adequate to analyze and disclose new and important information relative to a particular program area. In cases where major changes are apparent, a supplement to this EIS or a new EIS may be required. Specific procedures for site-specific evaluation are included within this EIS (see appendix B).

Figure 1–3. The cardboard Jackson trap is one type of trap used to detect and delimit fruit fly infestations. (Photo credit USDA, APHIS)

II. Purpose and Need

The U.S. Department of Agriculture, Animal and Plant Health Inspection Service (APHIS), as lead agency in cooperation with other Federal and State organizations (refer back to table 1–1 for list), is evaluating the potential environmental effects of a broad cooperative program for the control of various fruit fly species that could be introduced to areas of the United States. This program is necessary because of the destructive potential of these exotic pests and the serious threat they represent to U.S. agriculture. Refer back to table 1–2 for a list of the fruit fly species, their representative ranges, and their principle hosts.

Figure 2–1. Citrus exhibiting characteristic fruit fly larval feeding damage. (Photo credit USDA, APHIS)

APHIS' authority for cooperation in the program is based upon Title IV–Plant Protection Act, *Public Law 106–224, 114 Stat. 438–455*, which authorizes the Secretary of Agriculture to take measures to prevent the dissemination of a plant pest that is new to or not known to be widely prevalent or distributed within or throughout the United States.

APHIS and its cooperators have responded to invasive pest species introductions several times in the past, combining forces for the exclusion, detection, and eradication of harmful fruit fly pests. Many of those programs used common strategies or methods, although species differences and site-specific environmental characteristics made it impossible to use the same strategies and methods for all fruit fly species.

This environmental impact statement (EIS) analyzes in a broad way the potential environmental consequences of activities and methods for the exclusion, detection, and control (eradication or suppression) of specified exotic fruit fly species. It evaluates, in programmatic fashion, a single program that now integrates program components that once existed (and were analyzed previously) as separate fruit fly eradication programs. This EIS focuses, in particular, on strategies to reduce risk in such programs. It examines previously available and new technologies that can be used against fruit fly pests, and also considers the potential environmental impacts of no action. This EIS is not a decision document, but it will be used in conjunction with other relevant material to plan actions and make decisions. It fulfills the need to inform decision makers and the public of potential environmental impacts and reasonable alternatives which would avoid or minimize adverse impacts or enhance the quality of the human environment.

III. Alternatives

A. Introduction

The Animal and Plant Health Inspection Service (APHIS) and its cooperators have analyzed a range of alternatives and their associated components in this environmental impact statement (EIS). The analyzed alternatives are broad in scope, reflecting the overall need for a program objective that will accommodate emergency responses to any of a large number of potentially damaging fruit fly species. Although our previous analysis of Medfly programs required us to choose between suppression or eradication alternatives, a number of factors (e.g., the wide range of fruit fly species considered in this EIS, the pests' varying potentials for damage, and the characteristics of future outbreaks) make it highly likely that APHIS and its cooperators will be involved in both suppression and eradication programs for fruit flies in the future.

The alternatives for fruit fly programs have been framed in a way that facilitates the identification of issues and the choices that are to be made—especially the choices involving the inclusion or exclusion of chemical pesticide components. The alternatives considered in this EIS, therefore, include (1) no action, (2) a nonchemical program, and (3) an integrated program (the preferred alternative). The alternatives and associated components are reasonable, but vary with regard to their practicality or feasibility based on environmental, scientific, regulatory, economic, and logistical perspectives. They may vary considerably with regard to their effectiveness, capability to attain program objectives, and immediate applicability for large-scale programs. Refer to table 3–1 for a summary listing of the alternatives and their components.

B. Alternatives Evaluated

Analysis has determined that there are potential environmental consequences for each of the alternatives, including the no action alternative. Environmental consequences would result from the program's activities and capabilities to exclude, detect, protect from, or control fruit flies. The inability to prevent or control large infestations would result in risk to the environment, our agricultural products, and our economy. Environmental consequences may also result from the program and nonprogram use of control methods against fruit flies (especially the chemical control methods). The environmental consequences of future fruit fly programs may be predicted generally, but cannot be predicted with absolute confidence or be quantified because of

Table 3–1. Alternatives' Component Methods

	No Action	Nonchemical	Integrated
Exclusion			
Quarantines			
Federal/State Cooperation	O	X	X
Inspection			
Inspection Teams	O	X	X
X-ray Technology	O	X	X
Canine Teams	O	X	X
Computer Tracking	O	X	X
Detection and Prevention			
Detection			
Detection Trapping	O	X	X
Delimitation Trapping	O	X	X
Prevention			
Pathway Studies	O	X	X
Prevention Initiatives	O	X	X
Sterile Insect Technique	O	X	X
Control			
Nonchemical Control Methods			
Sterile Insect Technique	O	X	X
Physical Control	O	X	X
Cultural Control	O	X	X
Biological Control*	O	O	O
Biotechnological Control*	O	O	O
Cold Treatment	O	X	X
Irradiation Treatment	O	X	X
Vapor Heat Treatment	O	X	X
Chemical Control Methods			
Aerially-applied Baits	O	O	X
Ground-applied Baits	O	O	X
Soil Treatments	O	O	X
Fumigants	O	O	X
Mass Trapping	O	X	X
Pesticide Devices	O	O	X

*Method under development; not approved for use.

the uncertainties regarding the areas, the extent of the infestations, the future availability of control methods, and the implementation of various mitigative methods.

The relative environmental consequences of each alternative (see table 3–2, Alternatives Evaluated) were determined from individual analyses of their components (subjectively for the nonchemical components, qualitatively and quantitatively for the chemical components). The scale of potential consequences appears below table 3–2.

Table 3–2. Alternatives Evaluated

	Relative Consequences (See Scale Below)		
	No Action	**Nonchemical**	**Integrated**
Exclusion			
Quarantines			
Federal/State Cooperation	N/A	1	1
Inspection			
Inspection Teams	N/A	1	1
X-ray Technology	N/A	1	1
Canine Teams	N/A	1	1
Computer Tracking	N/A	0	0
Detection and Prevention			
Detection			
Detection Trapping	N/A	1	1
Delimitation Trapping	N/A	1	1
Prevention			
Pathway Studies	N/A	0	0
Prevention Initiatives	N/A	1	1
Sterile Insect Technique	N/A	1	1
Control			
Nonchemical Control Methods			
Sterile Insect Technique	N/A	1	1
Physical Control	N/A	1	1
Cultural Control	N/A	1	1
Biological Control	N/A	U	U
Biotechnological Control	N/A	U	U
Cold Treatment	N/A	1	1
Irradiation Treatment	N/A	1	1
Vapor Heat Treatment	N/A	1	1
Chemical Control Methods			
Aerially-applied Baits	N/A	N/A	2
Ground-applied Baits	N/A	N/A	1
Soil Treatments	N/A	N/A	2
Fumigants	N/A	N/A	1
Mass Trapping	N/A	1	1
Pesticide Devices	N/A	N/A	1
Summary Evaluation	2	2*	2*

(The summary evaluations for the no action and nonchemical alternatives are based on the anticipated, uncoordinated, nonprogram use of pesticides.)

Scale:

0 = None — No anticipated environmental consequences.

1 = Minimal — Minimal or minor environmental consequences; determination based on initially low intrinsic effects or on reduction of effects to minimal levels by means of programmatic standard operational procedures.

2 = Higher — Higher relative potential for environmental consequences than above category. * Denotes capable of being reduced to minimal levels through application of programmatic standard operational procedures, mitigative measures, and/or site-specific protection measures.

N/A = Not Applicable — Federal action not a part of this alternative.

U = Unknown — Unknown potential for environmental consequences; control technology may be in an early stage of development, not enough details are known about potential environmental consequences, or more detailed information about control methods and patterns of use are required.

C. Alternatives in Detail

1. No Action

The no action alternative would be characterized as no APHIS cooperation to control (suppress, eradicate, or otherwise manage) outbreaks of invasive alien fruit fly pests. Any control efforts would be left up to State or local governments, growers or grower groups, and individual citizens. There is no way of predicting whether any of those groups would have the resources or the authorities to take the actions required to exclude or control alien fruit fly pests.

The most probable outcome of the no action alternative would be that many exotic species of fruit flies would be able to establish a permanent foothold and expand their ranges within the United States. The restrictions on movement of local produce by State authorities from these infestations would result in domestic market losses to growers within the affected areas. The exotic fruit flies could eventually spread to all areas of the United States having suitable hosts and climate. This would result in widespread destruction of commercial food crops and home garden products. Because of the threats the pests would constitute to the agricultural systems of foreign countries, certain countries would restrict or prohibit the entry of host produce from the United States, thereby eliminating many current (and potential future) U.S. export markets.

In the absence of government efforts to control exotic fruit fly pests, losses and damage to private and commercial crops would provoke independent control efforts. Lacking the resources or capability to use sophisticated program techniques, such as detection trapping, sterile insect technique, and regulatory controls, the growers or homeowners could be expected to rely predominantly on chemical pesticides. Those efforts could result in continually increasing, uncoordinated, and less-controlled use of pesticides.

The severity of environmental consequences to human health, nontarget species, and the physical environment would depend upon the area of the application and the characteristics of the pesticides used. Where people are present, they might be uninformed of the times and areas of applications, and therefore would be unable to take the precautions necessary to avoid exposures. Public exposure to various pesticides used privately or commercially at differing application rates may pose increased risks of synergistic or cumulative effects from the interaction of the pesticides. In general, the potential for environmental consequences from no action would be expected to exceed that from a cooperative control program using approved program pesticides according to APHIS risk reduction strategies (see chapter 6).

2. Non-chemical Program

APHIS could participate in a nonchemical program (one that uses only nonchemical control measures) to suppress (reduce populations to below an economic threshold), eradicate (eliminate a pest from an area), or otherwise manage fruit fly pests. Under this alternative, APHIS and its cooperators would need to review all available data about fruit fly pest species and their occurrences, determine the most appropriate objective, and select a course of action using only nonchemical components as described in depth later in this chapter. A suppression (management) program's potential for success might depend upon such factors as (1) the infestation's distance to the pests' home range, (2) the availability (or nonavailability) of hosts during the growing season, and (3) the availability of an effective regulatory protocol (to contain the infestation while still permitting commerce). APHIS' choice of nonchemical program components for an individual program would depend upon site-specific circumstances, the biology and vulnerability of the pest species, and the resources that could be brought to bear on the problem.

APHIS' level of involvement for a nonchemical program would be dependent upon a number of factors, including the availability of control technology, the nature of the infestation, the technological and logistical capabilities of State cooperators, and the availability of resources. (APHIS obtains much of its resources for emergency eradication programs through emergency funding; funding for prevention activities and suppression programs could become extremely limited.) Regulatory efforts would be maintained; grower groups and individuals would be encouraged and required to comply with regulations designed to reduce the potential spread of pest species.

APHIS' exact role and its dedication of resources in the implementation of a nonchemical program would depend upon the pest species and the nature of the outbreak. For many species of exotic fruit flies effective nonchemical control or eradication techniques do not exist, and therefore the nonchemical option does not apply to them. APHIS' authority to take action in a nonchemical program is based upon Title IV–Plant Protection Act, *Public Law 106–224, 114 Stat. 438–455,* which authorizes the Secretary of Agriculture to take measures to hold, seize, quarantine, treat, and destroy plant pests that are new to or not known to be widely prevalent or distributed within and throughout the United States. APHIS and its cooperators prefer to eradicate exotic fruit fly pest outbreaks while they are small in size, thereby reducing risk of spread and resultant serious impacts to agriculture and the environment. APHIS currently

Figure 3–1. Detector dogs are trained to find smuggled fruit at airports, seaports, and land border ports. (Photo credit USDA, APHIS)

cooperates, however, in a Mexican fruit fly suppression program in the Lower Rio Grande Valley of Texas. (The Mexican fruit fly is found over a wide area of Mexico and also in the Lower Rio Grande Valley.) This program is predominantly a nonchemical suppression program using sterile insect technology, but includes some chemical regulatory commodity treatments.

In most other cases, although the direct environmental consequences of a nonchemical program would be expected to be minimal, the indirect environmental consequences would be expected to be substantial. The probable result of implementation of a nonchemical program would be similar to that of no action: without effective chemical control methods, many exotic species of fruit flies would be able to gain a permanent foothold and expand their ranges within the United States, and other countries would restrict or prohibit the entry of host produce from the United States. Growers and homeowners could be expected to use greater quantities of whatever pesticides are available to control their fruit fly pests with increasing environmental consequences.

As with no action, the severity of environmental consequences to human health, nontarget species, and the physical environment would depend upon resultant nongovernmental use of pesticides and those pesticides' characteristics. The public would be uninformed of the times and areas of applications, and therefore be unable to take the precautions required to avoid exposures. Public exposure to various pesticides used privately or commercially at differing application rates poses increased risks of synergistic or cumulative effects from the interaction of the pesticides. Finally, the potential for environmental consequences from a nonchemical program would be expected to be less than that of no action (because of the effect of cooperative programs which would help to mitigate pest impacts), but more than that of a properly controlled integrated program (because of an integrated program's capability of responding quickly and more effectively to pest outbreaks).

3. Integrated Program (Preferred Alternative)

An integrated program would be characterized by cooperative integrated efforts to control (suppress, eradicate, or otherwise manage) invasive exotic fruit fly pests. It would utilize principles of integrated pest management (IPM), defined by the Council on Environmental Quality in 1972 as ". . . the selection, integration, and implementation of pest control actions on the basis of predicted economic, ecological, and sociological consequences" (CEQ, 1972).

Such a program would use (singly, or in combination) exclusion, detection and prevention, and control (nonchemical and chemical) components. The selection of those components would take into consideration several factors, including economic (the cost and the cost effectiveness of various methods in both the short- and long-term), ecological (the impact on nontarget organisms and the environment), and sociological (the acceptability of various integrated control methods to cooperators, or the potential effects on land use).

In an integrated program, program managers would vary their use of control methods so as to protect human health, nontarget species (including endangered and threatened species), sensitive areas, and other components of the environment within the potential program area. They also would utilize specific protection measures and/or mitigation methods in combination with their selection of those control methods, to maximize efficacy and minimize environmental risk. Provided that the potential environmental effects of the program components have been analyzed and that necessary protective measures are employed, maximum flexibility can be afforded the program manager for the selection of control methods to fit the situation.

For an integrated program, the range of environmental consequences to human health, nontarget species, and the physical environment would depend upon the control methods used. However, integrated programs (especially eradication programs), under careful program supervision, which use chemical pesticides as control tactics, are expected to have less adverse impacts than no action or nonchemical programs which would be expected to result in continually escalating private uses of pesticides (as pest infestations spread). Eradication has an end point; private use has no end point and would result in much greater use of pesticides over the long-term. In addition, the protective measures, mitigative methods, and public information activities under a government managed integrated program would also be expected to reduce the severity of adverse environmental consequences. For example, members of the public would be informed of the times and areas of applications, and therefore would be able to take, at their discretion, the precautions required to minimize and/or avoid exposure.

Figure 3–2. Release of sterile Medflies from the back of a truck in a suburban neighborhood. (Photo credit USDA, APHIS)

D. Control Components Evaluated

The control methods examined within this EIS vary extensively with respect to their potential environmental consequences. The nonchemical methods, used exclusively, have relatively minimal direct environmental impacts but relatively severe indirect environmental impacts (based on their predicted failure to establish control and resultant uncoordinated use of pesticides. The chemical methods have relatively greater direct environmental impacts, but because of their expected use patterns, their net indirect impacts are less severe. From the risk assessments and the subjective evaluations done for this EIS, a broad categorization of the potential environmental effects of the control methods was developed (refer to table 3–3 on the next page).

E. Control Components in Detail

1. Non-chemical Control Methods

a. Sterile Insect Technique

Sterile insect technique (SIT) involves the release of sterilized fruit flies into infested areas where they mate with the feral fruit flies, producing only infertile eggs. SIT has been used successfully and/or developed as a control method for the Medfly, Mexican fruit fly, Caribbean fruit fly (Carib fly), and the melon fly. SIT may be used as a component of an overall detection and prevention strategy, or it may be used as a component of suppression or eradication programs. In practice, if the sterile insects are released often enough and in sufficient numbers, a feral population will decline and can eventually be eradicated. SIT has been proven effective against low-level Medfly and Mexican fruit fly populations where high overflooding ratios are possible to achieve. There has also been success in use of SIT as an area-wide prevention effort at certain locations in California and Florida. SIT has not been an effective eradication tool in production areas because of inadequate overflooding ratios and losses from grower applications of insecticides.

Chemical bait sprays, such as those that include malathion, are considered necessary in eradication programs to eliminate gravid female fruit flies and reduce the population density to a low level before SIT is employed. Increasing the ratio of sterile male fruit flies to feral male fruit flies improves the effectiveness of the technique. Current data indicate that sterile female fruit flies do not contribute to the suppression of the target pest and that releases of predominantly male flies work much better. This is the force driving the change to predominantly male release programs against the Medfly and the effort to develop genetic sexing

Table 3–3. Control Methods Evaluated

Potential Consequences
0 = None
1 = Minimal
2 = Higher
U = Unknown

	Physical Environment	Human Health & Safety	Biological Resources	Cumulative Effects	Unavoidable Environmental Effects
Nonchemical Control Methods	1	1	1	1	1
Sterile Insect Technique	1	1	1		
Physical Control	1	1	1		
Cultural Control	1	0	1		
Biological Control	U	U	U		
Biotechnological Control	U	U	U		
Cold Treatment	1	1	1		
Irradiation Treatment	1	1	1		
Vapor Heat Treatment	1	1	1		
Chemical Control Methods	1	2	2	2	2
Aerially Applied Baits					
Malathion	1	1	2		
Spinosad*	1	1	2		
SureDye**	1	1	2		
Ground Applied Baits					
Malathion	1	1	1		
Spinosad	1	1	1		
SureDye*	1	1	1		
Soil Treatments					
Chlorpyrifos	1	2	2		
Diazinon	1	1	2		
Fenthion	1	2	2		
Fumigants					
Methyl Bromide	U	1	1		
Mass Trapping	1	0	1		

* Presently applied aerially only in rural areas.
** Not approved and labeled at this time; undergoing testing.

strains for other fruit flies under mass production. Used in integrated programs, SIT also affords continuing effectiveness on adults that emerge from the ground where they were not affected by earlier chemical bait sprays.

Sterile fruit flies are reared under sanitary laboratory conditions. At some stage in their life cycle, often the pupal stage, the fruit flies are subjected to chemosterilents, irradiated with gamma rays, or subjected to radiation from electron beams to make them sterile. The sterilized insects are then packaged in containers for shipping and later released into the environment by means of aircraft or ground vehicles. Generally, APHIS will not permit the rearing of specific fruit fly species within areas that are not regulated for the same pest species. Sterile Medflies are produced at the rearing facilities in Waimanolo, Hawaii; Honolulu, Hawaii; San Miguel Petapa, Guatemala; and Metapa de Dominguez, Mexico. Sterile Mexican fruit flies are produced at the rearing facility in Mission, Texas.

Safety guidelines are followed by the sterile insect laboratories in all steps of sterile insect production. Irradiation equipment is checked on a regular basis and no problems associated with its use under APHIS permits have been known to occur. The irradiated insects are not radioactive and pose no risk to the environment.

SIT can be a very effective control method. In combination with carefully coordinated malathion-based bait spray applications, SIT has been a principal tactic used in most recent successful Medfly eradications. However, SIT alone was attempted for Medfly eradication in the fall of 1980 in Santa Clara County, California; there, sole reliance on SIT was unsuccessful because the feral population was too high and the necessary release ratio of sterile to feral fruit flies could not be maintained. As a result, the Medfly population and the infested area expanded, requiring use of alternative control methods over a larger area, including aerial application of malathion bait spray.

b. Physical Control

Physical control involves physical actions taken to eliminate fruit fly hosts or host produce. Fruit stripping and host elimination are two principal physical control methods. Fruit stripping is employed when fruit fly larvae are found. The physical elimination of fruit fly hosts, when possible and appropriate, may be especially helpful in the elimination of small, isolated infestations.

Figure 3–3. The Steiner trap (made of plastic) is often used to monitor the effectiveness of the sterile insect technique. (Photo credit USDA, APHIS)

Typically, in Medfly programs, when trapping and subsequent fruit cutting determine that a property is infested, all host fruits on the property and those properties immediately adjacent are stripped promptly and disposed of according to APHIS protocols. With fruit stripping, only the actual host material (the fruit) is removed, causing little or no detrimental effect to the health of the plant. The area stripped of host fruit normally includes all properties within 200 meters (656 feet) of the confirmed larval site. The host fruit may be destroyed by burial, incineration, or a combination of both methods at an approved landfill or refuse site. The legal and logistical aspects of collecting and disposing of the fruit are a limitation to its operational use. For example, the size of the infested area and the ability to gain access to residential properties may limit the method's effectiveness.

Extensive fruit stripping, however, may have a drawback. In the 1980–81 California Medfly program, extensive fruit stripping was believed by many experts to have stimulated dispersal of gravid females thereby making eradication more difficult.

Although the goal of host elimination is the same as fruit stripping, its methods and effects differ substantially. In a moderate scenario, host elimination might mean the removal of only a few plants from an urban environment. In a more extreme scenario, host elimination could involve the destruction of numerous wild host plants (native or escaped exotic species). This could result in potential for adverse environmental effects from removal and/or destruction of entire plants (especially trees and woody shrubs) in natural areas. Control of fruit flies in commercial plantings may require a method other than host elimination, if large perennial plantings are involved. Except in very limited circumstances, host elimination is unacceptable because of environmental considerations, time and resource constraints.

c. Cultural Control

Cultural control reduces pest populations through manipulation of agricultural practices. In general, agricultural practices are modified to make the crop environment as unfavorable as possible for the insect pest. Cultural control methods frequently include: clean culture, special timing, trap cropping, use of resistant varieties, crop rotation, varying plant locations, and manipulation of alternate hosts. Several of these methods (but not all) may have applicability for control of fruit flies and are discussed here. However, cultural control methods are considered to be of limited effectiveness and most useful as complementary control methods for fruit flies.

Clean culture, or careful and complete harvesting combined with destruction of infested and unmarketable fruit fly host crops, can be important in reducing fruit fly populations. Collecting and burying host fruit left after harvest, destroying damaged fruit, and removing unwanted or wild alternate hosts in and around fields are often recommended for suppressing fruit fly infestations. Collecting and destroying potential host fruit eliminates the fruit fly host stages in the fruit as well as the host fruit which is a possible source of continued infestation.

Special timing could be employed in some geographical regions by scheduling the planting of early-season or short-season fruit and vegetable crops so that fruit ripening does not coincide with peak fruit fly activity, or by harvesting the fruit before it reaches a stage of ripeness highly susceptible to fruit fly attack. Although this technique theoretically could reduce fruit fly populations, it is not likely to do so for a variety of reasons. First, the development of most fruit flies generally coincides with the development (growth) of their host crops. Also, it is doubtful that enough control could be exercised over commercial agricultural practices to make the technique effective or worthwhile. Finally, the presence of multiple hosts in many areas that are susceptible to fruit fly infestations limits the applicability of this method.

Trap cropping involves the planting of a crop that is favored by the pest in order to attract and concentrate the pest in a limited area where the pest can be destroyed by chemical or cultural methods. For other insect pests, trap cropping often involves planting a small plot of the favored host crop earlier than the main crop so that overwintered life stages of the pest will be concentrated and destroyed by pesticides or by plowing the crop under before the main crop is infested. It is unlikely that this method could be applicable to most fruit fly programs because of the perennial nature of many host species, the availability of multiple host species in the program areas, and the lack of data on effectiveness of trap crops in attracting fruit flies from distant areas.

Resistant varieties may be of some future benefit in helping to prevent fruit fly infestations. Some reduction in risk of fruit fly infestations could be achieved through public response to a public information program designed to illustrate the value of and recommend the selection of plant varieties that are nonhosts or are partially resistant to fruit flies. Mechanisms that serve as a basis for host plant resistance to the Medfly have been demonstrated in some host plants (Greany *et al.*, 1983; Eskafi, 1988). However, there are so many hosts and secondary hosts of fruit fly pest species that this technique may be of limited value for eradication programs. Also, as with special timing, it is not likely that sufficient control could be exercised over the commercial agricultural industry or homeowners to make this control method worthwhile. It is not likely that industry would restrict its selection of varieties on the basis of a *potential* threat.

Crop rotation and varying the locations of plantings have little applicability to fruit fly programs. Perennials (like oranges, grapefruit, and apples) cannot be moved around or rotated, and even if annual host crops were rotated it probably would not prevent fruit fly pests from finding suitable hosts in the surrounding area.

d. Biological Control

Biological control (or biocontrol) is a pest control strategy making use of living natural enemies, antagonists or competitors, and other self-replicating biotic entities. Biological control differs from natural control of pest organisms in that human intervention is involved in the dissemination of the pest's enemies (parasites, predators, and pathogens).

APHIS and its cooperators have successfully utilized biological control agents in several insect and weed pest control programs. APHIS believes that biological control, appropriately applied and monitored, is an environmentally safe and desirable form of long-term management of pest species. APHIS further believes that biological control is preferable when applicable, but recognizes its limited application to emergency eradication programs. Whenever possible, biological control should replace chemical control as the base strategy for integrated pest management (Melland, 1992).

However, biological control is neither a panacea nor a solution for all pest problems. There is no data that show that biological control of any fruit fly species has been important in reducing and maintaining the pest species below economically damaging levels. Although a number of organisms have been investigated as potential biological control agents against fruit fly species like the Medfly (see table 3–4), biological control has not been utilized for any eradication programs. There are a number of reasons for this, including unproven efficacy and lack of immediate results for large scale emergency eradication programs.

The USDA's Agricultural Research Service and APHIS have been working on biological control for Medfly and other fruit fly species populations in Hawaii and Guatemala. In recent tests, one biological control agent, a hymenopteran parasitoid, *Diachasmimorpha tryoni* (Cameron), was released from the air into Guatemalan coffee plantations that contained Medflies. The results of those air releases were studied with regard to factors such as mortality, flight-ability, and parasitization rate of the biological control agent. Improvements in release technology resulting from such research could enhance the use of biological control agents in suppression programs in places like Hawaii and Guatemala, ultimately contributing to eradication of fruit fly pests there, and thereby reducing risk of spread to the continental United States. Researchers are

Table 3–4. Organisms Reviewed for Use as Potential Biocontrol Agents of the Medfly

Name	Type of Organism	Targeted Medfly Life Stage
Parasite		
Steinernema carpocapsae (formerly S. feltiae)	Nematode	Larvae, pupae, and adults
Parasitoids		
Diachasmimorpha tryoni (formerly Biosteres tryoni)	Braconid wasp	Larvae, pupae
Psyttalia humulis	Braconid wasp	Larvae
D. longicaudatus (formerly Biosteres longicaudatus)	Braconid wasp	Larvae, pupae
Testrastichus giffardianus	Eulophid wasp	Larvae
Pathogens		
Bacillus thuringiensis	Bacteria	Adults
Picornavirus (V)	Virus	Adults
Reovirus (I)	Virus	Adults
Predators		
Iridomyrmex humilis	Argentine Ant[1]	Larvae
Solenopsis geminata	Fire Ant[1]	Larvae
Pheidole magacephala	Bigheaded Ant[1]	Larvae
Zygoptera	Zygopteran damselfly	Adults
Mantidae	Praying Mantis	Adults
Staphylinidae	Staphylinid beetle	Larvae
Vespidae	Vespid wasp	Adults

[1] Potential biocontrol agents that are themselves pests and, therefore, unacceptable for use in this program.

currently working in Guatemala with five additional biological control agents that they hope to introduce or use in mass releases.

If biological control of a fruit fly species could be demonstrated to be efficacious and reliable, a number of advantages might be associated with its use in a control program. It could be self-perpetuating under conditions where populations of the host or an alternate host remain and where climatic conditions allow the agent to overwinter. Even under conditions that would not allow a self-perpetuating population of biological control agents, inundative releases might still be of value in reducing fruit fly populations. The greatest value of biological control agents may be in situations where immediate results or containment of the pest population are not the overriding concerns.

In spite of its advantages, biological control has major limitations which influence its suitability for control programs, including: lack of immediate results; potential lack of effectiveness; logistical difficulties; and incomplete or unavailable information about rearing techniques, natural dispersal, and effects on nontarget species.

Biological control's results are achieved over a protracted timeframe. Since most potential biological control agents parasitize or prey on immature fruit fly life stages, the extant adult pest population would be able to continue to reproduce and move or be carried to other areas to spread the infestation. This characteristic would be undesirable for eradication programs where the objective is to destroy the pest population before it can reproduce further and fly, be carried, or be blown out of the area.

Also, biological control agents normally are not capable of achieving total elimination of a pest species, but instead reduce pest populations by varying percentages. They may reduce a pest population to lower levels (to the point where the pests become difficult for them to find), thereby diminishing the economic impact of the pest, but they seldom are capable of killing all of the pest population. If that were to happen, the biological control agent would destroy itself in the process; natural mechanisms usually prevent this. In addition, the consumer tolerance for infested fruit is very low (less than one larva per fruit), so even a minimal population of a fruit fly pest would be undesirable. Thus, the nature of most fruit fly eradication programs (which require early detection and elimination of the populations while they are still small) tends to rule out biological control as an option for eradication.

Although not of use in emergency eradication programs, biological control has potential for fruit fly suppression programs, especially in the role of a complementary control, where it may reduce or help to reduce fruit fly populations so that other control methods can be more effective. Although optimally used as a complementary control method, biological control alone may offer promise for some suppression programs, depending upon the degree of fruit fly control that would be acceptable. Biological control methods are rarely compatible with chemical control methods.

Augmentative biological control can be difficult to apply on a large-scale basis for eradication. It can be difficult, expensive, and labor-intensive to rear large quantities of biological control agents. Often the agents' life cycles (long generation times and few offspring) complicate rearing operations. The agents may need to be reared and/or distributed on the pest host, thereby complicating rearing logistics and requiring special containment and safeguarding. Biological control organisms are often fragile, requiring protection and careful handling prior to release. Also, the method might require massive releases of exotic organisms into the environment of the United States; the potential impacts of such releases, especially on nontarget species, are largely unknown.

Finally, because biological control technology for control of fruit flies has not been refined and is not available to the extent that it can be integrated into the Cooperative Fruit Fly Control Program, it is not possible to evaluate the method's environmental impacts comprehensively or with a great degree of precision.

e. Biotechnological Control

Biotechnological control would involve the use of genetic engineering techniques to control fruit fly pests. Currently, there are four primary areas of genetic engineering that show promise for control of insect pests: (1) bio-engineering of crop plants (insertion of specific genes into the plants to improve plant characteristics such as pest resistance), (2) improvement of insect-infecting viruses, (3) production of genetic mutations of the pest (thereby affecting its reproductive capabilities) by radiation or other means, and (4) gene probe techniques to screen for insecticidal properties in microorganisms.

Biotechnology is being developed for use against fruit flies, but has not been used extensively because of a number of constraints: (1) the technology is still relatively undeveloped; (2) some control mechanisms (bioengineered fruit fly host plants such as citrus are not yet available and, even if they become available, replacement of stands would require years) (Moore and Cline, 1989) have not been developed; (3) insect-infecting viruses have not been proven effective, nor are they available commercially for fruit fly control; (4) screening done for new strains of bacteria against fruit flies is only the first step in basic research and development of insect-infecting microorganisms; and (5) the information relative to the environmental impacts of bioengineered organisms is incomplete and unavailable.

One biotechnological control method that has been developed and is in the early implementation phase is the use of a temperature sensitive lethal (TSL) strain of the Medfly in SIT programs. The International Atomic Energy Agency has worked with a recessive mutant TSL gene that causes death in the insect at temperatures above about 29 °C. Females are homozygous for the mutant gene and, therefore, temperature sensitive. The males are heterozygous for the gene and are not temperature sensitive. By putting the Medfly eggs in a water bath at around the threshhold temperature, the females are killed and the males survive. The TSL-sexing method is of benefit in SIT programs for a variety of reasons: (1) it avoids ovipositional "sting" damage from sterile females; (2) it avoids detrimental (wasted) matings between sterile males and females; (3) it reduces SIT production costs by eliminating females in the egg stage; (4) it uses a relatively stable strain under mass rearing conditions; and (5) it improves the overall efficiency of SIT. Development of the TSL technology continues to take place. Operational releases have been made in Guatemala, California, and Florida.

Based upon the single example provided above, the potential impacts of biotechnological control appear to be minimal (equivalent to the impacts generated by use of the SIT method). Other biotechnological controls, however, are undeveloped and unavailable for program implementation at this time. In general, detailed information relative to the environmental impacts of those other forms of biotechnological control are unavailable. No substantial body of scientific evidence relative to evaluating the impacts of this control method exists, nor can it be summarized within this document.

f. Cold Treatment

Cold treatment involves the refrigeration of produce over an extended period of time, according to treatment schedules established in the Plant Protection and Quarantine (PPQ) Treatment Manual (USDA, APHIS). Cold treatment is used to kill fruit flies in regulated articles as a prerequisite for movement of those articles out of quarantined areas. Cold treatment is preferable to fumigation for commodities that are known to be damaged by methyl bromide. Cold treatment may also be combined with methyl bromide fumigation as an authorized regulatory treatment for some commodities.

All cold treatments are conducted in approved facilities under strict supervision. The facilities must be within the quarantine area and the cold treatments must be completed before commodities are moved from the quarantine area. The regulatory cold treatments are commodity-specific and are described in detail in the PPQ treatment manual.

A number of constraints (duration of treatments, approval for facilities, availability of facilities, and logistical and budgetary problems for producers) tend to limit the use of this treatment. In addition, some commodities are not compatible with cold treatments and would tend to be destroyed if such treatments were employed.

g. Irradiation Treatment

Irradiation treatment is a method that has been used to sterilize or kill certain species of fruit flies. The treatment may be used as a condition of entry into the United States for some fruit products, or it may be applied to certain articles to allow their movement outside of the regulated area. As with other regulatory treatments, there are constraints associated with irradiation treatments. Treatments for bulk shipments may be logistically difficult to accomplish and may not be as cost-effective as those smaller shipments.

Irradiation treatments must be conducted in an approved facility and the treatments are conducted in accordance with strict safety guidelines. The irradiation equipment releases radiation to the regulated commodity, but the treated commodity does not retain any radioactivity from the exposure.

Irradiation equipment at approved facilities is checked on a regular basis by the USDA Radiation Safety Staff in accordance with standards set by the Nuclear Regulatory Commission. No problems have been associated with the use of irradiation equipment under APHIS permits. Equipment design and shielding ensure negligible risks to workers at these facilities.

The facility must be within the quarantine area and the irradiation treatment must be completed prior to moving the commodity from the quarantine area. This treatment is presently used for some fruits from Hawaii. However, some commodities are not compatible with irradiation treatment and would tend to be destroyed if such treatments were employed. Irradiation treatment probably would not be used much as a control method because the facilities would be lacking in most quarantine areas and effective treatments that do not damage the regulated articles have not been developed for most commodities.

h. Vapor Heat Treatment

Vapor heat (steam) treatment is another regulatory control method used to kill fruit flies in regulated articles to allow movement of the regulated articles outside of the regulated area. As with cold treatments, there are a number of constraints associated with vapor heat treatment. Treatments for bulk shipments may be logistically difficult to accomplish and may not be as cost effective as those for smaller shipments. Program vapor heat treatments must be conducted in an approved facility and are strictly supervised. The facility must be within the quarantine area and the vapor heat treatment must be completed prior to moving the commodity from the quarantine area. These treatments are described in detail in the PPQ Treatment Manual (USDA, APHIS). This treatment can be used only for certain heat tolerant commodities. Vapor heat treatment probably would not be used very much as a control method because of the lack of facilities in quarantine areas.

2. Chemical Control Methods

Several chemical pesticide formulations have proven effective as controls for various fruit fly species. This section describes the potential uses of the chemicals which have been used or recommended for use in fruit fly control programs. Because much of the concern over fruit fly control programs relates to their use of chemical pesticides, this EIS (especially chapter 5, Environmental Consequences) focuses on their potential effects.

All chemical pesticides used by APHIS in cooperative fruit fly control or eradication programs are evaluated by the U.S. Environmental Agency (EPA). APHIS' research and testing of new and safer pesticides may result in proposals for their inclusion in those cooperative programs. Their use in those programs is predicated on approval by APHIS (based on efficacy, logistical, and environmental considerations) and the acquisition of a pesticide registration or quarantine exemption. Therefore, the chemical pesticides used in cooperative control or eradication programs have all been evaluated, but may be in various stages of the pesticide registration process. The chemicals are used under: a regular registration (7 U.S.C. 136a); a registration for special local needs (7 U.S.C. 136v), also known as a section 24c; or an emergency exemption (7 U.S.C. 136p), also known as a section 18. Uses of some of these formulations for fruit fly control programs may be considered "minor uses" by the pesticide manufacturers who haven't sought regular registrations because the high costs of those regular registrations are not justified by the volume of sales that are projected. In addition, most species of fruit flies are nonnative, invasive species which are not routinely registered by manufacturers as a pest covered on labels for control applications in the United States. The introduction of invasive species to the United States is not consistent enough for a manufacturer to justify advance registration for formulations of pesticides known to be effective against nonnative pests. When these species are detected, the only available pesticides must often be accessed through emergency exemptions. Also, because of differing State pesticide registration requirements, not all of the proposed chemicals are registered in the same way for each program State, and some chemicals may not be registered and therefore are unavailable for use in certain program States.

Recent research has shown that two pesticides, spinosad and SureDye, may serve as substitutes for malathion in aerial and ground bait formulations. Spinosad is registered for use with EPA and has tolerances for many crops. One formulation is now registered for use against fruit flies. Spinosad has been used successfully in some recent fruit fly eradication programs and is planned for use in eradication programs in the future. Research of spinosad is continuing to determine optimal formulations for effective control of several fruit fly species. SureDye is not currently registered and would need to be registered before it can be used in any control programs in the United States, unless EPA waives the registration requirements. Additional field testing is being done with SureDye to further determine its suitability and parameters for use in APHIS programs.

There has also been research of soil treatment chemicals to provide potential substitutes if use of the current soil drench pesticides is restricted or prohibited. This has become more important with tighter regulation of organophosphate insecticides (including the soil drench pesticides) under the Food Quality Protection Act. Current research has shown that imidacloprid may be effective as a soil drench insecticide. Program development of this compound and other potential substitutes is ongoing. Should any of these compounds be effective and available for program use, potential risks will be assessed in site-specific analysis.

Some other pesticides which are not considered in this EIS are registered for use against fruit flies. However, research indicates they are unsuitable for various reasons, including: (1) unacceptably high toxicity to environmental components, (2) lack of efficacy against targeted species, (3) lack of residual effect, (4) lack of thorough field testing, or (5) lack of suitability in large-scale programs.

The chemical control methods target various life stages of the fruit flies. For example, malathion, spinosad, and SureDye bait sprays target the adult fruit fly stages, while diazinon soil drenches target the larval and emerging adult stages. The selection of chemical control methods (as with nonchemical control methods) would be predicated on the circumstances and urgency of need, and any substitution of chemical control method would be predicated on the chemical's substantiated efficacy as a replacement. The availability of chemical control methods is subject to change, based on: (1) new information relative to environmental consequences, (2) planned phase-outs of some chemicals, (3) new limitations placed on their usages, and (4) the availability of newer replacement controls.

Figure 3–4. Helicopters are used to aerially apply malathion bait in some control programs. (Photo credit USDA, APHIS)

a. Aerial Bait Applications

(1) Aerial Malathion Bait

Aerial malathion bait may be used for primary control purposes (to suppress or eradicate fruit flies) or as a regulatory treatment (to establish freedom from fruit fly pests, so that commodities may be shipped out of regulated areas). It remains one of the most effective control tools against exotic fruit fly pests.

Aerial malathion bait consists of malathion mixed with a protein hydrolysate bait for adult fruit flies. The bait acts as an attractant and feeding stimulant to the fruit flies, which feed on it and ingest the toxicant. The use of a bait to attract fruit flies improves efficacy to the extent that the amount of malathion required is very low compared to labeled rates for most other uses. Bait applications substantially reduce the wild fruit fly populations. The method is especially effective when combined with SIT, for those species for which an effective SIT technology has been developed.

Full foliar coverage bait spray of host trees and other plants immediately reduces fruit fly populations by 90% or more and reduces subsequent reproduction. This decreases fruit fly numbers in the succeeding generation and reduces the risk that gravid female fruit flies will move to uninfested areas. In this manner, the malathion bait applications reduce wild fruit fly populations to a level of infestation where mating thresholds are not achieved or where continued releases of sterile fruit flies can be effective in reducing the rest of the emerging pest population.

Typical Medfly programs may use weekly aerial applications of malathion bait spray followed by the use of SIT in a 9 mi^2 area around each Medfly find, for a time span of one to two life cycles. Also, the speed at which sterile flies become available is often the factor that determines the number of pesticide sprays used before the initiation of sterile fly releases. The number of treatments varies depending upon the ambient temperatures and pest's life-cycle characteristics. Infestations that are heavy or widespread may require additional applications to lower populations to levels where release of sterile insects will be effective. Additional Medfly finds could indicate an expanding infestation, resulting in the need for aerial malathion bait application to areas surrounding the originally designated treatment area. Containment and reduction of Medfly populations are both critical factors for eradication.

Aerial malathion bait also may be used as a regulatory control method to establish freedom of nursery or orchard premises from living fruit fly stages, as a condition for movement of produce. To accomplish this, the establishment undergoes a series of treatments at intervals, designed to provide continued freedom from fruit flies during the quarantine period.

Bait spray applications normally are limited to locations producing regulated commodities within the quarantined area, but located outside the infested core area. Treatments must start at a sufficient time, at least 30 days, before harvest (to span the interval that normally would include the completion of egg, larval, and pupal development), then continue throughout the harvest period. The required preharvest treatment makes this option useful for only those commodities remaining in the field for more than 30 days after an area is quarantined.

(2) Aerial Spinosad Bait

Spinosad bait is a formulation of naturally produced bacterial compounds (spinosyns) and bait. The optimal formulation for use against different fruit fly species is still being developed to ensure efficacy and suitability to program applications. Spinosad is being used as a substitute for aerial malathion bait formulations in rural areas.

Spinosad has been used successfully in recent fruit fly eradication programs. If spinosad remains available for use, it may serve as an alternative to malathion in aerial bait formulations for primary control or for regulatory treatments. Aerial applications are currently restricted to use in orchards and croplands. Aerial applications may not be applied to fruit fly infestations in residential areas. Refer to the previous discussion on aerial malathion bait for further insight into how spinosad might be used in aerial bait applications.

Figure 3–5. Some aerial applications are made at night to minimize exposure of area residents. (Photo credit USDA, APHIS)

(3) Aerial SureDye Bait

SureDye bait spray is a formulation of xanthene dye and bait that is still being tested and developed for use against various fruit fly species. SureDye bait is being examined by the program as a substitute for malathion in both aerial and ground bait formulations.

If SureDye is approved, becomes available, and can be integrated successfully into fruit fly control programs, it would be used in place of malathion in bait formulations, either for primary control or as a regulatory treatment. Refer to the preceding discussion of aerial malathion bait for further insight into how SureDye might be used in aerial bait sprays.

b. Ground Bait Applications

(1) Ground Malathion Bait

Ground malathion bait also may be used for primary control purposes (to suppress or eradicate fruit flies) or as a regulatory treatment (to establish freedom from fruit fly pests so that commodities may be shipped out of regulated areas). Ground malathion bait applications use the same material as the aerial malathion bait, but the applications are applied from ground equipment such as backpack or pump-up sprayers, or truck-mounted mist blowers and hydraulic sprayers. Ground malathion bait is intended to reduce the wild fruit fly populations to levels below mating thresholds or to levels where SIT becomes effective. The combination of bait with malathion in the formulation substantially decreases the amount of malathion needed for area-wide control. Ground applications are preferable for small or isolated areas of host plants, locations adjacent to sensitive sites or water (where drift from aerial applications is of special concern), and sites where aerial applications would be either less precise or unsafe.

Generally, the spray is applied at close range to hosts in an area expanding outward from a fruit fly detection until the designated area is treated. This greatly reduces the potential for the fruit flies to spread. Depending on the species of fruit fly targeted, the malathion bait may be applied either as a full cover foliar spray or as a bait spot treatment (squirting a small amount on a portion of the host plant). Because of the uncertainty of how the applications would be made in a particular situation, this EIS evaluated the full coverage method which uses more material. Bait spot applications that use substantially less material would further reduce the potential for environmental consequences.

In recent Medfly programs, EPA has restricted the amount of pesticide used by ground or air to no more than 2.4 fluid ounces of malathion per acre. Thus, ground sprays cannot legally use more malathion per acre than air sprays. There are practical limitations to using ground sprays over large areas that prevent treatments from being repeated in a timeframe that will guarantee the destruction of overlapping pest generations.

Although ground applications may provide better control of pesticide deposition than aerial applications and result in greater public acceptance, they are more labor-intensive, they generally do not provide complete coverage with control materials, they increase exposure to applicators, and they may not be practical or even feasible in some areas (because of uneven terrain, presence of dangerous animals, or lack of access). If there is insufficient coverage of the epicenter of a fruit fly infestation, then there would be risk of a gravid female fruit fly locating a suitable host for oviposition without ever being attracted to the malathion bait spray. Thus, insufficient coverage could lead to establishment and further spread of the fruit flies.

(2) Ground Spinosad Bait

Spinosad also has been used as a substitute for malathion in ground bait formulations for recent fruit fly eradication programs. Research and development of optimal formulations of spinosad for control of different fruit fly species are continuing. If spinosad remains available for use, it may serve as an alternative to malathion in bait applications for primary control or for regulatory treatments. Refer to the previous discussion on ground malathion bait for further insight into how spinosad might be used in ground bait applications.

(3) Ground SureDye Bait

SureDye is being examined by the program as a substitute for malathion in both aerial and ground bait formulations. If SureDye can be integrated successfully into the program, it could be used as a substitute for malathion in ground bait applications, either for primary control or as a regulatory treatment. Refer to the preceding discussion of ground malathion bait for more information about the probable use patterns.

Figure 3–6. Ground applications of malathion bait precisely target fruit fly hosts. (Photo credit USDA, APHIS)

c. Soil Treatment

Diazinon, chlorpyrifos, and fenthion are soil drench chemicals that are approved for fruit fly control programs; refer to chapter 5 (Environmental Consequences) for more information about these chemicals. Imidacloprid is being investigated as an alternative soil drench chemical at this time. At the site of an infestation, soil treatment with diazinon, chlorpyrifos, or fenthion is used to kill fruit fly larvae entering the soil and new fruit fly adults emerging from the soil.

For suppression and eradication purposes, soil treatment is best used as a complementary control method, in combination with pesticide bait formulations, fruit stripping, and/or other methods. Typically, one treatment (but up to three, in the case of an infestation of long duration) may be made, applied directly to the soil within the drip line of host plants within the immediate vicinity of a fruit fly larval detection. Because of the nature of the chemicals and/or the method of delivery, there is no potential for drift.

Soil treatment also may be used as a regulatory treatment method to kill fruit flies in the soil so that regulated nursery stock or soil may be moved from a quarantined area. Used in combination with fruit stripping, soil treatment establishes freedom from the pests and provides the capability to certify the nursery stock for movement. Applications are limited to the soils of regulated nursery stock grown within the quarantined area. Generally no more than three applications are made.

d. Fumigation

(1) Methyl Bromide

Methyl bromide is an efficacious, broad spectrum pesticide that is widely used as a fumigant to control insects, nematodes, fungi, rodents, and weed seed. It is characterized by rapid dissipation following treatment with proper aeration, nonflammable and nonexplosive properties, and stability in gaseous form to relatively low temperatures (down to 4 ºC (39 ºF)).

Methyl bromide fumigation is used as a regulatory control method to kill fruit flies in regulated articles and allow the movement of those regulated articles from within a quarantine area to locations outside quarantine boundaries. Methyl bromide fumigations comply with the pesticide label and with all Federal, State, and local regulations. All fumigations are done under strict supervision within the quarantine area. Methyl bromide fumigation also may be combined with cold treatment to fulfill requirements for certifying some commodities free of fruit fly.

e. Mass Trapping

Mass trapping reduces fruit fly populations by attracting fruit flies to traps where they become stuck or are exposed to a minute amount of pesticide, and die before they have the opportunity to mate. The fruit flies are attracted to a bait at the traps (conventional fruit fly traps, sticky panels, fiberboard squares, wicks, or bait spots on telephone poles or roadside trees), where they become stuck with a sticky substance or are killed with a minute amount of pesticide (naled or malathion). Mass trapping has potential for many species of fruit flies but is not effective for all species.

The sticky panels employed for fruit fly control use a synthetic lure (trimedlure, ceralure, or cuelure) applied directly to the panels or to wicks attached to the panels. For the Medfly, the baits attract the male Medflies, hence the method has also been called male annihilation. Large numbers of panels must be placed within and surrounding the infestation area for the method to be effective. Mass trapping, in combination with other actions, can be used to lower the population of fruit flies to levels where eradication can be achieved through the combined use of other control methods, often including SIT.

Male annihilation can be used effectively and simultaneously against multiple fruit fly species when a powerful attractant is available that works on all of those species. For example, several species of *Bactrocera* (including Oriental and peach fruit flies) are attracted well to the parapheromone methyl eugenol.

Instead of traps or panels, some species of fruit flies may also be trapped and killed using cordelitos or fiberboard squares. Cordelitos are 30-mm long wicks that contain cuelure and naled. The fiberboard squares are wood chips approximately 20 cm^2 in size that contain cuelure and naled. Each may be applied aerially in rural or agricultural areas. Cordelitos have been used to eliminate some melon fly populations.

The use of panels and lures to control fruit flies is a relatively recent development that is still being tested and improved. It has been used against the melon fly. Tests conducted with the panels indicate that few nontarget arthropods are attracted by the panels. Placement of the panels in host trees out of reach of the public makes it unlikely that the public would be exposed to the lures or sticky panels. The low toxicity of the lures and sticky chemical result in negligible risk to humans, livestock, or pets as a consequence of any expected exposure.

There are some limits to the use of mass trapping. The approach is costly and labor-intensive. It may require placement and servicing of 1,000 or more panels or traps per square mile within the infestation area. Effectiveness is reduced if they are dislodged and inadvertently destroyed by the public, livestock, or pets. Panels and traps are believed most effective when new infestations are detected and integrated controls are used, but are believed ineffective for large populations where the fruit flies have mated prior to being trapped by the panels. Finally, the lures (natural and synthetic) have not proven equally effective on all species of fruit flies.

Figure 3–7. Sticky panels are one technique used in mass trapping. (Photo credit USDA, APHIS)

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IV. Affected Environment

A. Introduction

The Fruit Fly Cooperative Control Program has the potential to affect the environments of future program areas. The environments are complex and diverse, with characteristics and components that can influence the implementation of future fruit fly programs. Factors considered by program planners include the physical environment, human population, biological resources, cultural resources, and visual resources.

The geographical scope of the program is based on factors related to host range, climate, potential avenues of introduction, and past introductions. Parts of the potential program area share common characteristics, especially with regard to physical character and biological resources. The overall geographical scope of the Fruit Fly Cooperative Control Program includes all 50 States of the United States, but the likelihood of introduction for different species of fruit flies varies considerably by location and species.

For purposes of discussing the affected environment, this environmental impact statement (EIS) considers seven ecological regions (ecoregions). Although these ecoregions do not include all potential program areas, the ecoregions do include those sites most likely to have introductions of various fruit fly species. The physical and biological components of these ecoregions are developed within this chapter. Such an organization facilitates a broad perspective of the environment, as required for a programmatic EIS, while allowing a focus on essential aspects of the environment that may be affected.

1. Environmental Characteristics of the Potential Program Area

Although future fruit fly control programs may occur within any of the 50 United States, past fruit fly introductions suggest that future programs will probably involve areas where human activity occurs. Such areas may be urban, suburban, or agricultural in character, and characterized by considerable modification of natural features and processes. The majority of the introductions are, however, known to occur in or near residential areas. Most of these introductions can be traced to accidental or intentional (smuggling) human interventions, where there is a large volume of movement of international travelers and commodities, such as in proximity to ports of entry.

In urban and suburban areas, topography and vegetation have been modified to accommodate buildings and transportation corridors. Landscaping has changed vegetation patterns and species composition. Runoff has increased because of channelized water courses and impervious cover material, which may exceed 40 percent of the area (McBride and Reid, 1988). Losses of habitat and urban pesticide treatments (such as for mosquitoes by health departments) have altered populations of pest species and other insects.

Land in agricultural production is usually intensely managed and monotypic. Orchards, for example, generally contain a single crop species planted in uniform, evenly spaced rows, often with a single species of ground cover between the crops. Physical alteration, fertilization, irrigation, routine use of a variety of pesticides, and other agricultural practices have altered the structure and function of the natural environment. Fertilizers and herbicides have altered geochemical cycles in both urban and agricultural areas (Brady *et al.*, 1979).

Urban, suburban, and agricultural lands may include (or may be interspersed with) natural areas such as parks, forests, lakes, and refuges. Often the transition between the natural areas and the other lands is not distinct.

The physical and biological characteristics of the area, the agricultural practices, and the changes that are brought about by human activity all influence the environmental consequences of a fruit fly program.

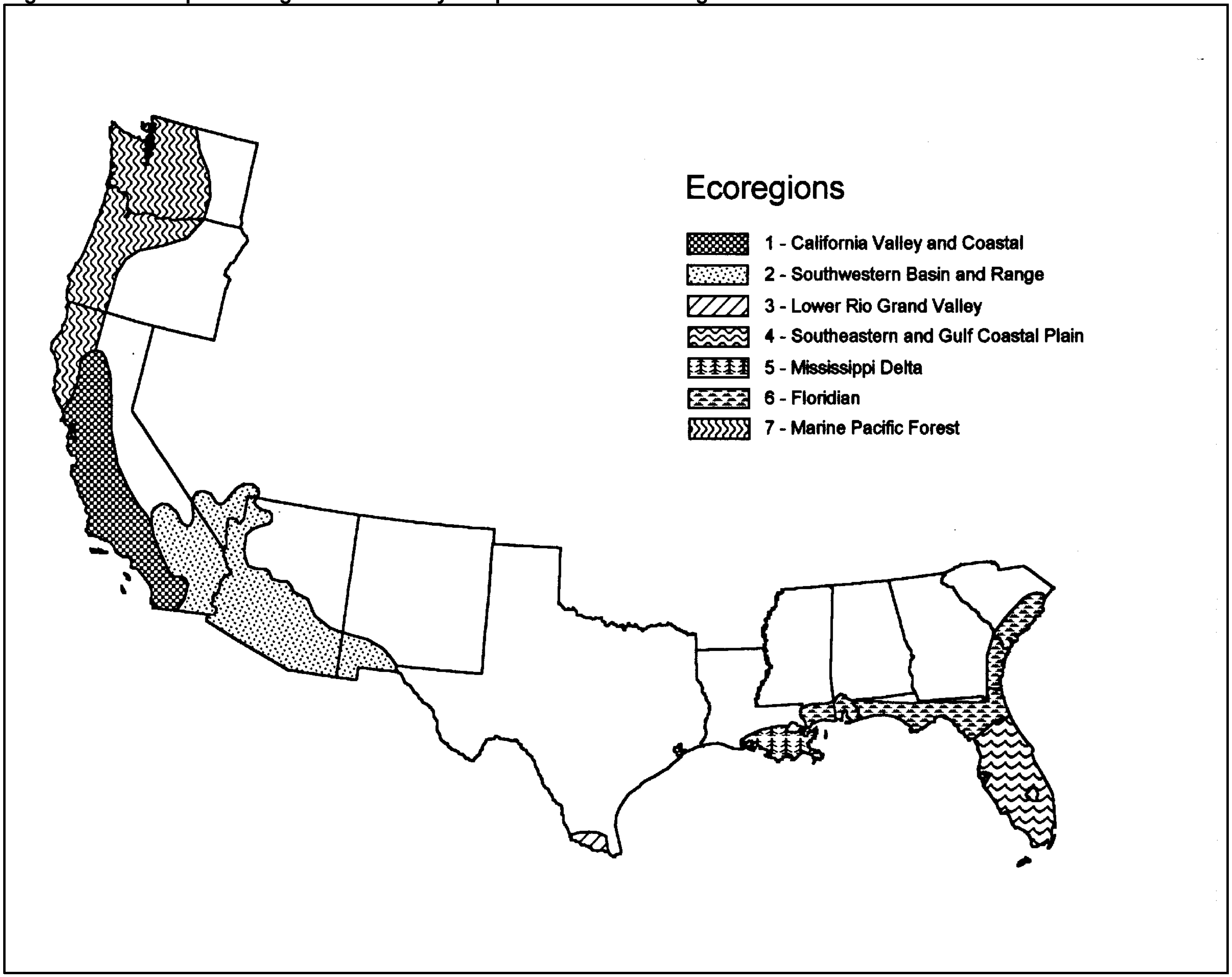
2. Ecoregions of the Potential Program Area

The geographic area most at risk for future programs falls within the boundaries of seven ecoregions. Refer to figure 4–1 for a general map of the seven ecoregions and the States included in each. The ecoregions have been adapted from several classification systems now in use (USDA, SCS, 1981; Omernik, 1986; Bailey, 1980; Kuchler, 1964; and Brown *et al.*, 1977).

California Central Valley and Coastal ecoregion includes southern coastal and south central valley areas of California. For the purposes of this EIS, the Sierra Nevada range (usually considered part of this ecoregion) has been omitted because it is an area unlikely to continuously support fruit fly populations.

Southwestern Basin and Range ecoregion spans potential program areas in Arizona and southeastern California.

Figure 4–1. Principle Ecoregions of Fruit Fly Cooperative Control Program



Lower Rio Grande Valley ecoregion in Texas is bounded on the east by the gulf coastal plain and on the south by the Rio Grande River. It marks the southern terminus of the central Texas plains and includes potential program areas in southern Texas.

Southeastern and Gulf Coastal Plain ecoregion is a low-lying area bounded by the Atlantic Ocean, the rolling hills of the southeastern plains, the Gulf of Mexico, and the southwestern plains. It includes potential program areas within Alabama, Florida, Georgia, Mississippi, South Carolina, and Texas.

Mississippi Delta ecoregion includes potential program areas in the Mississippi River Delta areas of Louisiana and Mississippi.

Floridian ecoregion includes most of peninsular Florida. Potential program areas are found throughout the State.

Marine Pacific Forest ecoregion includes potential program areas in the State of Washington and adjacent areas of Oregon. The program areas are primarily east of the Cascades in the Columbia River Basin. For the purposes of this EIS, the mountainous areas of the Cascades (usually considered part of this ecoregion) have been omitted because these areas are unlikely to continuously support fruit fly populations.

B. Environmental Components

1. The Physical Environment

A general description of the physical environment of the potential program areas (climate, land resources, water resources and quality, and air quality) follows. More detailed information on the physical characteristics of the area may be found in tables 4–1 through 4–7, for each ecoregion, according to major land resources subregions.

a. Climate

The climate of the potential program areas varies considerably. The cool, wet marine climate of the Pacific Northwest differs from the warm Mediterranean climate of southern California. The hot climate of the southwestern desert and lower Rio Grande Valley contrasts with the cooler climate of the mountains and foothills of the West.

Table 4–1. Land Resources and Characteristics California Central Valley and Coastal Ecoregion

Subregion	Land Use	Elevation/ Topography	Annual Precipitation ---------- Rainfall Distribution	Avg. Annual Temperature ---------- Freeze-free Period	Freshwater Resources	Soils	Representative Introduction Sites
Central California Coastal Valleys	Farming (including dairy), crops (wine grapes, strawberries, and other fruits; cut flowers; small grains; hay), pasture, ranches, urban development, wildlife habitats, salt ponds, recreation	Sea level to 600 m (1,969 ft), mostly less than 300 m (984 ft)	300 to 750 mm (12 to 30 in) ---------------------------- Precipitation very low mid-spring to mid-autumn	15 °C (59 °F) ---------------------- 210 to 300 days	Moderate rainfall and local streamflow (inadequate for needs), San Lorenzo River	Alkaline to acid pH, sandy gravelly loams to clay	Cities: Oakland and San Jose
Central California Coastal Range	Farming and ranching (80%), Federal property, open woodland, forests, urban areas	Sea level to 800 m (2,625 ft) up to 1,500 m (4,922 ft) in some mountains	300 to 1,025 mm (12 to 40 in) ---------------------------- Precipitation evenly distributed throughout fall, winter, and spring; low in summer	16 °C (61 °F) ---------------------- 120 to 270 days	Low to moderate rainfall; moderate streamflow; Nacimiento and San Antonio Reservoirs; Salinas River	Acid to alkaline pH, sandy loam to clay	City of San Luis Obispo
California Delta	Farming (including asparagus, sugar beets, potatoes, corn, grain, hay), fruit trees, recreation, wildlife habitat, pasture	Below sea level to slightly above sea level	325 to 375 mm (13 to 15 inches) ---------------------------- Dry summers	16 °C (61 °F) ---------------------- 270 days	Sloughs and waterways, Sacramento River	Moderately alkaline to strongly acid pH, silty clay to clay	City of Stockton
Sacramento and San Joaquin Valleys	Farming (fruits, nuts, citrus, grapes, melons, tomatoes, cotton, hay, grain, rice), pasture	Sea level to 200 m (656 ft)	125 to 625 mm (5 to 25 inches) ---------------------------- Dry summers, rainy winters	18 °C (64 °F); 13 °C (55 °F) in northern area ---------------------- 230 to 350 days	Low rainfall; small streamflow; irrigation from State and Federal water systems; California Aqueduct; and groundwater. Canals: Friant-Kern, Delta-Mendota; Lakes: Tulare, Buena Vista; Rivers: San Joaquin, Kern	Slightly acid to moderately alkaline pH, sandy loam to clay, some saline soils.	City of Sacramento

Table 4–1, continued.

Subregion	Land Use	Elevation/ Topography	Annual Precipitation ---------- Rainfall Distribution	Avg. Annual Temperature ---------- Freeze-free Period	Freshwater Resources	Soils	Representative Introduction Sites
Sierra Nevada Foothills	Ranching (75%), farming (5%) (fruit, nuts, grapes), brushland, open forest	200 to 500 m (656 to 1,641 ft), up to 1,200 m (3,937 ft) on mountain peaks	350 to 900 mm (14 to 35 inches) ---------------------------- Dry summers, moist winters	16 °C (61 °F) ---------------------- 200 to 320 days	Moderate rainfall, intermittent streamflow; storage or local watershed; and groundwater.	Neutral to moderately acid pH, sandy or sandy clay loam with some rocky or cobbly sandy loam	
Southern California Coastal Plain	25% Federal property, 20% urban, 33% brushland, 10 to 20% cropland (subtropical and deciduous fruits, grain, truck crops, grapes, hay), pasture, dairy farming, flower seed production	Sea level to 600 m (1,969 ft)	250 to 625 mm (10 to 25 inches) ---------------------------- Dry summers, fog provides moisture along the coast	17 °C (63 °F) ---------------------- 250 to 365 days	Low rainfall, intermittent streamflow. Colorado River Aqueduct, Los Angeles Aqueduct, and California Aqueduct. Rivers: San Diego and Santa Margarita.	Neutral to strongly acid pH	Cities: Anaheim, Los Angeles, Riverside, San Diego. Ports: Los Angeles and San Diego.
Southern California Mountains	40% Federal property, 5% urban, farming (fruit, grain, hay, citrus, vegetables, flowers), range, pasture	600 to 2,400 m (1,969 to 7,874 ft), up to 3,000 m (9,843 ft) peaks	400 to 1,025 mm (16 to 40 inches) ---------------------------- Dry summers, some snow in winter	16 °C (61 °F) ---------------------- 100 to 200 days (250 days in western area)	Moderate rainfall, deep sand and gravel deposits in valleys yield water, Colorado River Aqueduct. Rivers: Los Angeles and Santa Ana.	Neutral to moderately alkaline pH, sandy loams to clay.	City of Los Angeles

Source: Land Resource Regions and Major Land Areas of the United States (Agriculture Handbook 296)

Table 4–2. Land Resources and Characteristics Southwestern Basin and Range Ecoregion

Subregion	Land Use	Elevation/ Topography	Annual Precipitation ---------- Rainfall Distribution	Avg. Annual Temperature ---------- Freeze-free Period	Freshwater Resources	Soils	Representative Introduction Sites
Sonoran Basin and Range	80% Federal property, 20% local government property, recreation, range, wildlife habitat, irrigated crops (vegetables, fruits, nuts, citrus, grapes, cotton, small grains, grain sorghum, hay, pasture)	100 m (328 ft) below sea level to 1,200 m (3,937 ft) above sea level, up to 3,400 m (11,155 ft) in mountains	50 to 250 mm (2 to 10 in) in valleys, up to 625 mm (25 in) on mountain slopes ---------------------------- Even precipitation distributed through-out the year	20 °C (68 °F), as low as 10 °C (50 °F) in mountains ---------------------- 240 to 320 days	Large springs, wells. Rivers: Gila and Colorado	Neutral to alkaline pH, loamy sand to cobbly or gravelly sandy loam	
Imperial Valley and Associated Areas	Farming (irrigated crops -- citrus, dates, grapes, sugar beets, vegetables, small grains, flaxseed, hay, tame pasture grasses), ranching, recreation, wildlife habitat, urban development	50 m (165 ft) below sea level to 200 m (656 ft) above sea level	50 to 100 mm (2 to 4 in)	23 °C (73 °F) ---------------------- 280 to 350 days	Wells, Imperial Reservoir. Rivers: Gila and Colorado	Alkaline pH, sand to silty clay loam, some stony	Yuma
Central Arizona Basin and Range	Farming (irrigated crops-- cotton, alfalfa, barley, other small grains, lettuce, carrots, cabbage, cauliflower, other vegetables, melons, citrus), ranching, wildlife habitat, urbanization	300 to 1,100 m (984 to 3,609 ft)	125 to 300 mm (5 to 12 in) ---------------------------- Most precipitation July through September, and December through March	20 °C (68 °F) ---------------------- 250 to 300 days	Deep wells, Lake Pleasant. Rivers: Agua Fria, Gila, and Santa Cruz	Akaline pH; sandy loam to clay, some gravelly	Phoenix
Southeastern Arizona Basin and Range	Community development, range, recreation, wildlife habitat, irrigated crops (cotton, corn, alfalfa, small grains, lettuce, and other crops)	800 to 1,400 m (2,625 to 4,593 ft)	275 to 375 mm (11 to 15 in) ---------------------------- Most precipitation July through September	15 °C (59 °F) ---------------------- 150 to 250 days	Groundwater, artesian flows. Rivers: Santa Cruz and San Pedro	Moderately alkaline pH, sandy loam to gravelly clay loam	Tucson

Source: Land Resource Regions and Major Land Areas of the United States (Agriculture Handbook 296)

**Table 4–3. Land Resources and Characteristics
Lower Rio Grande Valley Ecoregion**

Subregion	Land Use	Elevation/ Topography	Annual Precipitation ---------- Rainfall Distribution	Avg. Annual Temperature ---------- Freeze-free Period	Freshwater Resources	Soils	Representative Introduction Sites
Rio Grande Valley	Ranching (beef cattle), wildlife habitats, crops (cotton, grain sorghum, onions, cabbage, citrus, and other fruits, warm and cool season vegetables, melons, sugarcane)	Sea level to 300 m (984 ft), mostly less than 100 m (328 ft)	425 to 700 mm (17 to 28 in) ---------------------------- Maximum precipitation is during the growing season	23 °C (73 °F) ---------------------- 300 to 330 days	Rainfall, deep wells and ponds, various oxbow lakes, Falcon Reservoir, Rio Grande River	Moderately alkaline to slightly acid pH, sandy loam to clay loam	Cities of Brownsville and Harlingen
Rio Grande Plain	Ranching (beef cattle), wildlife habitats, crops (grain sorghum, cotton, and small grains for grazing)	25 m (82 ft) to 200 m (656 ft)	425 to 650 mm (17 to 26 in) ---------------------------- Maximum precipitation is during the growing season	22 °C (72 °F) ---------------------- 260 to 325 days	Rainfall, deep wells and ponds, Rio Grande River	Moderately alkaline to slightly acid pH, sand to sandy clay loam, some gravelly	

Source: Land Resource Regions and Major Land Areas of the United States (Agriculture Handbook 296)

Table 4–4. Land Resources and Characteristics Southeastern and Gulf Coastal Plain Ecoregion

Subregion	Land Use	Elevation/ Topography	Annual Precipitation ---------- Rainfall Distribution	Avg. Annual Temperature ---------- Freeze-free Period	Freshwater Resources	Soils	Representative Introduction Sites
Gulf Coastal Saline Prairies	Ranching, urban, recreation, rice, grain sorghum, wildlife refuges	Sea level to 3 m (10 ft), occasional coastal dunes to 8 m (26 ft)	750 to 1,400 mm (30 to 55 in) ---------------------------- Evenly distributed throughout year	22 °C (72 °F) ---------------------- 250 to 330 days	Rainfall, streams, ponds, Rio Grande River	Alkaline pH, clay to sand (often saline)	Port of Brownsville
Gulf Coastal Prairies	Farming (rice, row crops, cotton, and hay); range or pasture; forestry; urban	Sea level to 50 m (164 ft)	625 to 1,400 mm 25 to 55 in) ---------------------------- Slightly higher in winter	21 °C (70 °F) ---------------------- 280 to 320 days	Rainfall, perennial streams, groundwater, San Jacinto River	Neutral to alkaline pH, clay	City and Port of Houston
Western Gulf Coastal Flatwoods	Forestry (75%) (used for lumbering), rice, pasture, row crops, urban	25 to 100 m (82 to 328 ft)	1,175 to 1,400 mm (46 to 55 in) ---------------------------- Slightly higher in winter	20 °C (70 °F) ---------------------- 260 to 280 days	Rainfall, perennial streams, ground water, Lake Houston, San Jacinto River	Acid pH, sand to loam, high water tables	
Eastern Gulf Coastal Flatwoods	Forestry (used for lumbering), State and national forests, 4% crop, 4% pasture	Sea level to 25 m (82 ft)	1,325 to 1,625 mm (52 to 64 in) ---------------------------- Maximum in summer	20 °C (70 °F); ---------------------- 270 to 290 days	Rainfall, perennial streams, groundwater (may be affected by salt). Rivers: Dog, Escatawpa, Fowl, Middle, Spanish, Tchoutacabouffa, Tensaw, Wolf	Acid pH, sandy, coastal soils: sandy to organic	Cities: Mobile, Biloxi, Gulfport. Ports: Mobil and Gulfport
Southern Coastal Plain	69% woodland, row crops, melons, vegetables, cereals, range, pasture, urban development	25 to 200 m (82 to 656 ft)	1,025 to 2,525 mm (40 to 99 in) ---------------------------- Maximum in winter and spring	18 °C (64 °F) ---------------------- 200 to 280 days	Rainfall, perennial streams, groundwater, reservoirs	Acid pH, loamy or sandy (often clay subsoil)	
Atlantic Coastal Flatwoods	Forestry (70%), wildlife refuges, vegetables, fruits, cereals, row crops, peanuts	25 to 50 m (82 to 164 ft)	1,025 to 1,400 mm (40 to 55 in) ---------------------------- Maximum in summer	17 °C (63 °F) ---------------------- 200 to 280 days	Rainfall, perennial streams, groundwater. Rivers: Ogeechee, Vernon, Savannah.	Acid pH, sand to clay, organic soils	City and Port of Savannah

Table 4–4, continued.

Subregion	Land Use	Elevation/ Topography	Annual Precipitation ---------- Rainfall Distribution	Avg. Annual Temperature ---------- Freeze-free Period	Freshwater Resources	Soils	Representative Introduction Sites
Tidewater Area	Forestry (70%), wildlife refuges, pasture, recreation, row crops, tobacco, vegetables	Sea level to 25 m (82 ft)	1,150 to 1,275 mm (45 to 50 in) ---------------------------- Maximum in summer	19 °C (66 °F) ---------------------- 200 to 300 days	Rainfall, perennial streams, groundwater. Rivers: Ashley, Cooper, Coosaw, Edisto, Stono, Wando, Broad	Acid pH, some organic soils, soils often wet	City and Port of Charleston

Source: Land Resource Regions and Major Land Areas of the United States (Agriculture Handbook 296)

Table 4–5. Land Resources and Characteristics Mississippi Delta Ecoregion

Subregion	Land Use	Elevation/ Topography	Annual Precipitation ---------- Rainfall Distribution	Avg. Annual Temperature ---------- Freeze-free Period	Freshwater Resources	Soils	Representative Introduction Site
Gulf Coastal Marsh	Marsh vegetation for wildlife habitat; pasture, rice	Sea level to 2 m (7 ft), salt dome islands up to 50 m (164 ft)	1,224 to 1,650 mm (48 to 65 in)	21 °C (70 °F) ---------------------- 280 to 350 days	Rivers, lakes, bayous, manmade canals. Rivers: Atchafalaya and Mississippi	Alkaline pH, organic and often saline, often marshy	City and Port of New Orleans
Southern Mississippi Valley Alluvium	Woodland, pasture, crops (cotton, rice, soybeans, wheat, sugarcane), wetland wildlife areas	Sea level to 20 m (65 ft), mostly flatland, level to gently sloping flood plains and low terraces, swamps	1,150 to 1,650 mm (45 to 65 in)	18 °C (64 °F) ---------------------- 250 to 340 days	Precipitation,stream-flow, groundwater in northern Louisiana, oxbow lakes, bayous, Mississippi River	Acid pH, silt loam to clay	City and Port of New Orleans

Source: Land Resource Regions and Major Land Areas of the United States (Agriculture Handbook 296)

Table 4–6. Land Resources and Characteristics
Floridian Ecoregion

Subregion	Land Use	Elevation/ Topography	Annual Precipitation ---------- Rainfall Distribution	Avg. Annual Temperature ---------- Freeze-free Period	Freshwater Resources	Soils	Representative Introduction Site
Florida Everglades and Associated Areas	50% Indian reservations, national parks, and game refuges; 35% forest and recreation; 13% crops (winter vegetables, citrus fruits, avocado, papaya, sugarcane), urban development	Sea level to less than 25 m (82 ft)	1,275 to 1,625 mm (50 to 64 in) ---------------------------- Maximum precipitation in late spring through early autumn	24 °C (75 °F) ---------------------- 330 to 365 days	Rainfall, surface water, groundwater, marsh, Everglades, St. John’s River	Organic soils, some with tidal flooding	Everglades Cities: Miami, Ft. Lauderdale Port: Miami
Southern Florida Lowlands	Farming and ranching; 20% forest; 20% crops (citrus fruits, vegetables, and other cultivated crops), range, pasture; saltwater marsh	25 m (82 ft) mostly flat area	1,325 to 1,525 mm (52 to 60 in) ---------------------------- Maximum precipitation in summer	23 °C (73 °F) ---------------------- 330 to 360 days	Rainfall, surface water, and groundwater	Neutral to strongly acid pH, sand to loamy sand	
South-Central Florida Ridge	40% forest, 25% pasture, 5% crops (citrus, vegetables), urban development	25 to 50 m (82 to 164 ft), some hills up to 100 m (328 ft)	1,275 to 1,400 mm (50 to 55 in) ---------------------------- Maximum precipitation in summer	22 °C (72 °F) ---------------------- 290 to 350 days	Rainfall, groundwater, lakes, few perennial streams, Lake Apopka	Acid pH, sandy to sandy loam	Orlando
Southern Florida Flatwoods	65% forest, 15% pasture, 15% native range, 3% crops (mainly winter vegetables, citrus and other subtropical fruits)	Sea level to 25 m (82 ft)	1,300 to 1,525 mm (51 to 60 in) ---------------------------- Maximum precipitation in summer	22 °C (72 °F); ---------------------- 290 to 365 days	Rainfall, surface water, groundwater. Rivers: Caloosahatchee, Kissimmee, Peace, Withlacoochee; Lakes: Istokpoka, Kissimmee, Okeechobee	Acid pH, sandy	Cities: Tampa, Clearwater, St. Petersburg, West Palm Beach Port: St. Petersburg

Source: Land Resource Regions and Major Land Areas of the United States (Agriculture Handbook 296)

Table 4–7. Land Resources and Characteristics Marine Pacific Forest Ecoregion

Subregion	Land Use	Elevation/ Topography	Annual Precipitation ---------- Rainfall Distribution	Avg. Annual Temperature ---------- Freeze-free Period	Freshwater Resources	Soils	Representative Introduction Sites
Williamette-Puget Sound Valleys	Farming (including dairy), crops (apples, pears, peaches, cherries, and other fruits; vegetables; small grains; hay), pasture, forestry, urban development, wildlife habitats, recreation	Sea level to 460 m (1,500 ft); mostly 200 m (628 ft)	375 to 2,550 mm (15 to 102 inches) ---------------------------- Precipitation less in summer, even for rest of year	11 °C (52 °F) ---------------------- 120 to 240 days	Moderate to heavy rainfall; abundant local streamflow; rivers around Puget Sound and Lower Columbia River Basin	Alkaline pH in valleys to acid pH in mountains; alluvial, glacial till, and loess; sand or silt loams	Cities: Seattle and Portland
Upper Columbia River Basin	Farming (including dairy), crops (apples, pears, apricots, peaches, cherries, and other fruits; hops; vegetables; small grains, hay), pasture, Federal property, forestry, wildlife habitats, recreation	100 to 800 m (2,600 ft)	150 to 300 mm (6 to 12 inches) ---------------------------- Precipitation heavier in winter than in summer	10 °C (50 °F) ---------------------- 120 to 200 days	Low to moderate rainfall; moderate streamflow; Columbia River, Yakima River, and Snake River	Alkaline pH in valleys to acid pH in mountains; alluvial, glacial till, and loess; sand or silt loams	Cities: Wenatchee and Yakima

Source: Land Resource Regions and Major Land Areas of the United States (Agriculture Handbook 296)

Annual precipitation varies from less than 15 cm (6 in) in the Sonora Basin and Imperial Valley in Arizona and California, to 251 cm (99 in) in the southern coastal plain. The climate affects soils, vegetation, and wildlife that are indigenous to individual areas as well as land resources, socioeconomics, and human populations in potential program areas. Degradation of residues from potential program pesticide applications generally would be greater in areas with higher rainfall and temperatures. In general, warmer temperatures and longer freeze-free periods allow fruit fly populations to increase more rapidly with resultant increased potential for spread.

b. Land Resources

The topography of the potential program area varies from the level to slightly rolling gulf coast, to steep regions of the Cascades and Sierra Nevada. Elevations range from 24 m (80 ft) below sea level in the deserts of California to about 1,372 m (4,500 ft) in the southwestern Arizona Basin and Range ecoregion or slightly higher in the upper reaches of the Columbia River Basin. Soil reaction ranges from predominantly acid in the East to alkaline in the West. Introduced fruit fly populations would not be expected to survive or get established at high elevation. Degradation of residues from potential program pesticide applications would be expected to occur more rapidly at lower elevations. Varied topography and cropping patterns provide more host crops and microclimates that contribute to enhanced fruit fly survival and spread.

c. Water Resources and Quality

Water availability varies greatly across the potential program area, ranging from very abundant in Florida and the eastern gulf coast, to extremely scarce in the desert regions of the West. The more mountainous areas are characterized by natural lakes and large, deep reservoirs. Groundwater is abundant in the valleys and is used for irrigation and livestock production. Water supply is low to moderate in the prairie subregions. Surface lakes, shallow wells, and streams in these areas are used for irrigation and watering of animals. Intermittent waters, such as seasonally flooded impoundments, are important breeding grounds as well as migration stops for waterfowl and other wetland species. The southwest, intermountain areas, Sacramento Valley, and San Joaquin Valley are characterized by low precipitation and in constant water sources. Water for irrigation and livestock comes primarily from the few reservoirs and large rivers. Although the annual precipitation east of the Cascades in Washington is low, there is a constant source of available water from the mountains. Potential contamination of surface water and groundwater resources by program pesticides could pose a hazard to both wildlife and human populations. Because of agricultural and other uses, low-level background residues of certain pesticides in water are common in some areas. Therefore, cumulative effects of the program use of pesticides must be considered.

d. Air Quality

In general, the air quality of most of the potential program area is good. Most air pollution problems occur in industrialized and urban areas, particularly in the Eastern States. The air quality of most of the Western States is relatively good because of low population densities and lack of polluting industries. The major air quality problems that do occur in the West are confined to the urban areas of California (e.g., the Los Angeles Basin, the San Francisco Bay area, and Sacramento) and the smelter industrial areas of southeastern Arizona. Some undesirable conditions are also associated with agricultural activities and urbanization in central California. Release of radioactive particles from the U.S. Department of Energy's facilities in Hanford, Washington, has been an ongoing issue in the Columbia River Valley. Because of agricultural and other uses, low-level background residues of certain pesticides in air are common in some areas. Consequently, cumulative effects of the program use of pesticides must be considered.

Reduced air quality (smog) affects visibility, which is especially valued for some areas. The U.S. Environmental Protection Agency (EPA) has identified special class I areas (national parks and wilderness areas) and vistas outside Class I areas where visibility is an important value. The best visibility (more than 113 km or 70 mi) exists in the mountainous Southwest, while the Pacific coastal regions have the worst visibility (16 to 40 km or 10 to 25 mi). The potential for toxic air pollution resulting from agricultural and urban pesticide use remains a concern for the general public.

2. The Human Population

The human population of the potential fruit fly program area is extremely diverse (see table 4–8). The metropolitan areas are not homogeneous, but include human subpopulations with dissimilar compositions and social structures. That diversity is apparent, for example, when comparing the retirement communities of Florida, the Mexican-American communities of southern Texas, and the Asian-American communities of California. In addition, communities adjacent to metropolitan areas may include Native Americans, suburban families, and farmers. Depending on the

Table 4–8. Demographics of Potential Fruit Fly Program Areas by Ecoregion

Ecoregion	Statewide Data				Metropolitan Area Data			
	State	% <5 years old	% >65 years old	% population in metropolitan areas	Major city or metro area(s)	% Hispanic	% Asian	Per[1] capita income
California Central Valley and Coastal	CA	8.6	10.6	95.7	Los Angeles-Anaheim-Riverside	32.9	9.2	18,938
					San Francisco-Oakland-San Jose	15.5	14.8	22,438
					San Diego	20.4	7.9	17,576
					Sacramento	11.6	7.7	17,050
Southwestern Basin and Range	AZ	8.7	13.1	79.0	Phoenix	16.3	1.7	16,815
					Tucson	24.5	1.8	14,995
Lower Rio Grande Valley	TX	8.7	10.1	81.6	Brownsville-Harlingen	81.9	ND[2]	14,753
Southeastern and Gulf Coastal Plain	SC	7.5	11.1	60.6	Charleston	ND	ND	12,907
	GA	7.9	10.1	65.0	Savannah	1.4	1.1	15,280
	AL	7.2	12.7	67.4	Mobile	ND	ND	12,814
	MS	7.7	12.4	30.1	Biloxi	ND	ND	11,055
	TX	8.7	10.1	81.6	Houston[3]	20.8	3.6	16,129
Mississippi Delta	LA	8.3	11.1	69.5	New Orleans	4.3	1.7	14,034
Floridian	FL	7.0	18.0	90.8	Miami-Ft. Lauderdale	33.3	0.7	18,322
					Tampa-St. Petersburg-Clearwater	6.7	1.5	16,409
					West Palm Beach	7.7	1.0	16,515
					Orlando	9.0	1.9	16,525
Marine Pacific Forest	OR	6.9	13.9	68.5	Portland[4]	3.2	5.3	16,446
	WA	7.7	11.9	81.7	Seattle[4]	3.6	11.8	16,446

Source: U.S. Census Bureau, 1991.
[1] Data from 1988, in dollars. Data are statewide averages for Tucson, Brownsville-Harlingen, Charleston, Savannah, Mobile, Biloxi, and West Palm Beach (no metropolitan area data available).
[2] ND - No Data Available.
[3] The Houston data also include the Galveston-Brazoria metropolitan area, which is not in the potential program area.
[4] Portland and Seattle are part of the same metropolitan area for per capita income.

locale of future programs (hence, also community structure and activity), the exposure to fruit fly control activities could vary considerably.

The economic levels vary widely across the potential fruit fly program area as well. Within the potential program areas, the lowest per capita incomes are in South Carolina, Alabama, and Mississippi. Although per capita income in metropolitan areas is higher than statewide averages, every large city contains at least one area characterized by low-income residents; homeless people are more numerous in cities than in rural areas.

The general health of a human population may be influenced by the population's economic status in that low-income people are often not able to afford nutritious food and good health care. Studies have demonstrated that liver disease and protein or thiamine deficiency can increase sensitivity to the effects of organophosphate pesticides (Casterline and Williams, 1969; Cavagna *et al.*, 1969). Thus, populations prone to these conditions may be at greater risk than the general population. In general, differences in populations that influence individual's risks are generally compensated by the U.S. Environmental Protection Agency's use of "ten-fold safety factors" in risk assessments.

The diverse demographic and economic characteristics of the potential program area indicate the need for special considerations in carrying out program activities. These considerations relate primarily to issues related to Environmental Justice for minority and low income populations (refer to section VIII.E). Notification of treatment, an important aspect of the program, can be complicated by language differences. The higher percentages of Hispanic or Asian Americans in cities such as Brownsville, Texas, and San Francisco, California, suggest that notification and other public communication may need to be presented in languages other than English.

Other human factors such as age, income, health, and culture may pose problems that will require special program considerations in order to minimize exposure to pesticides and resultant risk. Certain segments of the population (such as some of the elderly and children) will be more sensitive to the program activities than the majority of the population. Generally, metropolitan areas can be expected to include populations with a lower-than-average income and therefore with less health care, as well as more homeless people. Nonurban populations with low income might have more reliance on backyard fruits and vegetables as a food source. Cultural practices are another consideration if the program expands beyond metropolitan areas into Native American lands (such as those surrounding San Diego, California or Phoenix and Tucson, Arizona); program activities could affect a population of low-income sustenance farmers whose exposure might be greater because of their cultural practices (i.e., use of wild food).

a. Cultural Resources

Cultural resources (see table 4–9) are those resources that contribute to intellectual or aesthetic education. Cultural resources include historic sites, archaeological sites, Native American lands, religious sites, zoos, and arboreta. Many such sites exist within the potential program area, but those most likely to be affected by fruit fly program actions are located closest to urban areas where program activities will most likely occur.

Table 4–9. Representative Cultural Resources of Potential Fruit Fly Program Areas by Ecoregion

Ecoregion	City and State	Representative Cultural Resources
California Central Valley and Coastal	Los Angeles-Anaheim-Riverside, CA	University of California Botanical Gardens, Los Angeles Zoo, Los Angeles Arboretum
	San Diego, CA	Quail Botanical Gardens, San Diego Zoo, Indian reservations
Southwestern Basin and Range	Phoenix, AZ	Westward Expansion historical sites, Indian reservations, Phoenix Zoo, Desert Botanical Garden
	Superior, AZ	Boyce Thompson Southwestern Arboretum
	Tucson, AZ	Spanish historical sites, Indian reservations, Desert Museum, Tucson Botanical Gardens
Lower Rio Grande Valley	Brownsville, TX	Palo Alto National Historic Site
Southeastern and Gulf Coastal Plain	Charleston, SC	Magnolia Plantations, Cypress Gardens, Fort Sumter and other Civil War historical sites
	Savannah, GA	Colonial and Civil War historical sites
	Mobile, AL	Historical sites
	Biloxi, MS	Historical sites
	Houston, TX	Houston Zoological Gardens
Mississippi Delta	New Orleans, LA	French historical sites, Longue Vue House and Gardens, Louisiana Nature Center
Floridian	Miami-Ft. Lauderdale, FL	Metro Zoo, Orchid Jungle, Fairchild Tropical Garden, Seminole Indian Village reconstruction, Butterfly World
	Tampa-St. Petersburg, FL	Gamble Plantation, Yulee Sugar Mill, De Sota National Monument, Weedon Island Indian Mounds
	Orlando, FL	Fort Mellon, Mead Botanical Gardens
Marine Pacific Forest	Portland, OR	Portland Zoo, Forest Hills Park
	Seattle, WA	Seattle Zoo, botanical gardens, parks and trails

Cultural resources of special concern with respect to pest eradication programs include zoos, arboreta, and gardens because they contain nontarget species. The Floridian and California Central Valley and Coastal ecoregions have a large number of such sites in metropolitan areas.

Historic, archaeological, and Native American sites are protected by the National Historic Preservation Act, the Archaeological and Historical Preservation Act, and the Native American Graves Protection and Repatriation Act. Furthermore, many Native American reservations are considered as sovereign nations and, therefore, fruit fly program activities would have to be coordinated with their councils or the equivalent.

b. Visual Resources

Visual resources (see table 4–10) consist of the landscapes and wildlife of a particular area. Natural visual resources are preserved in parks, forests, and wilderness areas. Most "scenic areas" are located some distance from urban centers; however, a few are near major cities in the potential fruit fly program area, and could be affected by program activities. For example, traps placed in city parks could detract from the appearance of blossoms or foliage; equipment noise (trucks, airplanes, or helicopters) could intrude upon otherwise peaceful areas; and bird watchers or other visitors to natural areas could become upset if wildlife species are affected by program activities or treatments.

3. Nontarget Species

The nontarget species of the potential program area include the plants, animals, and microorganisms that are found there. These organisms exist as individuals, populations, and multispecies communities. They are dynamic, interactive components of their ecosystems which undergo structural and functional change and vary with location and over time. A broad consideration of the biological environment promotes understanding of the biological systems which are exposed to program operations and facilitates a more detailed analysis of the organisms or systems which might be at risk from those operations.

a. Domestic Animal and Plant Species

Fruit fly eradication efforts typically occur in urban, suburban, and agricultural areas. Domesticated species which may be exposed to program operations include dogs, cats, tropical pet birds, and in some locations, livestock and poultry. Goldfish or koi ponds and stock ponds occur in some locales.

Table 4–10. Representative Visual Resources of Potential Program Areas by Ecoregion

Ecoregion	City and State	Representative Visual Resources[1]
California Central Valley and Coastal	Los Angeles-Anaheim-Riverside, CA	Cucamonga WA, San Gabriel WA
	San Diego, CA	Sweetwater Marsh NWR, Tijuana Slough NWR, Agua Tibia WA, Hauser WA, Pine Creek WA, San Mateo Canyon WA
Southwestern Basin and Range	Phoenix, AZ	Tonto NF
	Tucson, AZ	Saguaro WA, Coronado NF
Lower Rio Grande Valley	Brownsville, TX	Laguna Atascosa NWR
Southeastern and Gulf Coastal Plain	Charleston, SC	Cape Romain WA, Little Wambaw Swamp WA, Wambaw Creek WA
	Savannah, GA	Savannah NWR, Tybee NWR
	Mobile, AL	Bon Secour NWR
	Biloxi, MS	Deer Island
	Houston, TX	Sheldon WMA, Armond Bayou WMA
Mississippi Delta	New Orleans, LA	Bayou Sauvage NWR, Bohemia State Park WMA
Floridian	Miami-Ft. Lauderdale, FL	Biscayne NP, Everglades NP and WA, Hugh Taylor Birch SP
	Tampa-St. Petersburg, FL	Weedon Island Preserve, Pinellas NWR, Caladesi Island SP
	Orlando, FL	Clear Lake, Lake Fairview, other lakes
Marine Pacific Forest	Portland, OR	Columbia River, Williamette Valley, Mt. Hood
	Seattle, WA	Puget Sound, Lake Washington, Pacific Cascades, San Juan Islands

[1] Abbreviations: NF = National Forest, NP = National Park, NWR = National Wildlife Refuge, SP = State Park, WA = Wilderness Area, WMA = State Wildlife Management Area.

Commercial aquaculture enterprises may rear fish or crustaceans in natural or artificial impoundments and are of major regional importance.

Backyard gardens occur throughout the program area. Annuals (such as peppers and tomatoes) as well as perennials (such as citrus and avocado trees) are commonly grown. Many of these are fruit fly hosts. Commercial groves of host plants such as apricots, apples, peaches, pome fruits, and citrus are found throughout the program area. There are organic growers found at certain locations within the program area, and their needs are an important program consideration.

b. Wild Animal and Plant Species

The numbers and kinds of wildlife associated with particular habitats depend on the season and on land resources. Typical species include a variety of invertebrate fauna, birds (American kestrels, European starlings, barn swallows, meadowlarks, and other songbirds), mice and other rodents, rabbits, raccoons, skunks, opossums, foxes, bats, and in some areas, coyotes.

Throughout the program area, soil and sediment support a great diversity of organisms which may inhabit the surface layer, occur beneath leaf litter or detritus, or are distributed throughout several layers. Earthworms and microorganisms inhabit the soil; many insects spend portions of their life cycle as larvae or pupae in soil and sediments. These species provide food for a variety of fish, birds, and small mammals.

Water birds, including ducks, frequent lakes, ponds, and reservoirs throughout the program area. Introduced and native fish (including shiners, sunfish, bass, and catfish) occur in these water bodies as well as canals. Commercial and sport fishing occur throughout the program area.

Representative species for each ecoregion are presented in tables 4–11 through 4–17. A sampling of typical species is analyzed in the nontarget risk assessment (incorporated by reference). The assessment serves as the basis for an evaluation of potential environmental consequences of the fruit fly eradication program.

c. Habitats of Concern

Aquatic habitats within the program area are of special concern because of the vulnerability of aquatic species to program pesticides, especially malathion. These habitats support a variety of endangered and threatened species, particularly in the more arid program areas. Estuaries are spawning and nursery grounds for many marine and anadromous fish, as well as crustaceans and mollusks. They support a high density and diversity of birds, as well as plankton, which provides the base for many food webs. Sediments contain a variety of macroinvertebrate species, many of which are sensitive to program pesticides. In addition, intermittent streams and ponds are seasonally important as breeding and egg development habitat for amphibians, and as reservoirs for migratory waterfowl. These areas often contain a variety of rare plants.

There is some disagreement as to the precise definition of a jurisdictional (regulated) wetland. Whether broadly or narrowly interpreted, there is a consensus that wetlands are extremely valuable ecosystem components. They provide wildlife habitat, flood control enhancement, water quality improvement, sediment stabilization, nutrient transformation, and groundwater recharge/discharge. Degradation of water quality in any

Table 4–11. Biological Resources California Central Valley and Coastal Ecoregion

Habitat	Dominant Vegetation	Representative Mammals	Representative Birds	Other Nontarget Species	Significance/Status
Grassland	Brome, fescue, wild oats	Pocket gopher, California vole, mule deer, coyote, California ground squirrel, black-tailed jackrabbit	Western meadowlark, savannah sparrow, American kestrel, horned lark, western kingbird, killdeer	Gopher snake, grasshoppers, spiders	Valuable for wintering birds; introduced grasses predominate; converted to agriculture and rangeland
Scrubland	Interior: chamise, California lilac, toyon Coast: coyote brush, purple and black sage, coastal sagebrush, scub oak	Brush rabbit, brush mouse, dusky-footed wood rat, bobcat, gray fox	California quail, California thrasher, rufous-sided towhee, sage sparrow, wrentit	Western rattlesnake, coast horned lizard, alligator lizards, common kingsnake	Interspersed with urban areas near coast; development threatens southern sage scrub
Woodland	Valley oak, interior live oak, blue oak, coastline oak, California buckeye, Engelmann oak	Mule deer, raccoon, striped skunk, bobcat, western gray squirrel, deer mouse	Acorn woodpecker, plain titmouse, western bluebird, American crow, scrub jay	Arboreal salamander, slender salamanders, alligator lizards, western fence lizard, ring-necked snake	Variety of wildlife foods; some southern woodlands reduced by development
Aquatic	Fresh marsh: cattail, sedge, bulrush. Salt marsh: salt grass, pickleweed, frankenia	Muskrat, beaver	Great blue heron, red-winged blackbird, marsh wren, mallard, Virginia rail	Garter snakes, red-legged frog, western toad, Pacific tree frog, California newt, mosquitofish, California killifish, bluegill	Especially valuable for wintering waterfowl; coastal marshes sometime near urban areas

Table 4–12. Biological Resources Southwestern Basin and Range Ecoregion

Habitat	Dominant Vegetation	Representative Mammals	Representative Birds	Other Nontarget Species	Significance/Status
Mojave and Sonoran Deserts	Joshua tree, ocotillo, Mojave yucca, California juniper, saltbush, spiny sage brush, creosote bush, saguaro, cholla cactus, burro bush	Antelope squirrel, kangaroo rats, black-tailed jackrabbit, round-tailed ground squirrel, kangaroo rats, cactus mouse, desert mule deer, coyote, desert pocket mouse	Scott's oriole, white-winged dove, greater roadrunner, Gila woodpecker, cactus wren, LeConte's thrasher, common poorwill, Gambel's quail, elf owl	Chuckwalla, fringe-toed lizards, zebra-tailed lizard, side-blotched lizard, shovel-nosed snake, glossy snake, western whiptail	Slow to recover from disturbance, e.g., off-road vehicle use
Wash	Mesquite, catclaw acacia, smoke tree, blue palo verde, ironwood	Bailey pocket mouse, white-throated woodrat, javelina, mule deer, coyote	Black-throated sparrow, verdin, black-tailed gnatcatcher	Red-spotted toad, spadefoot toads, desert spiny lizard, brush lizard, horned lizards, tiger rattlesnake	Desert wildlife concentrates here
Riparian/aquatic	Willow, sycamore, cottonwood, saltcedar	Striped skunk, ring-tailed cat, raccoon, deer mouse	Summer tanager, Lucy warbler, ladder-backed woodpecker, yellow-billed cuckoo, green-backed heron, mallard	Western diamondback rattlesnake, spiny soft shell turtle, Colorado River toad, red-side shiner, Gila topminnow, bluegill	Little woodland remains--invaded by saltcedar; heavily used by wildlife; often near agricultural and urban areas

**Table 4–13. Biological Resources
Lower Rio Grande Valley Ecoregion**

Habitat	Dominant Vegetation	Representative Mammals	Representative Birds	Other Nontarget Species	Significance/Status
Mid-grass grasslands	Grama, three-awns, bluestems, curly mesquite, buffelgrass (introduced)	White-tailed deer, cotton rat, coyote, least shrew, Mexican ground squirrel, Eastern cottontail	Turkey, turkey vulture, bobwhite, scaled quail, mourning dove, great horned owl, meadowlark	Grasshoppers, spiders, Texas ratsnake, bullsnake	Little native grassland remains; converted to agriculture or rangeland uses; brush encroachment
Shrublands	Blackbush (acacia), mesquite, guajillo, granjeno, pricklypear, ceniza	Javelina, raccoon, white-tailed deer, Mexican spiney pocket mouse, striped skunk, jackrabbit, bats	Harris' hawk, scaled quail, white-winged dove, mourning dove, mockingbird, lesser nighthawk	Spotted whiptail, rose-bellied lizard, reticulate collared lizard, diamondback rattlesnake, Texas tortoise	Many community types--largely fragmented, some threatened; nesting sites; used by migratory raptors; wildlife corridors; refugia from disturbed sites; native citrus thicket (Starr County)
Riparian woodlands	Mesquite, granjeno, cedar elm, hackberry, acacias, many fruiting species	Bobcat, ocelot, raccoon, bats, white-footed mouse	Ferruginous pygmy owl, orioles, mourning dove, chachalaca, green jay, kingfishers, warblers, boat-tailed grackle	Giant toad, Rio Grande leopard frog, Texas indigo snake, blue tilapia (introduced), killifish, catfish, green sunfish	Variety of wildlife foods; roosting and feeding areas; only occurrence of many species in the United States; unique biota in aquatic habitats
Seasonally wet basins and potholes	Granjeno, huisache, mesquite, pricklypear, Texas persimmon	Ocelot, jaguarundi	White-winged dove, white pelican, sandhill crane, black-bellied tree duck	Reticulate collared lizard, Texas tortoise	Wintering waterfowl habitat; habitat for many Texas rare and threatened species

Table 4–14. Biological Resources
Southeastern and Gulf Coastal Plain Ecoregion

Habitat	Dominant Vegetation	Representative Mammals	Representative Birds	Other Nontarget Species	Significance/Status
Alluvial and floodplain	Bald cypress, swamp gum, tupelo, swamp nettle	Otter, muskrat, raccoon	Red-eyed vireo, wood duck, pied-billed grebe	Many insects, eastern mud turtle, marbled salamander, ratsnake	Flood control; high density of nesting birds and amphibians
Marsh	Cordgrass, rushes, sedges, wild rice, some shrubs	Muskrat, marsh rice rat	Herons, egrets, ducks, common gallinule	Many insects and other invertebrates	Rookeries, fish nurseries
Pine forest	Species of pine, bay, blueberry, spicebush, hydrangea	Opossum, white-tailed deer, gray squirrel, short-tailed shrew, striped skunk, raccoon, big-eared bat, red fox	Long-eared owl, pine warbler, red-cockaded woodpecker	Tiger salamander, box turtle, coral snake, gopher tortoise	Cover and nesting sites; few old growth forests remain, most are intensively managed
Hardwood forest	Species of oak, gum, hickory, elderberry, greenbriar, ferns	Opossum, white-tailed deer, gray squirrel, short-tailed shrew, striped skunk, raccoon, big-eared bat, red fox	White-eyed vireo, blue jay, great-crested flycatcher, wood duck, red-tailed hawk, cardinal		
Grassland	Species of bluestem or panic grass	Ground squirrel, cottontail, plains woodrat	Common nighthawk, eastern meadowlark, bobwhite, killdeer, scissor-tailed flycatcher, mockingbird	Many insects	Undisturbed grasslands very rare

Table 4–15. Biological Resources Mississippi Delta Ecoregion

Habitat	Dominant Vegetation	Representative Mammals	Representative Birds	Other Nontarget Species	Significance/Status
Salt marsh	Smooth cordgrass, wire grass, salt grass, black rush	Muskrat, otter, Norway rat	Marsh hawk, pintail, common loon, white pelican	Gulf salt marsh snake, gulf coast toad, diamondback terrapin	Feeding grounds for nesting and migrating birds; fish nursery
Fresh/brackish marsh	Maidencane, bulltongue, spike rush, alligator weed	Nutria, harvest mouse, rice rat	Scaup, teal, widgeon, gadwall, shoveler, mottled duck	Green treefrog, green anole, green frog	Feeding grounds for nesting and migrating birds
Bottomland hardwood	Water oak, overcup oak, bitter pecan, green ash, hawthorns	White-tailed deer, opossum, cottontail	Wood duck, red-shouldered hawk, turkey vulture	Three-toed box turtle, Mississippi ring-necked snake	Very high nesting density; habitat for large mammals
Swamp	Southern cypress, bald cypress, pond cypress, tupelo, black willow, swamp gum, cottonwood, button bush, swamp privet	Mink, bobcat, swamp rabbit, red bat	Great blue heron, great egret, anhinga, white ibis, Louisiana heron	Western cottonmouth, green anole, bronze frog, alligator	Rookeries for herons and egrets
Levee	Water oak, live oak, hackberry, American elm, honeylocust, hawthorn, marsh elder, groundsel bush	Rice rat, fulvous harvest mouse, least shrew		Bronze frog, ribbon snake, narrow-mouthed toad	Refuge during flooding; dry land corridors

Table 4–16. Biological Resources Floridian Ecoregion

Habitat	Dominant Vegetation	Representative Mammals	Representative Birds	Other Nontarget Species	Significance/Status
Cypress swamps	Cypress, longleaf pine, slash pine, sabal palm	Cotton mouse, raccoon, shrews	Wood stork, herons, Everglades snail kite, turkey, warblers, bald eagle	Alligators, spiders, aquatic invertebrates	More rare or endangered species found in Cypress Swamps than any other Florida swamp; Florida panther habitat
Freshwater marshes	Pickeral weed, beakrush, maidencane, sawgrass	White-tailed deer, Florida water rat	Egrets, wood stork, ducks, Florida sandhill crane	Apple snail, amphipods (scuds), prawns, catfish, alligator	
Lakes, rivers, canals	Water hyacinth, cattails, eelgrass, pondweed	Raccoon, river otter, manatee	Kingfisher, herons, egrets, anhinga	Zooplankton, snails, clams, gar, catfish, suckers, silversides, minnows, sunfish	
Mangroves	Black mangroves, red mangrove, white mangrove, buttonwood	Raccoon, river otter, striped skunk, black bear, manatee	Brown pelican, spoonbill, wood stork, egrets, herons	Tarpon, mullet, snappers, shrimp, sea turtles, American crocodile	Nursery area for many commercial fish species
Salt marshes	Saltmarsh cordgrass, saltbush	Raccoon, marsh rabbit, cotton rats, bottlenose dolphin, rice rat	Common egret, swallows, marsh wren, seaside sparrow	Fiddler crab, shrimp, marsh crab, grasshoppers, plant hoppers, spiders, diamondback terrapin	Nursery area for many fish species
Pine flatwoods	Longleaf pine, slash pine, wax myrtle, saw palmetto	White-tailed deer, cotton mouse, cotton rat, gray fox, fox squirrel	Brown-headed nuthatch, pine warbler, great horned owl	Box turtle, black racer, pinewoods snake, anoles	
Scrub	Scrub oak, saw palmetto, myrtle oak, sand live oak, Florida rosemary	Flying squirrel, Florida mouse, cotton mouse, bobcat, gray fox, white-tailed deer	Florida scrub jay, bobwhite, common nighthawk, palm warbler, woodpeckers, screech owl	Florida scrub lizard, blue-tailed mole skink, gopher tortoise, sand skink	40 to 60% of the species are endemic
Dry prairies	Switch grass, saw palmetto, wiregrass, gallberry	Cotton rat, nine-banded armadillo, Eastern harvest mouse, Eastern spotted skunk	Florida sandhill crane, common nighthawk, vultures, burrowing owls, crested caracara	Box turtle, black racer	

Table IV-16 , continued.

Habitat	Dominant Vegetation	Representative Mammals	Representative Birds	Other Nontarget Species	Significance/Status
Rocklands	Gumbo limbo, pigeon plum, royal palm, live oak, strangler fig, wild coffee	Opossum, key deer, Florida mastiff bat, mangrove fox squirrel, white-tailed deer, raccoon	Northern cardinal, gray kingbird, Carolina wren, red-bellied woodpecker, pine warbler	Florida tree snail, Schaus swallowtail, anoles	Many tropical species only found in this habitat of the United States
Coastal dunes	Sea oats, sea lavender, saltbush	Marsh rabbit, rice rat, raccoon, cotton rat	Seaside sparrow, marsh wren, wading birds, fish crow	Sea turtles, diamondback terrapin, marsh crab, fiddler crab, grasshoppers, mollusks	

Table 4–17. Biological Resources Marine Pacific Forest Ecoregion

Habitat	Dominant Vegetation	Representative Mammals	Representative Birds	Other Nontarget Species	Significance/Status
Grassland	Needle and thread grass, bunchgrass, wheatgrass, downy brome	Mule deer, rabbits, coyote	Western meadowlark, grouse, mourning dove, American kestrel, western kingbird, killdeer	Gopher snake, grasshoppers, spiders	Valuable for wintering birds; introduced grasses predominate; converted to agriculture and range land
Woodland	Western redcedar, hemlock, Douglas-fir	Western gray squirrel, opossum, black-tailed deer, deer mouse, bobcat	Western bluebird, American crow, scrub jay	Western rattlesnake	Variety of wildlife foods; strong lumber industry
Alluvial and floodplain	Willow, cottonwood, cattail, sedge, bulrush	Muskrat, beaver, mink	Great blue heron, mallard duck, red-winged blackbird	Garter snake, Western toad, Pacific tree frog, bluegill, mosquitofish, rainbow trout	Especially valuable for wintering waterfowl; coastal marshes near urban areas

aquatic or wetland habitat could disrupt food webs and have serious implications for composition, density, and diversity of invertebrate, fish, and bird species.

The Eastern coastal plain wetlands have been designated by the U.S. Department of the Interior's Fish and Wildlife Service (FWS) as Habitats of Special Concern because of their value to migrating birds and as breeding grounds for shorebirds. As a whole, the Mississippi Delta is adversely affected by the high rates of erosion and submergence caused, in part, by human alteration of the natural drainage systems. The wetlands of the delta are designated as Habitats of Special Concern for waterfowl.

Much of the southern tip of Florida is occupied by Everglades National Park, Big Cypress National Preserve, and several smaller State and private wildlife refuges. The Everglades' ecosystem is unique in North America and many species are threatened or endangered. Water management projects have altered the timing and quantity of freshwater flow, and preservation of the Everglades' ecosystem relies on the supply of high-quality water from the north. Runoff from adjacent agricultural and urban areas can enter the water conservation areas and contaminate water in the park with high concentrations of nutrients and pesticides.

Wildlife refuges and other land preserves are also areas of potential concern. These lands have been set aside to protect wildlife resources and often become islands surrounded by altered, intensely managed land. Generally comprised of many habitat types, they serve as refuges for less common species, provide wildlife corridors, and are important habitats for migratory birds. Nature Conservancy lands are protected because they contain unique features, which often includes rare plants. Impacts to these habitats could affect many species.

The Laguna Atascosa National Wildlife Refuge in eastern Cameron County, Texas, on the gulf coastal plain, is the southernmost waterfowl refuge in the central flyway, and is a primary overwintering area. It is the focal point for the recovery of the endangered northern aplomado falcon. FWS has issued a Biological Opinion that the use of chlorpyrifos, diazinon, and several other pesticides will jeopardize the continued existence of this species. As a result, FWS has recommended a 20-mile prohibited-use zone around the refuge for these pesticides.

In addition to national- or State-protected areas, many areas of considerable importance are not afforded protection. An example of an unprotected area is the Colorado River in Yuma County, Arizona, which is known internationally as a prime bird watching location. Many such locations occur throughout the program area.

The Columbia River Basin and the tributaries of Puget Sound in Washington State are also important wildlife habitats. The damming and diversion of water on the Columbia River have threatened the survival of several species of anadromous fish, particularly salmon.

d. Endangered and Threatened Species

Various species of fish, wildlife, and plants in the United States are so few in number that they are in danger of or threatened with extinction. The decline of most of these species is directly related to loss of a habitat, but may also be the result of other factors including hunting, collecting, pollution, road kills, interspecies competition, or pesticides. (Refer to appendix D for a listing of species in potential program areas.) More than 200 federally listed species are found within the potential program area; they include plants, birds, fish, mammals, amphibians, reptiles, and at least one insect.

The Endangered Species Act of 1973 (ESA) as amended (16 U.S.C. 1531 *et seq*.) mandates the protection of federally-listed endangered and threatened species and their critical habitats. It also requires Federal agencies to consult with FWS or the U.S. Department of Commerce's National Marine Fisheries Service (NMFS) to ensure that any actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species or a species proposed for listing, or result in the destruction or adverse modification of its critical habitat or its proposed critical habitat. Also, the United States Environmental Protection Agency has the authority to require that pesticide labels comply with requirements of ESA.

Because of the existence of endangered or threatened species found within fruit fly program areas, APHIS consults with FWS. For the Medfly Cooperative Eradication Program, for example, APHIS prepared a biological assessment (incorporated by reference) for endangered and threatened species to determine if those species may be affected, either directly or indirectly, by program operations (especially those related to pesticide usage).

For the Fruit Fly Cooperative Control Program, which has even broader scope than the Medfly Cooperative Eradication Program (all 50 of the United States are subject to fruit fly infestations from one or more species), the potentially affected endangered and threatened species include all of those species which are federally listed for the entire United States. APHIS presently is consulting with FWS and NMFS for the States which are at the highest risk of fruit fly infestations: California, Florida, Texas, and Washington. In consultation with FWS and NMFS, APHIS is determining which control methods may be used safely within the range and habitats of the endangered and threatened species. If fruit fly infestations are detected in other States, individual site-specific consultations with FWS will take place to ensure protection of the species. APHIS will abide by protection measures for endangered and threatened species that are developed in cooperation with FWS and/or NMFS. Such consultations and any relevant protection measures will be finalized before program operations are initiated.

V. Environmental Consequences

A. Introduction

1. General Approach

The environmental consequences of the Fruit Fly Cooperative Control Program result from or are related to program actions (especially program use of chemical control methods). This chapter focuses on the potential effects of chemical control methods, and analyzes potential effects of nonchemical and chemical methods on: the physical environment, human health and safety, biological resources, socioeconomics, and cultural and visual resources. Control methods are individually analyzed and discussed, but a section on cumulative effects contains information on potential effects of the combined use of control methods. Refer also to chapter III, Alternatives, which characterizes program alternatives and control methods in detail.

2. Risk Assessment Methodology

The potential environmental consequences were analyzed qualitatively and quantitatively. Chemical control methods were quantitatively assessed in a human health risk assessment (APHIS, 1998a) and a nontarget risk assessment (APHIS, 1998b), incorporated by reference. More recently, a human health risk assessment (APHIS, 1999a) and a nontarget risk assessment (APHIS, 1999b) were completed for spinosad bait spray applications and these documents are also incorporated by reference. All control methods were qualitatively assessed. Findings of these analyses are summarized within this chapter.

Classical risk assessment methodologies (NRC, 1983) were used for both the human health and nontarget risk assessments. Using the guidelines provided by National Research Council, the risk assessments employ existing government risk assessments and risk assessment methodologies, where possible, to avoid a duplication of effort, capitalize on the expertise of other organizations, and allow a more concise document. Each risk assessment had the following components: hazard assessment; exposure analysis (and dose-response assessment for quantitative risk calculations); and risk assessment characterization. The risk assessments are not predictive of what *will* occur, but rather what *could* occur in a program. The characterizations of risk that are determined assume the usage of control methods in specific ways and under certain circumstances. The assumptions involve reasonably foreseeable events and represent most possible exposures. Based on actual program operations and observed results, the results of these assessments should be considered to be conservative (tending to err on the side of higher rather than lower risk). The probability of the occurrence of the analyses' results cannot be determined. More detailed discussions of the methodology are in the human health and nontarget risk assessments (APHIS, 1998). A review of the general approach follows.

a. Hazard Assessment

The hazard of each chemical to either humans or nontarget species was assessed by reviewing toxicity studies of species that best simulated the physiology and behavior of humans or other nontarget species under evaluation. Benchmark or reference toxicity values used in the risk characterization were identified from acute exposure studies for the nontarget species and from acute, subchronic, and chronic exposure studies for humans.

Laboratory toxicity studies provide the basis for assessing quantitatively the hazard of a chemical. These studies use a variety of concentrations and formulations. Very few toxicity studies have been conducted with the exact formulations used in APHIS fruit fly programs. Hazard is, therefore, based on toxicity information available for each chemical to approximate toxicity of the specific formulations.

b. Exposure Analysis

Specific scenarios based on the program application methods, chemical concentrations, and exposed populations were developed to estimate exposures. To assess the plausible ranges of potential exposure, certain conditions within each scenario were varied to account for routine, extreme, and (for humans) accidental exposures. After environmental concentrations were estimated through the use of models or based upon application rates, dose estimates for the individual human or nontarget species were calculated, considering oral, dermal, and inhalation routes of exposure.

Because this analysis considered (from a programmatic perspective) scenarios incorporating control methods that could be used across the broad program area, its routine scenarios are very conservative and tend to overestimate the actual exposure for specific scenarios.

c. Risk Assessment

The quantitative risk assessments are based on methodologies and models detailed in sections C ("The Human Population") and D

("Nontarget Species") of this chapter. Results of these analyses were compared with actual fruit fly program data when these data were available. In the human health risk assessment, the calculated dose estimates were compared with the reference or benchmark toxicity values to express the level of concern for a particular exposure scenario or set of scenarios. The risk to an individual was determined by comparing the estimated dose and the reference or benchmark value. The magnitude of this ratio indicated the degree of risk. Risks to nontarget species were estimated for the population as a whole rather than individual organisms.

d. Computer Modeling

Computer models were used to estimate the concentrations of pesticides in the environment and exposure to humans and nontarget species. The environmental fate models provided estimates of pesticide concentrations in air, soil, water, and on vegetation. A model developed by USDA's Forest Service, the Forest Service Cramer Barry Grim (FSCBG) model, was used to estimate bait spray residues from drift on soil and vegetation outside the treatment area.

The Groundwater Loading Effects in Agricultural Management Systems (GLEAMS) model was used to estimate pesticide concentrations in soil, runoff water, and groundwater. Environmental Services (ES) of APHIS developed a surface water model that was used to estimate bait spray concentrations in aquatic systems. Estimated environmental concentrations from these models and other sources were used in the exposure models. APHIS extrapolated from field measurements (Segawa *et al.*, 1991), made adjustments to the application rate, and used the Environmental Protection Agency (EPA) pesticide monograph (Urban and Cook, 1986) to estimate environmental concentrations in air and on vegetation.

Models and equations used in the human health risk assessment to estimate exposure and dose were based on methodologies developed and used by EPA to assess risk for chemicals under that agency's regulatory authority. APHIS developed two exposure models for its previous nontarget risk assessment (APHIS, 1992b): one for terrestrial organisms and another for aquatic species. These models are discussed in section D ("Nontarget Species") of this chapter.

e. Information Data Gaps

New data and more complete information are regularly obtained by APHIS about the program chemicals and application methods through independent researchers and monitoring data. This information is incorporated into risk analyses and applied to environmental assessments prepared for site-specific programs as it is made available.

The chemical pesticides used in APHIS programs are regulated by EPA. EPA has responsibility for pesticide registration and reregistration under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA, as modified by the Food Quality Protection Act of August 1996 (FQPA)). A variety of data, including product and residue chemistry, environmental fate, and human, wildlife, and aquatic toxicity, are required for this process (see 40 CFR 158). EPA uses these data to make regulatory decisions concerning these pesticides.

Data gaps (deficiencies) have been identified by EPA either because registration requirements have changed or because previously submitted data have been ruled inadequate under current registration guidelines. In some cases, data have been submitted since the document and are under review by EPA.

Data considered inadequate for registration purposes, or data not submitted to EPA but available through the literature or other sources, may be adequate to provide indications of potential environmental effects. Because all data needed for a complete evaluation were not available, APHIS used the available data and made extrapolations when necessary. State and/or Federal supplementary or emergency exemptions may be required to allow the use of some pesticides in the Fruit Fly Cooperative Control Program. Under FIFRA, EPA grants emergency exemptions (section 18) or special local need uses (section 24(c)). These registrations may be required for bait spray applications, soil drenches, fruit fly male annihilation treatments, and certain regulatory uses of methyl bromide because the program uses are relatively minor uses which have not justified the manufacturers to seek the costly and time-consuming regular registrations. Such registrations have been issued for earlier eradication efforts, but must be renewed periodically.

B. The Physical Environment

The program control methods were compared with respect to their potential to affect environmental quality. The concerns over environmental quality include issues related to the preservation of clean air, pure water, and a pollution-free environment.

The primary environmental quality impacts from fruit fly programs relate to the use of various control methods. In particular, the use of chemicals has multiple issues that relate directly to environmental quality. The primary issues related to environmental consequences of control methods on the physical environment are discussed by method in this section.

1. Non-chemical Control Methods

This section presents the potential effects of the nonchemical treatment methods on the physical components of the environment qualitatively.

a. Sterile Insect Technique

The release of sterile insects is not expected to directly impact soil, water, and air resources because their relatively small biomass is not anticipated to contaminate those environmental media to any great extent. Burial or disposal of debris (paper bags and release cups) associated with sterile insect technique (SIT) has little potential to result in soil disruption. Waste products associated with sterile insect production are disposed of in compliance with local laws and regulations.

Effects from SIT operations are not expected to greatly exceed the impacts associated with routine procedures that growers or homeowners use during planting, gardening, yard maintenance, or waste disposal operations. Only minor soil impacts will result from vehicular and foot traffic associated with monitoring of traps used with this technique.

(If SIT is used in combination with chemical control methods as a part of integrated control, then the risks associated with the use of those chemicals would also apply.)

b. Physical Control

Physical control methods (fruit stripping and host removal) may result in some soil disruption. Such activities also may increase soil erosion by removing protective plant material. In the southwest and western program areas where little natural vegetative cover exists, soil disturbances may be exacerbated by runoff during heavy winter rainstorms. Additionally, soil disturbance may also limit or disrupt populations of soil microorganisms because of soil desiccation or erosion.

These potential effects from physical control methods are not expected to exceed the impacts upon soil, air, or water resources associated with routine procedures that growers or homeowners use during planting, gardening, or yard maintenance operations.

c. Cultural Control

Clean culture, or complete harvesting, of fruit fly hosts would not result in effects on soil, water, or air resources or quality. Burial of host material would be in existing approved landfills and would not be expected to result in any measurable increased impact to those facilities. Soil disturbance may limit or disrupt populations of soil microorganisms because of soil desiccation or erosion. Most other cultural practices, including crop in rotations or trap crops, are not applicable to fruit fly eradication programs.

d. Biological Control

Although biological control has potential for the future, biological control of fruit flies has not yet been proven logistically or technologically feasible on any scale. Therefore, information on biological control agents' potential effects upon land, water, or air resources and quality is unavailable at this time.

e. Biotechnological Control

Biotechnological control methods are currently under development and are not available for program use at this time. Because the circumstances surrounding their uses are uncertain, information on their potential effects upon land, water, or air resources and quality cannot be determined at this time.

f. Cold Treatment

All cold treatments are conducted in approved facilities under strict supervision. This treatment is only applicable to certain approved commodities. The necessary restrictions (duration of treatments and approval of facilities) and availability of facilities for cold treatment are likely to continue to limit the use of this treatment. The impacts on the physical environment would not be expected to differ from those resulting from cold storage facilities of comparable size. The use of cold treatment is expected to have negligible environmental impact to soil, water, or air resources or quality.

g. Irradiation Treatment

Irradiation treatments are conducted in approved facilities in accordance with stringent safety guidelines. This treatment method is limited to use on certain approved commodities that are compatible with the radiation exposure. Other commodities could be destroyed or ruined by this exposure. The irradiation equipment is designed to release radiation to the regulated commodity only. Monitoring of radiation at facilities has demonstrated low ambient background radiation levels at plant boundaries; any stray radiation from proper equipment use is negligible. The treated commodity does not retain any radioactivity from the exposure. Irradiation equipment at approved facilties is checked on a regular basis by the USDA Radiation Safety Staff in accordance with standards set by the Nuclear Regulatory Commission. No problems have been associated with the use of irradiation equipment under APHIS permits. Therefore, the use of irradiation treatment is expected to have negligible impact on the physical environment.

h. Vapor Heat Treatment

All vapor heat treatments are conducted in approved facilities under strict supervision. This treatment is only applicable to certain heat tolerant commodities. The necessary restrictions (duration of treatments and approval of facilities) and availability of facilities for vapor heat treatment are likely to continue to limit the use of this treatment. The use of vapor heat treatment is expected to have negligible environmental impact to soil, water, or air resources or quality.

2. Chemical Control Methods

The chemicals proposed for use in the Fruit Fly Cooperative Control Program have potential to affect soil (land), water, and air. These effects are minimized by the low application rates, the standard program protective measures (see section 6.B), and the program mitigative measures.

a. Bait Spray Applications

The effects of bait spray applications would not differ greatly between aerial and ground applications. However, the greater precision of ground-based applications would lead to reduced exposure of soil, water, and air, with a subsequent reduction in residues. Aquatic habitats have fewer impacts from ground applications because they are not being sprayed directly. Modeling predicted runoff from ground applications of malathion in only Ecoregion 5—Mississippi Delta (5.4 µg/L) and Ecoregion 6—Floridian (5.1 µg/L).

Application rates of SureDye are higher in ground applications than those in aerial applications. Although SureDye has a lower application rate than malathion, it is more water soluble. Modeling also predicted runoff from ground applications of SureDye in the Floridian ecoregion (6) (4.9 µg/L phloxine B) and in the Mississippi Delta ecoregion (5) (6.2 µg/L phloxine B). Spinosad has a lower application rate than malathion, but is not highly water soluble like SureDye. Modeling predicted runoff from ground applications of spinosad in the Floridian ecoregion (6) to be 0.0247 µg/L and in the Mississippi Delta ecoregion (5) to be 0.0466 µg/L. Minor soil and vegetation disturbance could result from ground applications that use the truck-mounted equipment. Although targeting is more precise with ground applications, failure to detect or treat host material jeopardizes program efficacy and may result in subsequent need for aerial applications, with increased potential for environmental consequences. The discussions that follow all relate principally to the consequences of aerial applications, but statements regarding half-life and degradation pertain to both aerial and ground applications.

(1) Malathion

(a) Land Resources

The character of a soil is dependent not only upon its physical and chemical components, but also upon the presence of microorganisms. The persistence of malathion bait in soil is related to a variety of factors, including the soil's microbial activity, pH (relative acidity), and organic matter content. Malathion's half-life in natural soil ranges from less than 1 day to 6 days, with 77 to 95% of the degradation occurring through microbial activity (Neary, 1985; Walker and Stojanovic, 1973). In laboratory studies, malathion toxicity to nitrifying bacteria was variable, with malathion causing slight toxicity to *Nitrobacter* sp., while causing complete inhibition of *Nitrosomonas* sp. (Bollen, 1961; Garretson and San Clemente, 1968). Malathion applied to soils did not affect the growth of several fungi or their ability to degrade other pesticides (Anderson, 1981). Malathion application to a forested watershed resulted in no observed effects on bacteria or fungi (Giles, 1970).

Inorganic degradation of malathion may be more important in soils that are relatively dry, alkaline, and low in organic content, such as those that predominate in the Western program areas. Malathion is subject to hydrolysis under neutral and alkaline conditions, but is more stable under acidic conditions. It does not penetrate much beyond the soil surface and does not adsorb tightly to inorganic soil particles, although it binds tightly with organic matter (Jenkins *et al.*, 1978). Adsorption to organic matter and rapid degradation make it unlikely that detectable quantities of malathion would leach to groundwater (LaFleur, 1979; HSDB, 1991). Because of agricultural and other uses, low-level background residues of malathion may occur in certain areas.

Malathion degradation products also have short half-lives. Malaoxon, the major malathion degradation product of concern in soil, has half-lives of 4 and 5 days in soils of pH 7.2 and 8.2, respectively (Pascal and Neville, 1976).

Environmental fate modeling using FSCBG predicts detectable malathion bait spray residues as far as 12 miles (mi) from the treatment block in high winds (10 miles per hour (mph)) and high release heights (500 feet (ft)). With lower wind speeds (5 mph) and release heights (200 ft), detectable residues (1 microgram per square foot (1 $\mu g/ft^2$)) were predicted up to 3 ½ mi from the treatment block. Using GLEAMS, predicted concentrations of malathion in the upper centimeter of soil were highest immediately following application, and ranged from a high of 0.34 micrograms per gram (µg/g) for the Lower Rio Grande Valley ecoregion (3) to a low of 0.30 µg/g for the Southeastern and Gulf Coastal Plain ecoregion (2). Following a rainstorm, the concentration of malathion would be expected to decrease in the upper 1 centimeter (cm) of soil, but increase slightly in the lower soil layers.

(b) Water Resources and Quality

Surface water contamination may occur from direct applications or runoff from treated plants and soils, particularly if a rainfall occurs soon after application. The half-life of malathion on foliage ranges from 1 to 6 days (Matsumara, 1985; Nigg *et al.*, 1981; El-Refai and Hopkins, 1972). Degradation of malathion in water is mostly by photolysis (decomposition induced by light), microbial degradation under acidic conditions, and chemical transformations under alkaline conditions (Wolfe *et al.*, 1977). The half-life of malathion in water with pH values from 5 to 8 ranges from 6 to 18 days (Paris and Lewis, 1973). The half-life was calculated from program monitoring data for natural waters during the 1997 Medfly Cooperative Eradication Program in Florida (USDA, APHIS, 1997). The half-life of malathion was determined to be 8 hours in a retention pond and 32 hours in the Hillsborough River.

Half-life in seawater at pH 8 was 2.6 days (Horvath, 1982). Malathion in chlorinated swimming pool water degrades readily to the more toxic metabolite malaoxon (Oshima *et al.*, 1982j; Segawa *et al.*, 1991). The half-life of malaoxon in chlorinated swimming pool water depends upon weather conditions. Malaoxon was determined to have a half-life of 37 hours in one California study of chlorinated swimming pool water (CDFA, 1991), but more recent monitoring data for the Florida program in Umatilla found a half-life of 7.4 hours (USDA, APHIS, 1998). Monitoring of four aerial bait spray applications in the 1991 study showed no cumulative concentrations of malathion or malaoxon in fresh water or chlorinated swimming pools. Because of agricultural and other uses, low-level background residues of malathion may be present in water in certain areas.

Various sources have set different water quality criteria for malathion in freshwater and saltwater habitats. EPA's chronic water quality criterion for malathion is 0.1 µg/L (equivalent to 0.1 part per billion) for both fresh water and salt water. This criterion is near or below the limit of detection for malathion using standard analytical techniques. By comparison, the California Department of Fish and Game (CDFG) water quality criteria for malathion (based on acute exposure) are 3.54 µg/L for freshwater and 10 µg/L for saltwater. The criteria for aquatic life are quite a bit lower than for human drinking water—the California Department of Health Services (CDHS) has established a Health Advisory Level of 160 µg/L for malathion in human drinking water.

Some directly sprayed water within the treatment area could have malathion concentrations exceeding the EPA chronic freshwater and saltwater criteria immediately following malathion aerial bait application. The concentrations of malathion in unprotected freshwater bodies immediately after treatment during the 1997 Cooperative Medfly Eradication Program in Florida ranged from below the detection limit (less than 0.1 ppb) to 460 ppb (USDA, APHIS, 1997). Environmental fate modeling predicted that in directly sprayed water bodies greater than 6 ft deep, malathion concentrations immediately after spraying were 11 µg/L or less. Shallow water bodies were estimated to have higher concentrations (e.g., greater than 64 µg/L in water less than 1 ft deep). The modeling data are consistent with monitoring data from past programs. Malathion concentrations in aquatic habitats would decrease readily over time because of the chemical degradation, biological metabolism, and water flow into and out of the water body. Modeling predicts that malathion concentration decreases rapidly in flowing water and in water bodies with drainage outlets. For shallow water bodies in which CDFG water quality criteria may be exceeded for a short time, natural degradation processes make it unlikely that chronic exposures could result from program activities.

(c) Air Quality

Because of malathion's low volatility, high concentrations are unlikely to be detected in air. However, because of agricultural and other uses, low-level background residues of malathion may be present in the air at certain locations. The California Department of Food and Agriculture has documented malathion residues in the air of several urban cities that arise from non-government use of the pesticide. The atmospheric vapor phase half-life of malathion is 1.5 days (HSDB, 1990).

Criteria pollutants (pollutants for which maximum allowable emission levels and concentrations are enforced by State agencies) will be produced by internal combustion engine fuel consumption during control activities. Effects will be localized and minimal compared with vehicular activities in urban areas.

(2) Spinosad

(a) Land Resources

The persistence of spinosad bait in soil is related to a variety of factors, including the soil's microbial activity and organic matter content. Spinosad exposed to sunlight on the surface of soil can be expected to degrade readily with a half-life from 8.68 days for spinosyn A to 9.44 days for spinosyn D (Dow Agrosciences, 1998). The residues in bait could persist longer (protected from sunlight), but degradation would be rapid when exposed to precipitation and weathering. Although spinosyn A is highly water soluble, it has a high octanol/water partition coefficient that results in strong adsorption to organic matter (Borth *et al.*, 1996). Spinosyns A and D are immobile in soil and will not leach into groundwater (EPA, 1998). The half-lives in pre-sterilized soils were substantially longer than in unsterilized soils and the degradation in soils has been largely attributed to microbial action (Hale and Portwood, 1996).

Environmental fate modeling using GLEAMS predicted concentrations of spinosad in the upper centimeter of soil were highest immediately following application. Spinosad concentrations ranged from a high of 0.0006 μg/g for the Floridian ecoregion (6) to a low of 0.0004 μg/g for the California Central Valley and Coastal ecoregion (1). The strong adsorption to organic matter in soil would prevent movement into lower soil layers.

(b) Water Resources and Quality

Surface water contamination may occur from direct applications or runoff from treated plants and soils, particularly if a rainfall occurs soon after application. The degradation of spinosad is rapid, particularly in the presence of sunlight. The half-life of spinosad on foliage of cotton was determined to be 3.4 hours. Degradation of spinosad in water is mostly by photolysis (decomposition induced by light) and the half-life in tap water under sunlight was determined to be less than a day (Borth *et al.*, 1996).

Environmental fate modeling predicted that in directly sprayed water bodies greater than 6 ft deep, spinosad concentrations immediately after spraying were 0.016 µg/L or less. Shallow water bodies were estimated to have higher concentrations (e.g., 0.102 µg/L spinosad in water less than 1 ft deep). Modeling predicts that spinosad concentrations decrease rapidly in flowing water and in water bodies with drainage outlets. For shallow water bodies, natural degradation processes make it unlikely that chronic exposures could result from program activities.

(c) Air Quality

Because of low volatility (low vapor pressure), high concentrations are unlikely to be detected in air. Sunlight exposure of spinosad is expected to result in rapid photodegradation. This rapid degradation in sunlight indicates that residues will not persist in the atmosphere. Any drift from aerial applications would be expected to readily deposit on surfaces of leaves or soil.

Criteria pollutants (pollutants for which maximum allowable emission levels and concentrations are enforced by State agencies) will be produced by internal combustion engine fuel consumption during control activities. Effects will be localized and minimal compared with vehicular activities in urban areas.

(3) SureDye

(a) Land Resources

The persistence of SureDye bait in soil is related to a variety of factors, including the soil's microbial activity, pH (relative acidity), and organic matter content. Phloxine B exposed to sunlight on the surface of soil can be expected to degrade readily with a half-life of about an hour (Heitz and Wilson, 1978). The residues that are carried below the soil surface would be expected to persist about 4 days. The high water solubility (RTECS, 1994a) and low lipophilicity (Valenzano and Pooler, 1982) indicate that this compound does not adsorb readily to organic matter, but its rapid degradation makes it unlikely that detectable quantities of phloxine B would leach to groundwater.

Environmental fate modeling using GLEAMS predicted concentrations of phloxine B in the upper centimeter of soil were highest immediately following application. Phloxine B concentrations ranged from a high of 0.0182 µg/g for the Southeastern and Gulf Coastal Plain ecoregion (4) to a low of 0.0079 µg/g for the Southwestern Basin and Range ecoregion (2). Following a rainstorm, the concentrations of phloxine B would be expected to decrease in the upper 1 centimeter (cm) of soil, but increase slightly in the lower soil layers.

(b) Water Resources and Quality

Surface water contamination may occur from direct applications or runoff from treated plants and soils, particularly if a rainfall occurs soon after application. The degradation of phloxine B is rapid, particularly in the presence of sunlight. The half-life of phloxine B on foliage ranges from 1 to 6 days. Degradation of phloxine B in water is mostly by photolysis (decomposition induced by light). The half-lives of phloxine B in tap, stream, and sea water under sunlight range from 10 to 26 minutes (Li *et al.*, 1997; Wang *et al.*, 1998).

Environmental fate modeling predicted that in directly sprayed water bodies greater than 6 ft deep, phloxine B concentrations immediately after spraying were 0.983 µg/L or less. Shallow water bodies were estimated to have higher concentrations (e.g., 6.447 µg/L phloxine B in water less than 1 ft deep). Modeling predicts that phloxine B concentrations decrease rapidly in flowing water and in water bodies with drainage outlets. For shallow water bodies, natural degradation processes make it unlikely that chronic exposures could result from program activities.

(c) Air Quality

Because of low volatility, high concentrations are unlikely to be detected in air. The evaporation rate of xanthene dyes was determined to be negligible (CHEMHAZIS, 1994). Sunlight exposure of phloxine B is expected to result in photodegradation (simultaneous photodetoxification) with a half-life of approximately 1 hour (Heitz and

Wilson, 1978). This rapid degradation in sunlight indicates that residues will not persist in the atmosphere.

Criteria pollutants (pollutants for which maximum allowable emission levels and concentrations are enforced by State agencies) will be produced by internal combustion engine fuel consumption during control activities. Effects will be localized and minimal compared with vehicular activities in urban areas.

b. Soil Treatments

(1) Chlorpyrifos

(a) Land Resources

The half-life of chlorpyrifos in natural soils is about 30 days (EPA, OPP, 1992). When applied as a soil drench, chlorpyrifos tends to remain in the upper 1 cm of the soil profile. Chlorpyrifos degrades most rapidly in sandy loam soils, and least rapidly in organic soils. Studies show plants take up very little chlorpyrifos or its metabolite TCP (3,5,6-trichloro-2-pyridinol) following soil application (Smith *et al.*, 1967). Chlorpyrifos tightly adsorbs to soil, and vertical movement is limited (Felsot and Dahm, 1979; Pike and Getzin, 1981). Residues on plants degrade at half-lives that range from 1 day to weeks and depend on application rates.

GLEAMS estimated chlorpyrifos concentrations in the upper 1 cm of the soil, ranging from 7.56 µg/g in the Floridian ecoregion (6) to 10 µg/g in the Mississippi Delta ecoregion (5), for the 1 pound (lb) active ingredient per acre (a.i./acre) application rate. Chlorpyrifos concentrations predicted from the 4 lb a.i./acre application rate ranged from 30.22 µg/g in the Floridian ecoregion (6) to 39.25 µg/g in the Lower Rio Grande Valley ecoregion (3). Following a rainstorm, the highest concentrations of chlorpyrifos were predicted to remain in the upper 1 cm of the soil.

(b) Water Resources and Quality

Surface water contamination from chlorpyrifos can occur following a rainstorm because of runoff from the treated area. EPA has set water quality criteria for aquatic life for chlorpyrifos in freshwater of 0.063 µg/L for acute exposure and 0.041 µg/L for chronic exposure. For saltwater these criteria are 0.011 µg/L for acute exposure and 0.0056 µg/L for chronic exposure. Environmental fate modeling predicts little or no runoff following small storms, but more runoff following a large storm in two of the ecoregions—the Mississippi Delta and Floridian.

Chlorpyrifos concentrations in runoff water from the soil drench area were predicted to be 825 µg/L at 4 lb/acre and 205 µg/L at 1 lb/acre in the Mississippi Delta ecoregion (5) and 725 µg/L at 4 lb/acre and 189 µg/L at 1 lb/acre in the Floridian ecoregion (6). Only a small volume of runoff water in a 9 mi^2 program area (0.14%) would come from areas treated with soil drenches. Concentrations of chlorpyrifos in surface waters would be several orders of magnitude lower than the concentration of chlorpyrifos in runoff water from the soil drench area. In natural waters, chlorpyrifos adsorbs to sediments, reducing its bioavailability.

(c) Air Quality

The photolysis half-life of chlorpyrifos in air is 2.27 hours (Klisenko and Pis'mennaya, 1979, as cited in EPA, OPP, 1984). Approximately 0.27% of soil applied chlorpyrifos active ingredient will volatilize to air in the first 24 hours. As with all soil drench treatments, there will be little production of pollution by internal combustion engine fuel consumption during control activities with chlorpyrifos.

(2) Diazinon

(a) Land Resources

Diazinon's half-life was reported to range from 1.5 weeks in clay loam soils to 10 weeks in an organic soil (Getzin and Rosefield, 1966). In an actual California Japanese beetle program, however, the half-life of diazinon was reported to be only a few days. The persistence of diazinon in soil increases with lower soil moisture content, increasing pH, decreasing temperature, and increasing organic matter content. Fifty percent of diazinon on a soil surface degraded after 24 hours of exposure to light (Burkhard and Guth, 1979). Microbial degradation of diazinon is a major source of its breakdown (Getzin, 1967; Getzin, 1968; Miles *et al.*, 1979). Diazinon leaches very slowly in soil and is unlikely to reach groundwater (Sumner *et al.*, 1987).

When applied as a soil drench, diazinon tends to remain in the upper 10 cm of the soil, with the majority of the chemical found in the upper 1 cm. In turf grass, 96% of the diazinon remained in the top 10 mm of turf; an increase in irrigation caused diazinon to break down more quickly, but did not increase leaching of the pesticide into the soil (Branham and Wehner, 1985). There is a possibility of plant uptake of diazinon from treated soil; however, breakdown in plant tissue is rapid (Lichtenstein *et al.*, 1967). Environmental fate modeling (GLEAMS) predicts diazinon concentrations in the upper 1 cm of soil ranging from 11.81 µg/g in the Southeastern and Gulf Coastal Plain ecoregion (4) to 24.85 µg/g in the Southwestern Basin and Range ecoregion (2).

(b) Water Resources and Quality

Surface water contamination from diazinon can occur following a rainstorm because of runoff from the treated area. Environmental fate modeling predicts little or no runoff following small storms, but more runoff following a large storm in the Mississippi Delta ecoregion (5) and the Floridian ecoregion (6). Diazinon concentrations in runoff water from the soil drench area were predicted to be 25.1 µg/L in the Mississippi Delta ecoregion (5) and 0.4 µg/L in the Floridian ecoregion (6). Only a small volume of runoff water in a 9 square mile program area (0.14%) would come from areas treated with soil drenches. Concentrations of diazinon in surface waters would be several orders of magnitude lower than the concentration of diazinon in runoff water from the soil drench area.

(c) Air Quality

Diazinon volatilizes only slightly from soil (Burkhard and Guth, 1981). Air volatility of diazinon applied to soil in an orchard was 2.4% of applied active ingredient within the first 24 hours following application, 0.93% the second day, 0.11% the third day, 0.09% the fourth day, and was negligible thereafter (Glotfelty *et al.*, 1990). Consequently, little or no diazinon would be expected to be detected in the air following a treatment. Because diazinon is applied as a soil drench, there will be little pollution produced by internal combustion engine fuel consumption during control activities.

(3) Fenthion

(a) Land Resources

Under aerobic soil conditions the half-life of fenthion is 24 hours (EPA, OPP, 1992). Fenthion residues in a column of loam soil leached with 570 mm (22.5 inches of rain in a 45-day period, but the majority of the residues remained in the upper 4 cm (approximately 2 in) of soil (EPA, 1988a). Leaching would not appear to be a major concern from soil applications for fruit fly control. Some uptake of fenthion by plants (0.5% to 2% of applied active ingredient) has been observed following soil applications (Sirharan and Suess, 1978). Plant residues do not appear to be persistent except under silage conditions (Bowman *et al.*, 1970).

EPA's environmental fate data base is incomplete. However, it is clear that fenthion degrades by aerobic microbial metabolism with calculated half-lives of <1 day in an aerobic soil metabolism study and 11 days under anaerobic aquatic conditions (EPA, OPP 1998). Fenthion is more persistent in pond water (half-life of 1.5 days) but the presence of sediment reduces the chemical's bioavailability because fenthion will sorb to sediment.

Using GLEAMS, predicted fenthion concentrations in the upper 1 cm of soil ranged from 4.50 µg/g in the Southeastern and Gulf Coastal Plain ecoregion (4) to 8.19 µg/g in the Mississippi Delta ecoregion (5). Following a rainstorm, fenthion concentrations were predicted to be higher in the 1 to 10 cm soil layer than in the top centimeter.

(b) Water Resources and Quality

Surface water contamination from fenthion may occur after a rainstorm if there is runoff from the area drenched with fenthion. Environmental fate modeling predicts little or no runoff following small storms, but more runoff following a large storm in the Mississippi Delta ecoregion (5) and the Floridian ecoregion (6). Fenthion concentration in runoff water from the soil drench area were predicted to be 85 µg/L in the Mississippi Delta ecoregion (5) and 24 µg/L in the Floridian ecoregion (6). Only a small volume of runoff water in a 9 mi^2 program area (.14%) would come from areas treated with soil drenches. Concentrations of fenthion in surface waters would be several orders of magnitude lower than the concentration of fenthion in runoff water from the soil drench area.

(c) Air Quality

No studies of the fate of fenthion in air are available. Based on chemical properties, approximately 0.1% of applied fenthion active ingredient would be expected to volatilize from soil in the first 24 hours. Air contamination from soil applications for fruit fly control would not appear to be a major concern. There will be little production of pollution by internal combustion engine fuel consumption during control activities with fenthion.

c. Fumigation

(1) Methyl Bromide

(a) Land Resources

After commodity fumigation, methyl bromide gas is vented into the atmosphere where it dissipates. Methyl bromide is not expected to reach soil; however, any methyl bromide that might reach soil breaks down to inorganic bromide residues and methanol with a half-life of 3 to 7 days (EPA, 1992).

(b) Water Resources and Quality

The solubility of methyl bromide in water is low. The half-life in water is 6.63 hours (Wegman *et al.*, 1981). Preliminary EPA groundwater monitoring data show no detectable methyl bromide.

(c) Air Quality

Methyl bromide is highly volatile and disperses rapidly when released or vented from a fumigation chamber. However, methyl bromide is heavier than air and can accumulate briefly in low areas; treatment facilities, therefore, must be designed to avoid exposure to applicators or the general public in areas downwind from treatments. Long-term toxicity in air or half-life in air is not relevant because dispersal is so rapid. Several environmental groups petitioned EPA to classify methyl bromide as a class I ozone depleting chemical. Since then, EPA ordered that U.S. companies phase out production of methyl bromide by the year 2005. Under the Montreal Protocol agreements, quarantine uses of methyl bromide will be continued (as of the date of this writing). The relative importance of methyl bromide in ozone depletion, however, is subject to fundamental uncertainties. Halogen gases (the class of compounds which includes bromine) have been implicated in ozone destruction in the stratosphere (mid-atmosphere); ozone forms a layer around the earth which protects the surface from excessive ultraviolet light exposure. Chlorine from sources such as chlorofluorocarbons (CFCs) is believed of primary importance in ozone depletion (Solomon *et al.*, 1986).

CFCs have long half-lives in the atmosphere (80 to 100 years), but methyl bromide has a half-life in the stratosphere of only 1.6 years or less (Mix, 1992). Aerosols from marine wave action have been assumed to account for the vast majority of atmospheric bromine (Sturges and Harrison, 1986). Estimates of the contribution of industrial and agricultural sources to atmospheric bromine levels range from less than 10 to 35% (Prather *et al.*, 1984; Wofsy *et al.*, 1975). Reactions of combinations of bromine and chlorine with ozone have been modeled; however, bromine's actual contribution to ozone depletion is unclear (McElroy *et al.*, 1986). Even if atmospheric bromine may contribute to ozone depletion, the extent of the contribution from agricultural methyl bromide uses is uncertain.

d. Mass Trapping and Other Methods

Mass trapping involves the use of natural or synthetic lures to attract fruit flies to traps, bait stations, sticky panels, wicks, or fiberboard squares, where they are killed, either by becoming stuck to a sticky substance or by being exposed to minute quantities of pesticide. Lures used include nulure, cuelure, trimedlure, and methyl eugenol. A new three-component lure has been developed for use in traps that consists of ammonium acetate, putrescine, and trimethylamine. This has been proposed for use in wet trapping, but dry trapping applications are being investigated further. Chemicals used include borax, dichlorvos, malathion, naled, or phloxine B (SureDye).

Traps containing lures and insecticides are used for detection trapping, delimitation trapping, monitoring of populations, and mass trapping. Three kinds of traps are used to detect fruit flies: the Jackson trap, the McPhail trap, and the yellow panel sticky trap. For mass trapping, the inexpensive Jackson trap or the yellow panel traps are normally used. The nature of these traps (which use a sticky substance to trap the fruit flies) minimizes the potential for adverse effects to the physical environment. No direct effects to soil or water are anticipated. Although some volatilization of insecticides is known to occur from some traps (particularly with dichlorvos and naled), the effects to air quality outside the trap are still negligible because of the small quantities involved. Depending on the frequency of monitoring and replacement of traps, slight soil impacts could result from vehicular and foot traffic.

The fruit fly male annihilation technique involves traps, sticky panels, bait stations, or spot treatments of lure-insecticide mixture to tree trunks, utility poles, and fences using hand-held equipment. Spot treatments are made from slow-moving vehicles. The placement of spot treatments is generally out of the reach of the general public. Although insecticide could be washed by rainfall from the spot treated, the small amount of insecticide that could be carried to soil or in runoff water following rain would have negligible effects on soil or water resources and quality. Use of spot treatments, bait stations, or sticky panel traps to attract male fruit flies is not expected to directly affect soil, water, or air resources. Depending on the frequency of spot treatments, slight soil impacts could result from vehicular and foot traffic.

Cordelitos (30-mm long wicks containing cuelure and naled) and wood fiberboard squares (20 cm^2 wood chips with cuelure and naled) are also used in mass trapping. These devices can be applied aerially in rural or agricultural areas, and have been shown to be effective on melon fly. The low concentration of insecticide and the low quantities of the devices used in program applications are insufficient to adversely affect soil, air, or water resources and quality.

C. The Human Population

Risks to human health and safety are analyzed quantitatively and qualitatively in this section by alternative. These risks associated with chemical, nonchemical, and combined fruit fly control methods were analyzed. The primary concern for impacts to human health in the fruit fly program relates to the potential effects of the chemical insecticides. Most of this section is taken from the Human Health Risk Assessment for APHIS Fruit Fly Programs (APHIS, 1998a) and the Spinosad Bait Spray Applications Human Health Risk Assessment (APHIS, 1999a), and these documents are incorporated by reference into this EIS. This section also covers principal related issues to human health such as environmental justice, hypersensitivity, noise, potential psychological effects, socioeconomics, cultural resources, and visual resources.

1. Nonchemical Control Methods

This section summarizes the potential risks to human health and safety from the implementation of nonchemical methods to control fruit fly populations. Nonchemical methods of fruit fly control include sterile insect technique, physical control, cultural control, biological control and biotechnological control.

a. Sterile Insect Technique

Effects on the human population from the use of sterile insect technique (SIT) as a control method are unlikely. The public should not be affected at all, unless by inadvertent involvement in an airplane or ground vehicle accident. The unique design and shielding of the equipment at fly-rearing facilities prevents workers from being accidentally exposed to the radiation used to sterilize the fruit flies. During release of the flies, a worker on the back of a truck could be at risk of being involved in a vehicle accident. However, safety controls are built into the program to minimize accidental injury to workers. The rearing and release of sterile fruit flies is expected to have little, if any, impact on human health and safety. (If SIT is used in combination with chemical control methods as a part of integrated control, then the risks associated with the use of those chemicals would also apply.)

b. Physical Control

Physical controls, including fruit stripping and host elimination, are not likely to have health or safety effects on the human population. Human health risks are limited to workers involved in mechanical accidents resulting from the stripping of fruits and removal of host plants, and from subsequent disposal. Because of environmental considerations, time constraints, and economic concerns, host elimination generally is considered undesirable and is done only on an extremely limited basis. Therefore, the main human health risks from physical controls would be to workers performing fruit stripping and disposal of the fruits. Accidents resulting from these tasks could include falls from trees or ladders, or injuries resulting from carrying heavy loads, or from burning or burying the infested material. One risk to workers picking infested fruits is exposure to unknown pesticide residues that may have been applied by the grower or homeowner. However, workers are required to wear gloves, which would protect them from most exposures. For the most part, physical controls do not pose health and safety concerns, except for the possibility of occasional accidents.

c. Cultural Control

The cultural controls that could apply to the fruit fly program include clean culture, special timing of planting or harvesting, and the use of resistant varieties. None of these control methods is likely to be effective alone, but as individual methods, none represent any risk to human health or safety. However, if used solely in an effort to eradicate fruit flies, the effects to human health would be similar to those from other ineffective eradication efforts. These effects would include exposure to unknown types and concentrations of pesticide residues from applications by the grower or homeowner, and the possibility of occasional accidents.

d. Biological Control

Biological control has not yet been shown to be effective for fruit fly control programs, and therefore, probably would not be used alone. The method itself poses little, if any, risk to human health and safety. However, there is much about biological control that remains unknown, leaving the question of safety open. As with other methods that, when used alone, prove ineffective in eradicating a pest, the risk to humans could come from exposure to unknown types and quantities of pesticide residues that growers or homeowners have applied to protect their crops.

e. Biotechnological Control

Biotechnological control is a potential future control method, and is presently in the testing stage. The actual risks to human health and safety will remain largely unknown until the methods are developed. The process of genetic engineering used to produce the organisms necessary to control insect pests may involve some risks. Radiation or chemical mutagens could be used to alter reproductive capability in the pest, or disrupt other life systems. Under these circumstances, workers could be exposed to radiation or chemicals with adherent potential for risk. However, laboratories involved in these procedures are required to adhere to good laboratory practices which minimize risk to the workers.

f. Cold Treatment

All cold treatments are conducted in approved facilities under strict supervision. This treatment is only applicable to certain approved commodities. The necessary restrictions (duration of treatments and approval of facilities) and availability of facilities for cold treatment are likely to continue to limit the use of this treatment. The impacts on the human health would not be expected to differ from those resulting from cold storage facilities of comparable size. The strict supervision of these treatments ensures that program personnel and the general public do not enter the cooling chambers during treatment. The use of cold treatment is expected to have negligible adverse effect on human health.

g. Irradiation Treatment

Irradiation treatments are conducted in approved facilities in accordance with stringent safety guidelines. The use of this treatment method is limited to certain approved commodities that are compatible with its application. The irradiation equipment is designed to release radiation to the regulated commodity only. There is negligible stray radiation from proper equipment use. Monitoring for stray radiation at facilities has demonstrated only ambient background radiation levels at plant boundaries. The treated commodity does not retain any radioactivity from the exposure and poses no risks to humans. Irradiation equipment at approved facilities is checked on a regular basis by the USDA Radiation Safety Staff in accordance with standards set by the Nuclear

Regulatory Commission. No problems have been associated with the use of irradiation equipment under APHIS permits. Equipment design and shielding ensure negligible risk to workers at these facilities.

h. Vapor Heat Treatment

All vapor heat treatments are conducted in approved facilities under strict supervision. This treatment is only applicable to certain heat tolerant commodities. The necessary restrictions (duration of treatments and approval of facilities) and limited availability of facilities for vapor heat treatment are likely to continue to restrict the use of this treatment. The strict supervision of these treatments ensures that program personnel and the general public do not enter the vapor heat chambers during treatment. The use of vapor heat treatment is expected to have negligible adverse effect on human health.

2. Chemical Control Methods

This subsection provides information about the assessment of potential risks to human health from program chemical control methods. The introductory paragraphs summarize the methodology used in the human health risk assessment (APHIS, 1998a). This is followed by descriptions of potential risks from each type of control method (e.g., bait spray application, soil treatment, fumigation) for the specific pesticides available in each program control application. The discussion for each pesticide summarizes the hazard of the chemical, the potential public and workers' exposure to that chemical, and the quantitative and qualitative risks associated with the estimated doses to humans. The discussions for those chemical control methods with lower exposures or lower hazard (e.g., fruit fly male annihilation technique, trapping, cordelitos, and wood fiberboard square applications) are presented as a brief summary of the findings from the Human Health Risk Assessment (APHIS, 1998a).

Models and equations used in the human health risk assessment to estimate exposure and dose to humans were based on methodologies developed and used by EPA in risk assessments for chemicals under its regulatory control (e.g., EPA, OHEA, 1990; EPA, OHEA, 1992; EPA, ORR, 1988). Refer to the Human Health Risk Assessment for APHIS Fruit Fly Programs (APHIS, 1998a) for greater detail on APHIS use of those methodologies. Potential exposure concentrations in or on various media, i.e., water, soil, and vegetation, were determined from application rates and the results of the environmental fate models. The risk assessment considered oral, dermal, and inhalation exposures, both single and multiple-route of exposure, in some cases. Absorption through the skin was estimated based on methodologies recommended by EPA (EPA, OHEA, 1992). Routine, extreme, and accidental scenarios were modeled for the general public in the treatment area and for workers in the program. Average population values of human characteristics that greatly influence exposure and dose, e.g., body weight, consumption patterns, and activity patterns, were taken from Exposure Factors Handbook (EPA, OHEA, 1990). In some cases, estimates of doses to workers were based on modifications to literature-based experimentally determined exposures or doses of other pesticides to workers performing similar tasks.

Quantitative toxicological assessments involve the derivation of dose levels associated with a regulatory risk goal. These derivations are termed regulatory risk values (RRVs) in this document. The risk assessment protocol for the determination of the RRV is described in greater detail in the Human Health Risk Assessment for APHIS Fruit Fly Programs (APHIS, 1998a). These values are estimates (with inherent uncertainty) of the dose to which an individual can be exposed over a specified period of time without an appreciable risk of adverse effects. RRVs are conceptually similar to a number of other toxicological assessments conducted by various governmental agencies, and were derived using methods similar to those used by EPA for deriving reference doses (RfDs) and reference concentrations (RfCs) and those used by the Agency for Toxic Substances and Disease Registry (ATSDR) for deriving minimum risk limits (MRLs). An attempt was made to determine the most sensitive toxicological endpoint or effect, and one that increased in severity as dose increased. An "experimental threshold" dose was selected, which is the highest dose in a series of doses causing the effect that is below any dose associated with any adverse effect.

To derive the RRV, the identified experimental threshold was divided by an uncertainty factor intended to account for differences between the experimental exposure and the conditions for which the RRV was being derived. Tenfold uncertainty factors were generally used to account for:

1. Variation in sensitivity among members of the human population,
2. Uncertainty in extrapolating animal data to humans,
3. Uncertainty in extrapolating from less than chronic No Observed Adverse Effect Levels (NOAELs) to chronic NOAELs (where NOAEL is the highest dose level of a chemical that, in a given toxicity test, causes no observed adverse effect in the test animals), and
4. Uncertainty in extrapolating from the Lowest Observed Adverse Effect Level (LOAEL) to NOAELs (where LOAEL is the lowest dose level of a chemical that, in a given toxicity test, causes an observable adverse effect in the test animals).

The tenfold uncertainty factor to account for variability among the human population was omitted when deriving the RRV for workers, under the assumption that the special disease conditions or impaired physical states that it was intended to account for among sensitive groups of the general population usually are not found in the workforce. Acute, subchronic, and chronic RRVs have been derived for various exposure durations.

Quantitative risk characterization was accomplished by comparing the exposure assessment with the toxicological assessment to determine a hazard quotient (HQ). When appropriate, all relevant routes of exposure were considered to derive a composite HQ. An HQ that approached or exceeded one (that is, when the exposure dose approached or exceeded the RRV) was generally associated with a cause for concern for adverse effect in the exposed population. In most cases, an HQ greater than one constituted unacceptable risk. However, in some cases, the uncertainties associated with the exposure and toxicological assessments resulted in a lack of confidence in the HQ. Therefore, a qualitative judgment was required to characterize the risk involved when the dose was above the RRV.

a. Bait Spray Applications

Bait spray applications may be applied aerially from airplanes or helicopters, or to foliage from the ground using either backpack or pump-up sprayers, or truck-mounted sprayers. Although the application rate per acre treated is the same for both application methods, there is less likelihood of public exposure from ground applications than from aerial applications because ground applications more precisely targeted and there is substantially less off-site drift. The risk to workers depends upon the type of application and their activity, and is expected to be different from the risk to the public. Therefore, risks to the public and to workers were analyzed separately.

(1) Malathion Aerial Application

(a) Hazard Assessment

Malathion is an organophosphate insecticide whose mode of toxic action is primarily through acetylcholinesterase (AChE) inhibition (Smith, 1987; Klaassen *et al.*, 1986). At low doses, the symptoms include slight AChE inhibition in humans as well as effects such as nausea, sweating, dizziness, and muscular weakness. The effects of higher doses of malathion may include irregular heartbeat, elevated blood pressure, cramps, convulsions, and respiratory failure. However, AChE inhibition can be measured in blood at levels much below that which causes symptoms; therefore, adverse health effects do not necessarily result from all levels of AChE inhibition.

Generally, complete toxicity data are unavailable for individual formulations of pesticides. The malathion bait formulation is no exception. In these cases, regulatory values established by EPA and other agencies have been based on the toxicity characteristics of the technical grade (or pure) chemical or other similar formulations of the pesticide. It is this information that has been reviewed and incorporated into this hazard assessment of malathion. The acute oral toxicity of malathion is slight to humans (U.S. DHHS, NIOSH, OSHA, 1978). Malathion's acute toxicity by the dermal route is minimal and malathion is considered one of the least dermally toxic of the organophosphorus insecticides (EPA, OPP, 1989b). Malathion is a very slight dermal irritant and a slight eye irritant (EPA, OPP, 1989b). Studies of acute delayed neurotoxicity have been negative (EPA, OPP, 1989b).

Testing also indicates relatively low chronic toxicity. The human RfD was established at 0.02 milligrams per kilogram per day (mg/kg/day) based upon no AChE inhibition at a higher concentration (0.23 mg/kg/day) and applying an uncertainty factor of 10 (Moeller and Rider, 1962; EPA, OPP, 1989b). Malathion may be immunosuppressive and immunopathologic *in vitro* at high concentrations (Desi *et al.*, 1978; Thomas and House, 1989). Reproductive and teratology studies are outstanding data requirements of EPA for reregistration of malathion (EPA, OPTS, 1990), but adequate data are available for determining a teratogenic NOEL based upon a study of rabbits (25 mg/kg/day) (EPA, OPP, 1989b).

Carcinogenicity, mutagenicity, and genotoxicity tests have included many results that are clear and some that are equivocal. The tests for carcinogenicity provide either negative or equivocal data. EPA has classified malathion as having "suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential." This indicates that any carcinogenic potential of malathion can not be quantified based upon the weight of evidence determination used in this classification. EPA is continuing to review the carcinogenic potential of malathion and any decisions by APHIS regarding future program actions will take into account the findings provided by EPA in regard to this issue. Malathion does not induce gene mutations in bacteria, but can cause chromosomal damage to mammalian cells (WHO, IARC, 1983). Malathion may be an alkylating agent of DNA nucleic acids (Griffin and Hill, 1978).

An assessment of acute health effects from a Medfly eradication project in Santa Clara County, California, in 1981, (Kahn *et al.*, 1992) indicated that there was no detectable increase in reported symptoms or acute illnesses attributable to malathion exposure from individuals in a treatment area when compared with a nontreatment area. Independent review of the human health risks of malathion bait spray applications was made by CDHS (1991). Their health risk assessment reviewed the risks comprehensively and concluded that "malathion appears to be a relatively safe pesticide, particularly in the small amounts used in aerial malathion-bait. For the majority of citizens in an aerial application area, we are confident that there is no significant risk to health. Notwithstanding this, though, for certain individuals with higher than normal contact with the malathion-bait or with unusual susceptibility, there may be enough exposure to warrant some concern." Our risk assessment also recognizes these potential hazards and concurs with these findings.

(b) Exposure Analysis

Calculated doses of malathion from aerial applications were determined for routine, extreme, and accident scenarios. Calculated doses of malathion determined for single route exposure scenarios to the general public range from 4.3×10^{-6} mg/kg/day for a routine exposure scenario (a child incidentally ingesting a very small amount of soil from an area that had been aerially sprayed) to 9.3×10^{-2} mg/kg/day for an extreme exposure scenario (an adult contacting sprayed vegetation before the malathion bait spray dried). Calculations of groundwater concentrations were determined by using the leaching output for pervious ground surfaces (soil) from the GLEAMS model assuming a 2-year storm 24 hours after application (extreme), 48 hours after application (routine Florida), or 72 hours after application (routine California). Calculations for runoff water assumed a ½-inch rainfall at the same intervals, but used runoff calculations from impervious surfaces.

Other exposure scenarios included an individual eating vegetation from a backyard garden in a treated residential area and both dermal uptake and inadvertent drinking of directly-sprayed chlorinated swimming pool water contaminated with malathion and malaoxon. Other dermal exposures included contact with sprayed vegetation and direct exposure to the spray. Inhalation exposures were determined for breathing indoor and outdoor air within the treatment area. Based on available monitoring data, potential inhalation doses of malathion were not considered to be a substantial concern. A calculated inhalation exposure to malaoxon for the general public was 0.016 $\mu g/m^3$ for a routine exposure scenario of an adult breathing indoor air for 16 hours and outdoor air for 8 hours from a treated area.

Doses to workers involved in aerial application operations were calculated based upon routine, extreme, and accident scenarios. Calculated doses of malathion determined for single route exposure scenarios to workers range from 3.0×10^{-4} mg/kg/day for a routine exposure scenario for a mixer/loader to 8.4×10^{-2} mg/kg/day for an extreme exposure scenario for the ground personnel, including kytoon handlers, flaggers, and quality control crew. Exposures were also determined for pilots of the applicator airplanes. Data from pesticide studies of a surrogate chemical, 2,4-D, were the basis for calculations of exposures to pilots (Nash *et al.*, 1982) and mixers/loaders (Lavy *et al.*, 1987). For ground personnel, estimates of exposure were made from previously monitored air levels and nominal application rates. The calculated doses for ground personnel ranged from 6.2×10^{-2} to 8.4×10^{-2} mg/kg/day for various scenarios that involve spills of malathion concentrate onto the skin.

(c) Quantitative Risk Assessment

The regulatory reference values (RRVs) for malathion used in this risk assessment were 0.02 mg/kg/day for the public and 0.2 mg/kg/day for workers, both derived from a NOEL for AChE inhibition (0.23 mg/kg/day).

The HQs determined for the general public indicate that there are no unacceptable risks of adverse effects from malathion exposure from drinking or contact with groundwater or runoff water, or swimming in or inadvertently drinking swimming pool water (which also takes into consideration exposure to malaoxon). Inhalation of malathion was not a major route of concern, even when the risk assessment was modified with reasonably conservative assumptions to consider levels of malaoxon in air. The scenarios that considered soil consumption by children, even in cases of pica behavior, resulted in HQs of less than 1, and therefore no unacceptable risks. Pica may be defined as a pathological behavior characterized by the persistent eating of nonnutritive, generally nonfood, substance. There was some cause for concern with HQs greater than 1 from the scenarios representing an adult contacting contaminated vegetation or consuming contaminated vegetation, although both were extreme exposure scenarios that would be preventable by providing warnings. The routine exposure scenario of an adult consuming contaminated vegetation resulted in an HQ of less than 1.

Based on the HQs determined for the exposure scenarios for aerial application workers, there were no unacceptable risks for pilots, mixer/loaders, or the ground personnel. The scenario for the ground personnel incorporated exaggerated exposure conditions which encompass accidental exposures.

In addition, program operational procedures prevent unacceptable risks from exposures to pesticides. Workers are routinely tested for inhibition of AChE, which, at low levels of inhibition, indicates exposure to organophosphates but does not necessarily produce adverse health effects. When AChE inhibition is demonstrated, that worker should be prevented from continuing in any job that would further his exposure to the organophosphate pesticides. Operational procedures also dictate that program personnel be fully instructed in emergency procedures, and that appropriate equipment for washing is available, in the event of accidental pesticide exposure. Under the circumstances where a large quantity of pesticide is spilled on a worker, personnel have the appropriate equipment necessary to rinse the chemical off rapidly so that dermal absorption is minimized. By preventing additional exposures after a worker is showing AChE inhibition and by decreasing absorption of pesticides through the skin, risks of systemic effects from exposures are minimized.

(d) Qualitative Risk Assessment

Neurotoxicity

Neurotoxicity is any toxic effect on any aspect of the central or peripheral nervous system. Such changes can be expressed as functional changes (such as behavioral or neurological abnormalities) or as neurochemical, biochemical, physiological, or morphological alterations. Malathion poses a neurotoxic risk only as a consequence of inhibition of AChE. It does not pose any risk of delayed neurotoxic symptoms or structural neuropathy. The quantitative risk assessment of AChE inhibition analyzes the only neurotoxic risks. As a result, no unacceptable neurotoxic risks are anticipated other than those already presented in the quantitative risk assessment.

Immunotoxicity

Immunotoxicity is any toxic effect mediated by the immune system, such as dermal sensitivity, or any toxic effect that impairs the functioning of the immune system. Malathion has been shown to be immunosuppressive and immunopathologic to mammalian cells at high concentrations *in vitro*. Recent studies have shown that malathion may alter immune functions in mammals *in vivo* (Rodgers and Ellefson, 1992). Histamine was elevated in the blood of rats and mice alter oral exposure to malathion as low as 1 mg/kg (Rodgers and Xiong, 1997). The corresponding no-effect levels for both rats and mice were 0.1 mg/kg. The histamine levels of the test animals returned to levels comparable to control animals within 12 hours. Although cellular immune response to exposure to a xenobiotic does not necessarily constitute an adverse effect and this exposure is higher than program exposures, application of uncertainty factors could place some potential program exposures within regulatory reference values. None of the regulatory agencies have considered this effect in rodents to be an outcome of concern for adverse effects to humans. The implications of these findings with respect to human immune system toxicity remain unclear, but further research could help to clarify this issue.

Genotoxicity and Mutagenicity

Genotoxicity is a specific adverse effect on the genome (the complement of genes contained in the haploid set of chromosomes) of living cells that, upon the duplication of the affected cells, can be expressed as a mutagenic or a carcinogenic event because of specific alteration of the molecular structure of the genome. It results from a reaction with deoxyribonucleic acid (DNA) that can be measured either biochemically or, in short-term tests, with end points that reflect on DNA damage. DNA is the genetic material of a cell.

Mutagenicity is an adverse effect that produces a heritable change in the genetic information stored in the DNA of living cells. There is some evidence that malathion may pose a genetic hazard at high concentrations based upon some *in vivo* and *in vitro* cytogenetic studies where chromosomal aberrations and reactivity with DNA had a weak association to exposure, but the majority of studies do not support a finding of any genetic hazard from malathion exposure (WHO, IARC, 1983; Griffin and Hill, 1978). The potential risk of clastogenic injury increases if the high doses of malathion formulation contain sufficient impurities. The premium grade malathion is of high purity, and exposures resulting from applications are relatively low compared to the thresholds for genotoxicity. Based upon this, there should be no unacceptable risks of genotoxicity or mutagenicity from program applications of malathion.

Carcinogenicity

Carcinogenicity is an adverse effect that causes the conversion of normal cells to neoplastic cells and the further development of neoplastic cells into a tumor (neoplasm). A neoplasm is an altered, relatively autonomous growth of tissue composed of abnormal (neoplastic) cells, the growth of which is more rapid than, and not coordinated with, the growth of other tissues. EPA has classified malathion as having "suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential." This indicates that any carcinogenic potential of malathion can not be quantified based upon the weight of evidence determination used in this classification.

Guidelines for the expression of potential carcinogenic hazard are being revised by EPA to accommodate the increased understanding of the nature and causation of cancer. Historically, it was widely believed that cancer was caused by a limited number of discrete chemical, physical, or biological agents. It was assumed that this limited number of carcinogenic agents could be readily determined and regulated to eliminate cancer risks. This assumption that only certain compounds cause cancer led to a non-threshold approach to regulation. The finding of a positive result for cancer in an acceptable animal study, human study, or through epidemiological study presumed the agent to be a carcinogen. The finding of a negative result for cancer in these studies was interpreted as indicative that the agent was either not carcinogenic or the data were inadequate to classify the carcinogenic potential. This widespread assumption that potential initiation and promotion of cancer related to specific agents led EPA to issue guidelines on September 24, 1986, (51 Federal Register 33992-34054) to rank those agents according to carcinogenic hazard potential based upon the weight of evidence. Under these guidelines, chemical and other agents were identified as human carcinogens (Group A), probable human carcinogens (Group B), possible human carcinogens (Group C), not classifiable (Group D), or having evidence of non-carcinogenicity (Group E). Although this classification based upon positive or negative results could be used readily for regulation of agents, it is widely recognized by the scientific community that this approach does not adequately use the advances in knowledge of carcinogenesis and risk assessment.

Today, scientists recognize that cancer is a highly complex, multifactorial disease caused, in part, by endogenous (intrinsic) metabolic or other imbalances associated with age or genetic makeup and, in part, by a wide variety of exogenous (external) factors including diet, lifestyle, exposure to ionizing radiation, and exposure to chemicals of natural or man-made origin. It is now known that initiation of cancer may be caused by cell damage resulting from excess exposure to one or multiple agents and that promotion of genetic errors from the cell damage may also be caused by conditions or agents other than those causing the initial cell damage. It is also widely recognized that there is a threshold for all agents to cause carcinogenicity and the threshold for a given agent may be affected by the endogenous and exogenous factors mentioned above. This realization has led to changes in carcinogen regulation by some international organizations. Likewise, EPA has prepared new categories to address these issues and other advances in the understanding of carcinogenesis. Their narrative descriptors of carcinogenic risk for potential agents in the 1999 proposed guidelines include the following: (1) *carcinogenic to humans*, (2) *likely to be carcinogenic to humans*, (3) *suggestive evidence of carcinogenicity but not sufficient to assess human carcinogenic potential*, (4) *not likely to be carcinogenic to humans*, and (5) *data are inadequate for an assessment of human carcinogenic potential*. Classification of pesticides into a given category is based upon a weight of evidence approach. These new rankings recognize the potential risk of all agents to cause cancer, even if the actual occurrence is "not likely."

Uses of most chemicals in APHIS' fruit fly control programs are expected to be classified by EPA under the new guidelines as *not likely to be carcinogenic to humans* based upon the weight of evidence. As part of EPA's pesticide reregistration process (for all pesticides registered prior to 1984) and in compliance with the FQPA, it is expected that carcinogenic potential will be reclassified for all registered pesticides. Because of the changes in the terminology, this EIS' references to carcinogenic potential may rely on the terminology used in either the 1986 guidelines or 1999 proposed guidelines.

A preliminary draft review by EPA of a previously submitted application by APHIS for a 3-month renewal of the Section 18 Quarantine Exemption for use of malathion bait to control Medfly in Florida included an assessment of aggregate cancer risk from program use of malathion. Their draft assessment was made based upon several extremely conservative assumptions (no degradation, constant exposure, and residues at tolerance level) and used the default cancer potency value recommended by the Cancer Peer Review. The total aggregate cancer risk determined by calculation to be 4.5×10^{-7}. The preparers have indicated that their refinement of these risk calculations to more realistically address the actual potential exposure will lower the risk when their review is completed. Based upon existing data including recent reviews, there are no unacceptable risks of carcinogenicity anticipated for this program.

Ocular (Eye) Toxicity

Review of animal studies by EPA indicates that malathion is a slight eye irritant. Information on other ocular effects of malathion have been based mostly on anecdotal data. Reports from Japan in the early 1970's associated eye disease in a number of people with agricultural use of malathion (as well as other pesticides) at extremely high concentrations (the syndrome was called Saku Disease after the region in which it occurred). A review of the data by the Malathion Public Health Effects Advisory Committee, a committee formed by CDHS in 1990, found fundamental flaws in the original study and subsequent papers, and determined that the reported association between malathion and eye disease had not been established.

However, because data from various studies have demonstrated adverse ocular effects from other organophosphates, EPA has issued a data call-in to the registrant for ocular toxicity testing of malathion. The study is required to confirm or deny the potential for malathion to cause adverse eye effects.

Reproductive and Developmental Toxicity

Reproductive toxicity is any adverse effect that produces changes in the capacity to produce viable offspring, for example, by affecting the reproductive organ systems or hormonal functioning. Developmental toxicity is any adverse effect in the parent or the offspring that produces changes in fetal or neonatal growth and development, including physiological, morphological, biochemical, or behavioral changes.

The lowest NOEL determined for these effects from malathion exposure was a development NOEL of 25 mg/kg/day in rabbits (EPA, OPP, 1989b). This exposure level is considerably higher than the NOEL for AChE inhibition (0.23 mg/kg/day) analyzed in the quantitative risk assessment, so these effects would not be anticipated unless other effects were noted first. There are no unacceptable risks of reproductive or developmental toxicity to workers or to the general public from any exposure scenario. Recently there has been considerable interest in the hormones and functioning of the endocrine system. Endocrine disruption by malathion has only been observed at exposures much higher than could result from routine program applications.

Impurities in Formulations Applied

The main impurities of concern in malathion formulations are isomalathion (95 times as toxic as malathion) and malaoxon (68 times as toxic as malathion) (CDHS, 1991; Aldridge *et al.*, 1979; Ryan and Fukuto, 1985; Fukuto, 1983). Isomalathion formation results from improper storage or handling of malathion formulations. Malaoxon is formed from malathion's oxidation, which has been reported to occur in air and from volatilization from the bait droplets on various surfaces. A recent pilot study by the California Department of Health Services (Brown *et al.*, 1991; Brown *et al.*, 1993) found that, following aerial malathion applications, malaoxon and other transformation products were detectable in air and on various test surfaces for hours and, in some cases, days after the treatment. Levels of malaoxon increased, presumably via oxidation of malathion on some test surfaces for the 9 days of the study. However, another study (Ross *et al.*, 1990) indicated that the dermal uptake of a pesticide can be highly dependent on the amount that is bioavailable (i.e., the amount of residue that can be dislodged or assimilated) and that the amount can decrease substantially over a 12-hour period. The composition of the malathion used in those earlier programs is not as pure as in formulations used by the current program. The premium grade malathion used by the program is 96 to 97% pure. The impurities of primary concern (malaoxon and isomalathion) account for smaller percentages of the premium grade malathion than in previous programs. The variances in test data and the absence of any scientific accord over the interpretation of the results point to the need for further studies in this area.

Synergistic Effects

Although the toxicity of malathion may be potentiated by some other organophosphates and carbamates (Knaak and O'Brien, 1960; Cohen and Murphy, 1970), it is impossible to predict multiple exposures and synergism from applications not related to this program. Dichlorvos and naled were not found to be synergistic with malathion, but only additive (Cohen and Ehrich, 1976). Diazinon is synergistic with malathion (Keplinger and Deichmann, 1967), and although they may be used within the same treatment program, simultaneous application of the two pesticides usually does not occur. Even though it still may be possible for an individual to be exposed to malathion and diazinon within a critical exposure window, the implications of such an exposure are not clear. In addition, organophosphate insecticides are routinely used in various public health applications such as mosquito control programs. There is some potential for synergistic effects resulting from the combination of malathion and inadvertent simultaneous pesticide application by the public; however, public notification about program treatments helps to minimize this risk.

(2) Ground Applications of Malathion Bait

(a) Hazard Assessment

The hazard assessment for malathion bait spray is presented in the previous section on malathion aerial application. The formulation, including the lure, is the same with both application methods.

(b) Exposure Analysis

Calculated doses of malathion from ground application were determined for routine, extreme, and accident scenarios. Malathion exposures to the public from ground applications are generally the same, but may be somewhat less than from aerial applications because the ground application is directed at the trees and foliage rather than the entire surrounding area. Calculated doses to the public from ground application of malathion are, therefore, considered the same as from aerial application and are presented in that section.

Exposure to malaoxon is not expected to result from either swimming in a pool or ingesting pool water following ground application. The precise targeting of trees and vegetation from ground application should prevent the deposit of pesticide into pools. Malaoxon is the malathion oxidation product which results most readily from contact with chemicals in pool water. However, potential inhalation exposures to malaoxon by individuals in the treatment area are considered the same as those from aerial application, and are presented in that section.

Exposures to workers involved in ground applications are different from those to workers involved in aerial applications. Doses to ground workers were calculated based upon routine and extreme scenarios. Calculated doses of malathion determined for single route exposure scenarios to workers range from 3.0×10^{-4} mg/kg/day for a routine exposure scenario for mixer/loaders to 0.153 mg/kg/day for an extreme exposure scenario for the backpack applicators. Exposures were also determined for hydraulic rig applicators. Data from pesticide studies on a surrogate chemical, 2,4-D, were the basis for calculations of exposures to backpack and hydraulic rig applicators and mixer/loaders (Lavy *et al.*, 1987). The calculated doses for ground personnel determined for the assessment of aerial applicators, and which include scenarios for accidental exposure, ranged from $6.2x10^{-2}$ to $8.4x10^{-2}$ mg/kg/day for various scenarios that involved spills of malathion concentrate onto the skin.

(c) Quantitative Risk Assessment

Ground applications of malathion bait result in lower risk to the public than aerial applications. There is less likelihood of exposure to ground applications because the applications specifically target the trees and foliage rather than the entire area. Risks to the general public from ground applications therefore would be even lower than those from aerial applications, which were determined to be acceptable.

Based on the HQs determined for the exposure scenarios for ground workers, there were no unacceptable risks for backpack applicators, mixer/loaders, or hydraulic rig applicators. Accidental exposure conditions were evaluated in the section on malathion aerial application, and indicated that there were no unacceptable risks.

(d) Qualitative Risk Assessment

Risk of humans developing neurotoxic effects, immunotoxic effects, genotoxic or mutagenic effects, oncogenic effects, or reproductive or developmental effects from exposures to malathion bait spray are similar for both aerial and ground applications. These risks are discussed in the section on aerial application of malathion bait.

(3) Spinosad Aerial Application

(a) Hazard Assessment

Spinosad is a mixture of compounds produced naturally by the actinomycetes bacteria, *Saccharopolyspora spinosa*. Spinosad is registered for use on various crops and has permanent EPA-approved tolerances for some fruits (including citrus), nuts, vegetables, cotton, and meat. The active ingredients in spinosad are spinosyn A and spinosyn D. Although the bait formulation includes sugars and attractants, these chemical substances are of low toxicity and are not expected to contribute substantially to overall hazard.

Unlike malathion, spinosad has not been widely analyzed in toxicological testing because of its relatively recent registration status. Acute toxicity of spinosad to humans is low by all routes of exposure. The symptoms of intoxication are unique and are characterized by initial flaccid paralysis followed by weak tremors and continuous movement (Thompson *et al.*, 1995). The acute oral median lethal dose (LD_{50}) to rats is greater than 5,000 milligrams (mg) of spinosad per kilogram (kg) of body weight (Dow Agrosciences, 1998; EPA, 1998a). The acute dermal LD_{50} to rats is greater than 2,800 mg/kg. The acute inhalation median lethal concentration (LC_{50}) to rats is greater than 5.18 mg per Liter (L). Primary eye irritation tests in rabbits showed slight conjunctival irritation. Primary dermal irritation studies in rabbits showed slight transient erythema and edema. Spinosad was not found to be a skin sensitizer.

Subchronic and chronic studies of spinosad also indicate low hazard to mammals. The systemic NOEL for spinosad from chronic feeding of dogs was determined to be 2.68 mg/kg/day (EPA, 1998a). The LOEL for this study (8.22 mg/kg/day) was based upon vacuolated cells in glands (parathyroid) and lymphatic tissues, arteritis, and increases in serum enzymes. No studies found any evidence of neurotoxicity or neurobehavioral effects. A neuropathology NOEL was determined to be 46 mg/kg/day for male rats and 57 mg/kg/day for female rats. No evidence of carcinogenicity was found in chronic studies of mice and rats. EPA has classified the carcinogenic potential of spinosad as group E—no evidence of carcinogenicity (EPA, 1998b).

There has been no evidence of mutagenic effects from spinosad (EPA, 1998a). Tests have been negative for mouse forward mutations without metabolic activation to 25 µg/ml and with metabolic activation to 50 µg/ml. No increases in chromosomal aberrations in Chinese hamster ovary cells were observed without activation to 35 µg/ml or with activation to 500 µg/ml. No increase in frequency of micronuclei in bone marrow cells of mice were found for 2-day exposures of spinosad up to 2,000 µg/ml. No unscheduled DNA synthesis was observed in adult rat hepatocytes in vitro at concentrations of spinosad as high as 5 µg/ml.

Reproductive and developmental toxicity studies have found that these effects occur only at doses that exceed those which cause other toxic effects to the parent animal. The reproductive NOEL from a 2-generation study of rats was determined to be 10 mg/kg/day with a LOEL of 100 mg/kg/day based upon decreased litter size, decreased pup survival, decreased body weight, increased dystocia, increased vaginal post-partum bleeding, and increased dam mortality (EPA, 1998a).

As with any recently developed compound, there are some data gaps. However, adequate data are available to determine potential effects by quantitative and qualitative analyses for given environmental exposure.

(b) Exposure Analysis

Exposure to spinosad bait spray involves simultaneous exposure to both spinosad and bait in the formulated insecticide. The consequence of this fact is that the determined risk must be based on the cumulative exposure to both chemicals. However, the baits are of low toxicity and potential hazard from baits will not be considered in a quantitative manner. Hazard from exposure to the bait relates only to those individuals with allergic or hypersensitive reactions to the compounds present and this subject is discussed in the section on hypersensitivity.

Calculated doses of spinosad from aerial application were determined for routine, extreme, and accidental exposure scenarios. The exposure scenarios for the general population to spinosad indicate very low exposures by most potential routes. Calculated doses to the general public ranged from 2.01×10^{-9} mg/kg/day spinosad for the routine exposure scenario of a 10 kg child spending 4 hours in a swimming pool to 1.18×10^{-5} mg/kg/day spinosad for the accidental exposure scenario of a 10 kg toddler who consumes 250 milliliters (ml) of runoff water from a driveway that has not been washed off shortly after an application of spinosad bait.

Calculated doses from aerial applications of spinosad bait to workers ranged from 5.11×10^{-7} mg/kg/day spinosad for the routine exposure scenario of pilots to 3.0×10^{-3} mg/kg/day spinosad for the extreme exposure scenario of ground personnel. The dose from the accidental exposure scenario where a worker spills concentrate on an uncovered lower leg and does not wash it off for 2 hours is 2.78×10^{-3} mg/kg/day spinosad.

(c) Quantitative Risk Assessment

The RRV selected for spinosad is 0.027 mg/kg/day for the general population and 0.27 mg/kg/day for occupational exposures. These values are based on a chronic feeding study in dogs. This study determined a NOEL to dogs of 2.68 mg/kg/day and a LOEL to dogs of 8.46 mg/kg/day based upon vacuolization in glandular cells (parathyroid) and lymphatic tissues, arteritis, and increases in serum enzymes (EPA, 1998a). The RRV values were determined by applying an uncertainty (safety) factor of 10 to the NOEL to account for inter-species variation for occupational exposures and by applying an uncertainty factor of 100 to the NOEL to account for inter-species and intra-species variation for general population exposures. There is no increased sensitivity of infants or children to spinosad over that of the general population, so it is unnecessary to apply an additional uncertainty factor of 10 for protection of this subgroup of the population.

The risks of adverse effects to program workers and the general population are very slight. The HQs for all scenarios are much less than 1. The highest HQ for occupational exposures ($1.1x10^{-2}$) to spinosad is for the extreme scenario of ground personnel activity. The likelihood of any adverse effects to ground personnel in this scenario is very slight. The risks of adverse effects are negligible for all occupational exposures to spinosad. The highest HQ for general population exposures ($4.4x10^{-4}$) to spinosad is for the accidental scenario where a 10 kg toddler consumes 250 ml of runoff water shortly after an application of spinosad bait. The HQ for this scenario still exceeds a 100-fold safety factor, so the potential risks for this scenario are minimal. Other scenarios for the general population have even greater safety factors. Based upon the HQs determined for all exposure scenarios, there are not expected to be any unacceptable risks from applications of spinosad bait spray.

(d) Qualitative Risk Assessment

Neurotoxicity

No subchronic or chronic studies found any evidence of neurotoxicity or neurobehavioral effects. A neuropathology NOEL was determined to be 46 mg/kg/day for male rats and 57 mg/kg/day for female rats. Based upon this, it is expected that any neurotoxic response to spinosad would require exposures greater than those anticipated from aerial applications of spinosad bait spray.

Immunotoxicity

Primary dermal irritation studies in rabbits showed slight transient erythema and edema. Spinosad was not found to be a skin sensitizer. Although no studies indicate any evidence of immunotoxic response, some individuals may have allergic reactions at higher exposures than would be expected from program applications.

Genotoxicity and Mutagenicity

There has been no evidence of mutagenic effects from spinosad (EPA, 1998a). Tests have been negative for mouse forward mutations without metabolic activation to 25 µg/ml and with metabolic activation to 50 µg/ml.

No increases in chromosomal aberrations in Chinese hamster ovary cells were observed without activation to 35 µg/ml or with activation to 500 µg/ml. No increases in frequency of micronuclei in bone marrow cells of mice were found for 2-day exposures of spinosad up to 2,000 µg/ml. No unscheduled DNA synthesis was observed in adult rat hepatocytes in vitro at concentrations of spinosad as high as 5 µg/ml. Based upon this, no genotoxic or mutagenic effects are expected from program applications of spinosad bait spray.

Carcinogenicity

No evidence of carcinogenicity was found in any chronic studies of mice and rats. EPA has classified the carcinogenic potential of spinosad as group E—no evidence of carcinogenicity (EPA, 1998b). Based upon this, no carcinogenic effects are expected from program applications of spinosad bait spray.

Reproductive and Developmental Toxicity

Reproductive and developmental toxicity studies have found that these effects occur only at doses that exceed those which cause other toxic effects to the parent animal. The reproductive NOEL from a 2-generation study of rats was determined to be 10 mg/kg/day with a LOEL of 100 mg/kg/day based upon decreased litter size, decreased pup survival, decreased body weight, increased dystocia, increased vaginal post-partum bleeding, and increased dam mortality (EPA, 1998a). Based upon this, no adverse reproductive or developmental effects are expected from program applications of spinosad bait spray.

Impurities in Formulations Applied

The primary active ingredients in spinosad are spinosyn factor A and spinosyn factor D. All other substances in the formulated products of spinosad are of lower toxicity. Spinosyns are relatively inert and their metabolism in rats results in either parent compound or – and O-demethylated glutathione conjugates as excretory products (EPA, 1998a). Studies have found that 95% of the spinosad residues in rats are eliminated within 24 hours.

Synergistic Effects

The mechanism of toxic action of spinosad relates to persistent activation of nicotinic acetylcholine receptors and prolongation of acetylcholine responses (Salgado *et al.*, 1997). This prolonged response leads to involuntary muscle contractions and tremors. This mode of toxic action is unique to spinosyns. No evidence has been found that would indicate that exposure to other substances increases this intoxication response from exposure to spinosad in a synergistic manner. In fact, this mechanism may actually be antagonistic to the adverse effects from some other chemical classes of pesticides.

(4) Ground Applications of Spinosad Bait

(a) Hazard Assessment

The hazard assessment for spinosad bait spray is presented in the previous section on spinosad aerial application. The formulation, including the lure, is the same with both application methods.

(b) Exposure Analysis

Calculated doses of spinosad from ground application were determined for routine, extreme, and accident scenarios. Spinosad exposures to the public from ground applications are generally the same, but may be somewhat less than from aerial applications because the directed spray hits the trees and foliage and not the surrounding area. Calculated doses to the public from ground application of spinosad are, therefore, considered the same as from aerial application and are presented in that section.

Exposures to workers involved in ground applications are different from those to workers involved in aerial applications. Doses to ground workers were calculated based upon routine and extreme scenarios. Calculated doses determined for single route exposure scenarios to workers range from 9.0×10^{-7} mg/kg/day spinosad for a routine exposure scenario for hydraulic rig applicators to 7.3×10^{-6} mg/kg/day spinosad for an extreme exposure scenario for the mixers and loaders. Exposures were also determined for backpack applicators. Data from pesticide studies on a surrogate chemical, 2,4-D, were the basis for calculations of exposures to backpack and hydraulic rig applicators and mixer/loaders (Lavy *et al.*, 1987). The calculated doses for ground personnel determined for the assessment of aerial applicators, and which include scenarios for accidental exposures, ranged from 1.1×10^{-3} mg/kg/day spinosad to 3.0×10^{-3} mg/kg/day spinosad for various scenarios that involved spills of spinosad concentrate onto the skin.

(c) Quantitative Risk Assessment

Ground applications of spinosad bait result in lower risk to the public than aerial applications. There is less likelihood of exposure to ground applications than to aerial applications because the ground application is directed at the trees and foliage rather than the entire surrounding area. Risks to the general public from ground applications therefore would be even lower than those from aerial applications, which were determined to be acceptable.

Based on the HQs determined for the exposure scenarios for ground workers, there were no unacceptable risks for backpack applicators, mixer/loaders, or hydraulic rig applicators. Accidental exposure conditions were evaluated in the section on spinosad aerial application, and indicated that there were no unacceptable risks.

(d) Qualitative Risk Assessment

Risk of humans developing neurotoxic effects, immunotoxic effects, genotoxic or mutagenic effects, oncogenic effects, or reproductive or developmental effects from exposures to spinosad bait spray are similar for both aerial and ground applications. These risks are discussed in the section on aerial application of spinosad bait.

(5) SureDye Aerial Application

(a) Hazard Assessment

SureDye bait is a formulation of a red xanthene dye—phloxine B. The mechanism of toxic action of phloxine B to invertebrates occurs through the oxidation of susceptible tissues. Mammals and higher organisms lack this tissue structure and are not affected in the same way as invertebrates.

Phloxine B is a halogenated xanthene dye registered as D&C (Drug and Cosmetic) Red Dye #28 for use as a color additive in drugs by the Food and Drug Administration under 21 Code of Federal Regulations (CFR) 74.1328 and as a color additive in cosmetics under 21 CFR 74.2328.

Unlike malathion, phloxine B has not been widely analyzed as a pesticide in toxicological testing. Generally, toxicity data are available from tests related to drug and cosmetic usage. Acute toxicity of phloxine B to humans is low by all routes of exposure. The acute oral toxicity of phloxine B is very slight to mammals (Hansen *et al.*, 1958; Webb *et al.*, 1962; Industrial Bio-Test Laboratories, 1962a, 1962b). The low metabolism, low toxicity, and rapid excretion in mammals probably account for the low mortality observed (Webb *et al.*, 1962; Hansen *et al.*, 1958). Phloxine B is a mild skin and eye irritant. Phloxine B has been shown to be a skin sensitizer (Wei *et al.*, 1994).

Human experience using cosmetics containing phloxine B has been summarized by the number of complaints received per million units sold (Toilet Goods Association, Inc., 1965). These rates of alleged adverse effects from formulated cosmetics are well within reasonable limits of safety for the consuming public (range from 2.6 to 37.1 per million units sold for different cosmetic groups, although it is uncertain whether the dye or other agents in the product formulations were responsible. Although it is possible that some individuals may have allergic responses to phloxine B, there was no evidence of immunotoxic responses from repeated applications of the red dye to rabbit skin (Leberco Laboratories, 1965).

Testing also indicates low chronic toxicity of phloxine B to mammals. The MADI for phloxine B in humans is 1.25 mg/kg/day (FR 47(188):42567 on Tuesday, September 28, 1982). Studies of phloxine B indicate that this compound has a low systemic chronic toxicity to mammals. Phloxine B is not considered to be carcinogenic by either the National Toxicology Program (NTP) or the International Agency for Research on Cancer (IARC) (Baker, 1994; Baker, 1994a). Mutagenicity and genotoxicity tests have included some results that are clear and some that are equivocal. Reproductive and developmental toxicity have been recorded in laboratory tests equivalent to or greater than the highest doses in drugs (RTECS, 1994; Seno *et al.*, 1984; McEnerney *et al.*, 1977).

There are some data gaps. No regulatory review for registration has been performed for SureDye by EPA. However, adequate data may be available to determine potential effects by quantitative and qualitative analyses for given environmental exposures.

(b) Exposure Analysis

Exposure to SureDye bait spray involves simultaneous exposure to both phloxine B and the bait in the formulated insecticide. The exposure calculations are based upon exposure to the active ingredient, phloxine B. The bait is relatively non-toxic.

Calculated doses of phloxine B from aerial application were determined for routine, extreme, and accidental exposure scenarios. The exposure scenarios for the general population to phloxine B indicate very low exposures by most potential routes. Calculated doses to the general public ranged from $3.1x10^{-8}$ mg/kg/day phloxine B for the routine exposure scenario of a 10 kg child drinking from runoff water from impervious surfaces following a rainstorm to $4.26x10^{-3}$ mg/kg/day phloxine B for the extreme exposure scenario of an adult who consumes vegetation that has not been washed off shortly after an application of SureDye bait.

Calculated doses from aerial applications of SureDye bait to workers ranged from $4.6x10^{-6}$ mg/kg/day phloxine B for the routine exposure scenario of pilots to $1.32x10^{-1}$ mg/kg/day phloxine B for the extreme exposure scenario of ground personnel. The dose from the accidental exposure scenario where a worker spills concentrate on an uncovered lower leg and does not wash it off for 2 hours is $7.2x10^{-2}$ mg/kg/day phloxine B.

(c) Quantitative Risk Assessment

The RRV selected for phloxine B is the same as the MADI for humans of 1.25 mg/kg/day (FR 47(188):42567 on Tuesday, September 28, 1982) as determined by the U.S. Department of Health and Human Services. This is based on the contention that the maximum consumption allowed by the MADI is adequate to prevent adverse human health effects and exposures in agency eradication programs should not exceed the MADI. The same exposure level will be used for the RRV for both general population and occupational exposures.

The risks of adverse effects to program workers and the general population are very slight. The HQs for all scenarios are much less than 1. The highest HQ (0.1036) for occupational exposures ($1.32x10^{-1}$) is for phloxine B in the extreme scenario of ground personnel activity. The likelihood of any adverse effects to ground personnel in this scenario is very slight, particularly when considering that the diminished risk afforded by the safety precautions required by the program was not considered in this analysis. The risk of adverse effects are negligible for most occupational exposures. The highest HQ (0.0034) for general population exposures ($4x10^{-3}$) is to phloxine B is for the extreme scenario for consumption of contaminated vegetation. The hazard quotient for this scenario still exceeds a 100-fold safety factor, so the potential risks for this scenario are minimal. Other scenarios for the general population have even greater safety factors. Based upon the HQs determined for all exposure scenarios, there are not expected to be any unacceptable risks from applications of SureDye bait spray.

(d) Qualitative Risk Assessment

Neurotoxicity

Unlike malathion, phloxine B is not known to be neurotoxic. It is expected that any neurotoxic response to phloxine B would require exposures greater than those anticipated from aerial applications of SureDye bait spray.

Immunotoxicity

Human experience using cosmetics containing phloxine B has been summarized by the number of complaints received per million units sold (Toilet Goods Association, Inc., 1965). These rates of alleged adverse effects from formulated cosmetics are well within reasonable limits of safety for the consuming public (range from 2.6 to 37.1 per million units sold for different cosmetic groups, although it is uncertain whether the dye or other agents in the product formulations were responsible. Although it is possible that some individuals may have allergic responses to phloxine B, there was no evidence of immunotoxic responses from repeated applications of the red dye to rabbit skin (Leberco Laboratories, 1965). Skin sensitization from exposure to phloxine B has been found to occur with direct and high exposures (Wei *et al.*, 1994). These exposures are possible in accidents to workers who do not wear the required protective clothing or follow the safety procedures. The exposures to the general public are lower than would be anticipated to result in skin sensitization.

Genotoxicity and Mutagenicity

Genotoxicity and mutagenicity tests have included some results that are clear and some that are equivocal. A mutagenicity assay of carp indicated that phloxine B has DNA-damaging capacity (Tonogai *et al.*, 1979b). EPA GENETOX Program of 1988 determined that the data from rec assays and histidine reversion-Ames tests of phloxine B are inconclusive (RTECS, 1994).

Carcinogenicity

Two-year feeding studies of rats and dogs at dietary levels up to 1% phloxine B indicated no adverse effects from visible or pathologic observations (Industrial Bio-Test Labs, 1965a; 1965b). Lifetime studies of mice found no evidence of tumors when dermal applications as 1% solutions of phloxine B were applied weekly (Leberco Labs, 1964;

Hazleton Labs, 1969). Phloxine B is not considered to be carcinogenic by either the National Toxicology Program (NTP) or the International Agency for Research on Cancer (IARC) (Baker, 1994; Baker, 1994a).

Reproductive and Developmental Toxicity

The oral LEL for reproductive toxicity of phloxine B to 1- to 22-day pregnant female rats was determined to be 63,000 mg/kg and to 6- to 16-day pregnant female mice was determined to be 39,600 mg/kg (RTECS, 1994). D&C Red Dye #28 was shown to cause maternal toxicity to female mice at dietary levels of 3 and 5% dose levels. A teratogenic effect (split cervical arches) was observed at the 1% dose level (Seno *et al.*, 1984).

Impurities in Formulations Applied

The manufacturer indicates that there are no significant inert ingredients in SureDye. Phloxine B is relatively inert. Phloxine B is not metabolized by mammals (Webb *et al.*, 1962). Degradation of phloxine B results in detoxification of this relatively nonionic compound (Heitz and Wilson, 1978). Bromine is the only degradation product of toxicological interest from phloxine B, but the potential exposure resulting from the degradation process would be to only very low concentrations.

Synergistic Effects

Uranine has been shown to function as a synergist to phloxine B against some insect pests (Carpenter *et al.*, 1984). Knowledge of this synergistic action has been applied to increase the overall efficacy of the SureDye formulation. It is known that other halogenated and nonhalogenated xanthene dyes are also synergistic, but most are not used as pesticides or not expected to result in situations where there could be simultaneous exposures.

(6) Ground Applications of SureDye Bait

(a) Hazard Assessment

The hazard assessment for SureDye bait spray is presented in the previous section on SureDye aerial application. The formulation, including the lure, is the same with both application methods.

(b) Exposure Analysis

Calculated doses of SureDye from ground application were determined for routine, extreme, and accident scenarios. SureDye exposures to the public from ground applications are generally the same, but may be somewhat less than from aerial applications because the directed spray hits the trees and foliage, and not the surrounding area. Calculated doses to the public from ground application of SureDye are, therefore, considered the same as from aerial application and are presented in that section.

Exposures to workers involved in ground applications are different from those to workers involved in aerial applications. Doses to ground workers were calculated based upon routine and extreme scenarios. Calculated doses determined for single route exposure scenarios to workers range from 1.8×10^{-4} mg/kg/day phloxine B for a routine exposure scenario for mixer/loaders to 7.8×10^{-4} mg/kg/day phloxine B for an extreme exposure scenario for the backpack applicators. Exposures were also determined for hydraulic rig applicators. Data from pesticide studies on a surrogate chemical, 2,4-D, were the basis for calculations of exposures to backpack and hydraulic rig applicators and mixer/loaders (Lavy *et al.*, 1987). The calculated doses for ground personnel determined for the assessment of aerial applicators, and which include scenarios for accidental exposure, ranged from 2.7×10^{-1} mg/kg/day phloxine B to 6.9×10^{-1} phloxine B for various scenarios that involved spills of SureDye concentrate onto the skin.

(c) Quantitative Risk Assessment

Ground applications of SureDye bait result in lower risk to the public than aerial applications. There is less likelihood of exposure to ground applications than to aerial applications because the ground application is directed at the trees and foliage rather than the entire surrounding area. Risks to the general public from ground applications therefore would be even lower than those from aerial applications, which were determined to be acceptable.

Based on the HQs determined for the exposure scenarios for ground workers, there were no unacceptable risks for backpack applicators, mixer/loaders, or hydraulic rig applicators. Accidental exposure conditions were evaluated in the section on SureDye aerial application, and indicated that there were no unacceptable risks.

(d) Qualitative Risk Assessment

Risk of humans developing neurotoxic effects, immunotoxic effects, genotoxic or mutagenic effects, oncogenic effects, or reproductive or developmental effects from exposures to SureDye bait spray are similar for both aerial and ground applications. These risks are discussed in the section on aerial application of SureDye bait.

b. Soil Treatments

The human health and safety risks to the public and workers from the application of chlorpyrifos, diazinon, and fenthion as soil treatments are considered in this section. Because chlorpyrifos is being considered for use at two rates of application, a risk assessment was performed for the potential exposures that could occur from each application rate.

(1) Chlorpyrifos

(a) Hazard Assessment

Chlorpyrifos is an organophosphate insecticide whose mode of toxic action is primarily through AChE inhibition (Smith, 1987; Klaassen *et al.*, 1986). At low doses, the signs and symptoms of AChE inhibition in humans include localized effects (such as blurred vision) and systemic effects (such as nausea, sweating, dizziness, and muscular weakness). The effects of higher doses may include irregular heartbeat, elevated blood pressure, cramps, convulsions, and respiratory failure.

The acute oral toxicity of chlorpyrifos is moderate to severe in humans (Gosselin *et al.*, 1984). Chlorpyrifos is considered moderately toxic (EPA Toxicity Category II) to other mammals through oral and dermal routes of exposure. Acute inhalation toxicity is considered to be a data gap by EPA (EPA, OPP, 1984a), although studies have indicated that the acute inhalation toxicity of chlorpyrifos is moderate (EPA, OPP, 1984a). Chlorpyrifos is a slight to moderate dermal irritant, depending on the formulation, and is considered a slight to moderate eye irritant, showing conjunctival irritation that clears after 48 hours (EPA, OPP, 1984a; 1989d).

Reports of chronic and subchronic toxicity tests, as measured by plasma and red blood cell cholinesterase (ChE) inhibition, indicate that the toxicity to humans is relatively low. A human oral RfD of 0.003 mg/kg/day was established by EPA based on no cholinesterase inhibition at 0.03 mg/kg/day, and an uncertainty factor of 10 to account for the range of human sensitivity for cholinesterase inhibition (EPA, ORD, 1988). Cholinesterase inhibition in red blood cells from dermal exposure was reported to occur at higher doses (EPA, OPP, 1989c). Subchronic inhalation exposure at the highest attainable vapor concentration (20.6 ppm) to rats over 90 days produced no ChE inhibition. The major metabolite of chlorpyrifos, TCP, is structurally similar and is not thought to be a cholinesterase inhibitor (EPA, OPP, 1989d).

Chlorpyrifos has not shown delayed neurotoxicity at the doses tested (EPA, OPP, 1984a). There was no observable evidence of dermal sensitization, and data on immunotoxicity indicate that chlorpyrifos does not induce delayed dermal hypersensitivity, as tested in guinea pigs. The data on carcinogenicity suggest that chlorpyrfos is noncarcinogenic. Most studies on mutagenicity in mammals indicate that chlorpyrifos is nonmutagenic, although some results suggest that chlorpyrifos may cause chromosomal aberrations and may be directly toxic to DNA (LAI, 1992a).

Reproductive toxicity studies of chlorpyrifos have shown no effects at doses up to 1 mg/kg/day. EPA has determined that chlorpyrifos does not cause developmental toxicity at doses up to 15 mg/kg/day, and that it is not teratogenic at levels up to 10 mg/kg/day. Maternal effects (cholinesterase inhibition) were seen at 0.3 mg/kg/day, with a NOEL at 0.1 mg/kg/day (EPA, OPP, 1989d).

EPA lists a chronic feeding-oncogenicity study with rats as a FIFRA data gap, but adequate data are available to determine potential effects by quantitative and qualitative analyses for given environmental exposures.

(b) Exposure Analysis

Separate exposure analyses were performed for high and low application rates of chlorpyrifos soil drench treatments. Doses of chlorpyrifos to the general public were determined for routine, extreme, and accident scenarios. Calculated doses of chlorpyrifos at the low application rate determined for exposure scenarios to the general public range from 4.9×10^{-9} mg/kg/day for a routine exposure scenario of a 10 kg child drinking from a groundwater source in an area of California that was treated 72 hours before a rainstorm to 6.6×10^{-3} mg/kg/day for an extreme exposure scenario of a 10 kg child consuming soil from a drenched area immediately after application.

Doses to workers were calculated based upon routine, extreme, and accident scenarios for hand applicators and mixer/loaders. Calculated doses of chlorpyrifos from the low application rate determined for workers range from 7.7×10^{-4} mg/kg/day for a routine exposure scenario for mixer/loaders to 1.2×10^{-2} mg/kg/day for an extreme exposure scenario for a hand applicator. The calculated dose from an accident scenario in which a worker spills chlorpyrifos concentrate (or mixture which evaporates to pure chlorpyrifos) on an uncovered lower leg and does not wash for 2 hours is 8.7×10^{-4} mg/kg/day.

Calculated doses of chlorpyrifos at the high application rate determined for exposure scenarios to the general public range from 8.7×10^{-9} mg/kg/day for a routine exposure scenario of a 10 kg child drinking from a groundwater source in an area of California that was treated 72 hours before a rainstorm to 2.8×10^{-2} mg/kg/day for an extreme exposure scenario of a 10 kg child with pica consuming soil from a drenched area immediately after application.

Calculated doses of chlorpyrifos from the high application rate determined for workers range from 3.1×10^{-3} mg/kg/day for a routine exposure scenario for mixer/loaders to 4.8×10^{-2} mg/kg/day for an extreme exposure scenario for a hand applicator. The calculated dose from the accident scenario is the same as for chlorpyrifos at the low application rate because the exposure was assumed to be to the concentrate.

(c) Quantitative Risk Assessment

The oral RRVs used in this risk assessment were 0.003 mg/kg/day for acute, subchronic, and chronic effects for the general public and 0.03 mg/kg/day for acute, subchronic, and chronic effects for workers. The RRVs were derived from a NOEL for AChE inhibition (0.03 mg/kg/day) which was the basis for the derivation of the verified RfD from EPA. The inhalation RRV, based on the TLV-TWA recommended by ACGIH (1992), was 0.2 mg/m^3. For chlorpyrifos, exposures above the RRV, that is, an HQ above 1, may be cause for concern, and exposures that result in an HQ above 3 may be associated with clinical effects.

The HQs determined for routine exposure scenarios of chlorpyrifos at the low application rate to the general public indicated that there were no unacceptable risks of adverse effects. The extreme exposure scenario presented some cause for concern for a 10 kg child ingesting drenched soil immediately after application (HQ = 2.2). It is uncertain whether EPA would allow residential use of chlorpyrifos based on concerns relating to exposure to children.

The HQs for toxicity to workers were calculated based upon routine, extreme, and accident scenarios. In the routine and extreme scenarios at the low application rate, the HQs were less than 1, indicating that there were no unacceptable risks to soil drench applicators or mixer/loaders. An HQ of 0.3 was determined from the accident scenario in which a worker spilled chlorpyrifos concentrate on his/her lower leg and washed it off 2 hours later. Therefore, there is no cause for concern for an accidental exposure of this type.

In a routine exposure scenario of chlorpyrifos at the high application rate in which a 10 kg toddler plays for 1 hour on turf 6 hours after the pesticide is applied, the resulting HQ was 2.1. Another scenario that presented a cause for concern was the extreme exposure scenario in which a 10 kg child with pica ingests drenched soil immediately after chlorpyrifos application (HQ = 9.3). These exposures present a reason for concern in one case and a possibility of causing clinical effects in the other case. Again, concerns related to adverse health effects on children suggest that future program use of chlorpyrifos in residential settings is unlikely.

The HQs determined for workers were calculated based upon routine, extreme, and accident scenarios. The HQs calculated from the routine scenarios for the soil drench applicators and the mixer/loaders at the high application rate indicated that there were no unacceptable risks for these workers. However, the HQ of 1.6 for an extreme exposure scenario for the drench applicators might be cause for concern. Although the HQ is only slightly above 1, the dose/severity slope for humans was interpreted to be atypical based on the available data. Under these circumstances, any exposure level that exceeds the RRV might raise concerns, and exposure levels of 1 mg/kg/day (an HQ of about 3) may be associated with clinical effects. An HQ determined from the accident scenario was the same as for the low application rate (HQ = 0.3) because the exposure was assumed to be to the concentrate.

(d) Qualitative Risk Assessment

Neurotoxicity

Data on neurotoxicity of chlorpyrifos to mammals, other than that which occurs due to AChE inhibition, were not located. There was no evidence of delayed neurotoxicity in an acute study of hens (EPA, OPP, 1989d). It is not expected that the doses that could occur from exposures to either the low or high application rates of chlorpyrifos during program use would present an unacceptable risk of neurotoxicity.

Immunotoxicity

The only data available on immunotoxicity indicate that chlorpyrifos did not induce delayed dermal hypersensitivity in guinea pigs. Chlorpyrifos drench applications are not expected to pose an unacceptable risk of adverse immune system effects under the conditions of use in this program.

Genotoxicity and Mutagenicity

Most studies on mutagenicity in mammals indicate that chlorpyrifos is nonmutagenic. Some results suggest that chlorpyrifos may cause chromosomal aberrations and may be directly toxic to DNA, although these results were not seen in mammalian test systems (LAI, 1992a). The exposures to chlorpyrifos that are possible from program use are not likely to pose an unacceptable risk of genetic toxicity.

Carcinogenicity

EPA (EPA, OPP, 1989d) reported that mouse and rat chronic toxicity/oncogenicity studies did not reveal any evidence that chlorpyrifos is carcinogenic. Therefore, it is not expected that chlorpyrifos exposures from this program, at either the low or high application rates, would present an unacceptable risk of carcinogenicity.

Reproductive and Developmental Toxicity

Based on a 3-generation rat study, chlorpyrifos has shown no effects at doses up to 1 mg/kg/day. EPA has determined that chlorpyrifos does not cause developmental toxicity at doses up to 15 mg/kg/day, and that it is not teratogenic at levels up to 10 mg/kg/day. A reproductive and developmental NOEL is 2.5 mg/kg/day, based on postimplantation loss (EPA, OPP, 1989d). This NOEL is higher than the NOEL used for derivation of the RRV. Therefore, reproductive and developmental effects to the public are not expected from program use of chlorpyrifos at either the low or high application rates.

Impurities in Formulations Applied

TCP (also known as 3,5,6-TCP and 3,5,6-trichloropyridinol, or TC-pyridinol) is the major metabolite of chlorpyrifos. TCP is structurally similar to chlorpyrifos and is not considered to be an inhibitor of cholinesterase (EPA, OPP, 1989d).

Synergistic Effects

The toxicity of chlorpyrifos has been shown to be potentiated by another organophosphate (phosfolan). However, the insecticide phosfolan has been discontinued (Farm Chemicals Handbook, 1991) so that simultaneous exposure to the two pesticides should not occur. The addition of ascorbic acid (vitamin C) to the diet of rats was reported to enhance the toxicity of chlorpyrifos and increase serum phosphatase activity (U.S. DHHS, NIOSH, 1987).

(2) Diazinon

(a) Hazard Assessment

Diazinon is an organophosphate insecticide whose mode of toxic action is primarily through AChE inhibition (Smith, 1987; Klaassen *et al.*, 1986). At low doses, the signs and symptoms of AChE inhibition in humans include localized effects (such as blurred vision) and systemic effects (such as nausea, sweating, dizziness, and muscular weakness). The effects of higher doses may include irregular heartbeat, elevated blood pressure, cramps, convulsions, and respiratory failure.

The acute oral toxicity of diazinon is moderate to humans (Gosselin *et al.*, 1984). The acute toxicity of diazinon by the dermal route is low to moderate (Gaines, 1960; EPA, OPP, 1988a). Technical diazinon is not a dermal irritant, but other formulations may be slightly irritating to the skin (EPA, ODW, 1988). Diazinon has been shown to be a dermal sensitizer (EPA, OPP, 1988a). Diazinon is considered to be a mild eye irritant with corneal opacity and slight conjunctival redness from treatment (Agrochemicals Handbook, 1990; EPA, OPP, 1988a). Studies of delayed neurotoxicity have been negative or equivocal (EPA, OPP, 1988a).

Chronic testing indicates moderate to high toxicity in animals. The lowest NOEL based upon plasma AChE inhibition is 0.006 mg/kg/day in dogs (Williams *et al.*, 1959). A NOEL at 0.009 mg/kg/day was determined from a 92-day study of rats (Davies and Holub, 1980). Based upon the NOEL for AChE inhibition in this study, a human oral provisional acceptable daily intake (PADI) of 0.00009 mg/kg/day was established by EPA (EPA, OPTS, 1990a).

Several tests for carcinogenicity, mutagenicity, and genotoxicity have been completed. The tests for carcinogenicity provide good evidence that diazinon is not carcinogenic (NCI, 1979). Diazinon does not induce gene mutations in bacteria with or without metabolic activation (EPA, ECAO, 1984; EPA, OPTS, 1988). Studies of unscheduled DNA synthesis and sister chromatid exchange are also predominantly negative (Simmons *et al.*, 1979; Abe and Sasaki, 1982). Positive results were found for chromosomal aberrations in human lymphocytes (Lopez *et al.*, 1986).

Several reproductive and developmental studies have been conducted with diazinon. The lowest NOEL values for various outcomes were 7 mg/kg/day for reproductive effects, 20 mg/kg/day for maternal toxicity, 100 mg/kg/day for fetotoxicity, and 100 mg/kg/day for teratogenicity (EPA, ODW, 1988; EPA, OPP, 1988a).

Chronic feeding studies and rat reproduction studies are listed by EPA as FIFRA data gaps (EPA, OPTS, 1989), but adequate data are available to determine potential effects by quantitative and qualitative analyses for given environmental exposures.

(b) Exposure Analysis

Doses of diazinon for the general public were determined for routine, extreme, and accident scenarios. Calculated doses of diazinon determined for exposure scenarios to the general public range from 6.3×10^{-5} mg/kg/day for an exposure scenario of a child drinking from a contaminated groundwater source to 2.1×10^{-2} mg/kg/day for an extreme exposure scenario of a 10 kg child with pica ingesting soil immediately after application of the soil drench.

Doses to workers were calculated based upon routine, extreme, and accident scenarios for hand applicators and mixer/loaders. Calculated doses of diazinon determined for workers range from 4.8×10^{-4} mg/kg/day for a routine exposure scenario for mixer/loaders to 2.8×10^{-2} mg/kg/day for an extreme exposure scenario for a hand applicator.

(c) Quantitative Risk Assessment

The RRVs used in this risk assessment were 0.003 mg/kg/day for acute and subchronic effects, and 0.0005 mg/kg/day for chronic effects for the general public, and 0.03 mg/kg/day for acute and subchronic effects and 0.005 mg/kg/day for chronic effects for workers. The RRVs were derived from health advisories recommended by the EPA Office of Drinking Water (EPA, ODW, 1988). Since the health advisories were based on a study in which the high dose was associated only with cholinesterase inhibition, and no frank effects were observed, HQs of less than or equal to 2.5 did not cause substantial concern. However, HQs greater than 10 may be associated with severe clinical effects. The inhalation RRV, based on the threshold limit value-time weighted average (TLV-TWA) recommended by ACGIH (1992), was 0.1 mg/m^3. This TLV notes that skin absorption may be an important route of exposure.

The HQs determined for routine exposure scenarios of diazinon to the general public indicate no unacceptable risk from groundwater or soil consumption. The scenario in which a 10 kg toddler is exposed to diazinon dermally from 1 hour of playing on turf 6 hours after application results in an HQ of 1.7. However, because the HQ was less than 2.5, this exposure did not cause concern. The HQs determined for extreme exposure scenarios of diazinon to the general public indicate a cause for concern for a child consuming soil immediately after a soil drench application. However, the public will be adequately cautioned to prevent children or toddlers from entering the drenched area until after the spray has dried. Theoretical exposures of the public to drinking from groundwater sources or breathing air near areas where the soil has been drenched were determined to be toxicologically insubstantial relative to other routes of exposure.

The HQs determined for workers were calculated based upon routine, extreme, and accident scenarios. The HQs calculated from the routine and extreme scenarios for the soil drench applicators and the mixer/loaders indicated that there were no unacceptable risks for these workers. An HQ of 2 was determined from an accident scenario in which a worker spilled diazinon concentrate on a lower leg and washed it off 2 hours later. Again, for diazinon, HQs of less than or equal to 2.5 did not raise concern.

(d) Qualitative Risk Assessment

Neurotoxicity

Diazinon has been shown to cause neurological damage in offspring of mice treated during gestation (Spyker and Avery, 1977) and to nerve cells *in vitro* (Obersteiner and Sharma, 1976). Studies of delayed neurotoxicity of diazinon to chickens were either negative or equivocal (EPA, OPP, 1988a). Doses that might cause neurotoxicity in humans, other than that resulting from AChE inhibition, would not be expected to occur in this program. In addition, AChE inhibition would likely be noted (during routine testing) from exposures to lower doses, which would alert the worker to prevent continued exposure before higher doses could potentially produce lasting neurological effects.

Immunotoxicity

Diazinon has been shown to be a dermal sensitizer, but data demonstrating other immune reactions were not located. Therefore, there is insufficient evidence to clearly determine the risk of immune system effects in individuals exposed to diazinon at the levels anticipated in this program. However, based upon the limited evidence, program use of diazinon should not pose an unacceptable risk of adverse immune system effects.

Genotoxicity and Mutagenicity

Studies of mutagenicity of diazinon have generally produced negative results (EPA, ECAO, 1984; EPA, OPTS, 1988a; Simmons *et al.*, 1979; Abe and Sasaki, 1982), although chromosomal aberrations were detected in studies with human lymphocytes (Lopez *et al.*, 1986). However, it is unlikely that the exposures that could occur from program use of diazinon would pose an unacceptable risk of genotoxicity to the public or workers.

Carcinogenicity

From chronic bioassays in rats and mice, the National Cancer Institute (1979) has concluded that diazinon was not carcinogenic under the conditions of the tests. Therefore, it is unlikely that the potential diazinon exposures evaluated in the scenarios from this program would present an unacceptable risk of carcinogenicity.

Reproductive and Developmental Toxicity

The reproductive and developmental NOEL of 7 mg/kg/day (EPA, OPP, 1988a) is several orders of magnitude greater than the NOEL for AChE inhibition that served as the basis for the derivation of the RRV. Under these circumstances, parental cholinesterase inhibition and systemic effects, which both have lower NOELs, would be evident before there were unacceptable risks of developmental effects in humans.

Impurities in Formulations Applied

The main impurity and degradation product of concern in diazinon formulations is sulfotepp. This compound is relatively stable in the environment, can accumulate, and is more toxic than diazinon to mammals and aquatic organisms (Meier *et al.*, 1979). This compound has only been a problem when improper storage and handling resulted in transformation of the formulated product to higher levels of sulfotepp and monothiono-TEPP (Soliman *et al.*, 1982).

Synergistic Effects

Although the toxicity of diazinon may be potentiated by some other organophosphates and carbamates (Keplinger and Deichmann, 1967; Seume and O'Brien, 1960), it is impossible to predict multiple exposures and synergism from applications not related to this program. The toxicity of diazinon and malathion appears to be synergistic (Keplinger and Deichmann, 1967), and although they may be used within the same treatment program, simultaneous application of the two pesticides usually does not occur. The program applicators are instructed to allow the insecticide drench to penetrate the soil before leaving the treatment sites to prevent exposures to the soil drench chemicals. Even though it still may be possible for an individual to be exposed to diazinon and malathion within a critical exposure window, the implications of such an exposure are not clear. There is some potential for synergistic effects resulting from the combination of diazinon and inadvertent simultaneous pesticide application by the public; however, public notification about program treatments helps to minimize this risk.

(3) Fenthion

(a) Hazard Assessment

Fenthion is an organophosphate insecticide whose mode of toxic action is primarily through AChE inhibition (Smith, 1987; Klaassen *et al.*, 1986). At low doses, the signs and symptoms of AChE inhibition in humans include localized effects (such as blurred vision) and systemic effects (such as nausea, sweating, dizziness, and muscular weakness). The effects of higher doses may include irregular heartbeat, elevated blood pressure, cramps, convulsions, and respiratory failure. Fenthion has also been shown in animal studies to produce ocular effects similar to those observed in humans exposed to organophosphate pesticides (EPA, OPP, 1988b).

The acute oral toxicity of fenthion is moderate to severe in humans (Gosselin *et al.*, 1984). Acute dermal and inhalation toxicities are considered to be moderate, although in animal studies, whole-body exposure to fenthion was eight times more toxic than snout-only exposure (Iwasaki *et al.*, 1988). Fenthion is minimally irritating to the skin and eyes (EPA, OPP, 1988b).

Chronic and subchronic toxicity testing and accidental and intentional human exposure reports of fenthion indicate very high toxicity to humans. EPA has recommended an RfD of 0.00005 mg/kg/day based on an LEL of 0.05 mg/kg/day from a 1-year dog feeding study and an uncertainty factor of 1,000. The World Health Organization has established an acceptable daily intake of 0.001 mg/kg/day (EPA, OPP, 1990a).

Fenthion has five cholinesterase-inhibiting metabolites: fenthion sulfoxide, fenthion sulfone, fenthion oxygen analog, fenthion oxygen analog sulfoxide, and fenthion oxygen analog sulfone (EPA, OPP, 1988b).

Two studies using rat and chick cell cultures determined that fenthion can affect dopamine levels and nerve cell growth, indicating that there is a possibility of fenthion being neurotoxic. Reduced antibody titers in chickens that were fed fenthion suggest that it may be immunosuppressive. Fenthion was not a dermal sensitizer when tested in guinea pigs (EPA, OPP, 1985). Fenthion at doses up to 25 mg/kg has been found to be nonmutagenic in male mice (EPA, OPP, 1988b).

Reproductive and developmental toxicities have been investigated using rabbits exposed to fenthion during gestation. The maternal toxicity NOEL is 6 mg/kg/day, the fetotoxic NOEL is 2 mg/kg/day and the teratogenic NOEL is 18 mg/kg/day. Other reproductive effects were studied in rats that showed no adverse effects in 3 generations exposed to doses as high as 75 ppm in their feed (EPA, OPP, 1988b).

Fenthion is classified by EPA in category D for carcinogenicity, indicating that insufficient evidence is available to draw a conclusion regarding its potential to produce cancer in laboratory animals or humans. Therefore, carcinogenicity studies of fenthion have been listed by EPA as data required for reregistration (EPA, OPP, 1988b). Nonetheless, adequate data are available to determine potential effects by quantitative and qualitative analyses for given environmental exposures.

(b) Exposure Analysis

Doses of fenthion for the general public were determined for routine, extreme, and accident scenarios. Calculated doses of fenthion determined for exposure scenarios to the general public range from

$1.2x10^{-6}$ mg/kg/day for a routine exposure scenario of a 10 kg child drinking from a groundwater source in an area in California after a rainstorm 72 hours after a treatment to $2.2x10^{-2}$ mg/kg/day for an extreme exposure scenario of a 10 kg child with pica ingesting soil from a drenched area immediately after application.

Doses to workers were calculated based upon routine, extreme, and accident scenarios for hand applicators and mixer/loaders. Calculated doses of fenthion determined for workers ranged from $9.0x10^{-4}$ mg/kg/day for a routine exposure scenario for mixer/loaders to $4.0x10^{-2}$ mg/kg/day for an extreme exposure scenario for a hand applicator. The calculated dose from an accident scenario in which a worker spills fenthion concentrate or mixture on an uncovered lower leg and does not wash for 2 hours is $7.6x10^{-3}$ mg/kg/day.

(c) Quantitative Risk Assessment

The oral RRVs used in this risk assessment were 0.00005 mg/kg/day for acute, subchronic, and chronic effects for the general public and 0.0005 mg/kg/day for acute, subchronic, and chronic effects for workers. The oral RRVs were based on an RfD recommended by the EPA Office of Pesticide Programs, derived from an AEL of 0.05 mg/kg/day for spleen enlargement in a 1-year dog study. The inhalation RRV was 0.2 mg/m^3, which was adopted from the TLV-TWA established by the ACGIH (1992).

The HQs determined for the extreme and the routine exposure scenarios of fenthion to the general public indicated that the projected exposures in some scenarios presented substantial risk of adverse effects. The HQs exceeded 1 in routine scenarios depicting a 10 kg toddler incidentally ingesting a very small amount of soil from a drenched area immediately after a fenthion application (HQ = 11), and a 10 kg toddler dermally exposed to fenthion for 1 hour by playing on the ground 6 hours after drench application (HQ = 102). The extreme exposure scenarios obviously resulted in much higher HQs. The HQs determined for both routine and extreme scenarios of a 10 kg child drinking from a groundwater source receiving runoff from fenthion soil drench application indicated that groundwater contamination was toxicologically insubstantial relative to other routes of exposure.

The HQs for toxicity to workers were calculated based upon routine, extreme and accident scenarios. The HQs determined for mixer/loaders in both the extreme and routine exposure scenarios presented some risk of adverse effects (HQs = 3.3 and 1.7, respectively). For the hand applicators, the calculated HQs indicated that both the extreme and the routine exposure scenarios presented substantial risk of adverse effects (HQs = 80 and 44, respectively). An HQ of 0.15 was determined from the accident scenario in which a worker spilled fenthion concentrate on a lower leg and washed it off 2 hours later. Therefore, there was no cause for concern for an accidental exposure of this type. Although it may appear illogical that a routine exposure would be more of a health risk than an accidental exposure, the rationale is that under accidental exposure conditions, the pesticide would likely be rinsed off much more rapidly, diminishing the time for dermal absorption.

(d) Qualitative Risk Assessment

Neurotoxicity

In vitro studies have suggested that fenthion may be a neurotoxic agent, although the only clear data in animals and humans show cholinergic symptoms resulting from AChE inhibition after exposure to high doses. Epidemiological surveys of workers exposed to fenthion indicate that symptoms disappear within 4 hours of exposure; there was no evidence of peripheral neuropathy (Wolfe *et al.*, 1974; Beat and Morgan, 1977). Scenarios in which a child consumed soil or contacted sprayed ground predict exposures that pose a risk of adverse systemic effects. Therefore, exposures at this and higher levels may put the public or workers at risk of temporary nervous system effects.

Immunotoxicity

On the basis of negative responses in dermal sensitization studies in guinea pigs (EPA, OPP, 1985), and the lack of evidence for humoral and cell-mediated immunotoxic potential (Singh *et al.*, 1988; Rodgers *et al.*, 1986), fenthion is unlikely to present an unacceptable immunological risk to humans.

Genotoxicity and Mutagenicity

Fenthion was found to be nonmutagenic in male mice up to 25 mg/kg, with a systemic NOEL for mutagenicity at 10 mg/kg/day. Tests for gene mutation, structural chromosomal aberrations, and other genotoxic effects were negative (EPA, OPP, 1988b). This evidence suggests that fenthion does not pose a risk of causing heritable genetic mutations or somatic genotoxicity to humans exposed in the fruit fly program.

Carcinogenicity

EPA has classified fenthion as an Group D (inadequate evidence) relative to carcinogenic potential based on review of two oncogenicity studies in the rat and one in the mouse (EPA, OPP, 1988b). These studies did not provide sufficient evidence to draw a firm conclusion about carcinogenicity in humans.

Reproductive and Developmental Toxicity

Fenthion was found to produce reproductive and developmental effects in a rabbit teratology study (EPA, OPP, 1986b). In this study, the maternal toxicity NOEL was 6 mg/kg/day, the fetotoxic NOEL was 2 mg/kg/day, and the teratogenic NOEL was greater than or equal to 18 mg/kg/day. EPA concluded that fenthion does not induce developmental effects in rabbits. These exposure levels are several orders of magnitude greater than the NOEL (0.05 mg/kg/day) used to derive the RfD of 0.00005 mg/kg/day for fenthion recommended by EPA. Therefore, reproductive and developmental effects would be secondary to systemic effects that would be observed at a much lower dose. Under these circumstances, unacceptable risks of reproductive and developmental effects to the public and most workers would not be expected from program use of fenthion. However, the extreme exposure scenario posed some risk of toxicity to the fetus of a pregnant soil drench applicator.

Impurities in Formulations Applied

Technical fenthion was found to have 23 impurities, eight of which have been identified as phosphorus-containing. Some of these have been tentatively identified as the sulfoxide and sulfone of fenthion and the sulfoxide and sulfone of fenoxon. Technical fenthion was reported to be only slightly more toxic than the purified fenthion, based on results of rat LD_{50} studies. The symptoms observed were characteristic of AChE inhibition. The difference in toxicity may be attributed to the small amount of fenoxon in the technical material (Toia *et al.*, 1980).

Synergistic Effects

Several organophosphate pesticides, including malathion and dioxathion, were reported to cause potentiation of fenthion acute toxicity (EPA, OPP, 1985). Although malathion and fenthion may be used during the same treatment program, simultaneous application of the two pesticides usually does not occur. Even though it still may be possible for an individual to be exposed to fenthion and malathion within a critical exposure window, the implications of such an exposure are not clear. There is some potential for synergistic effects resulting from the combination of fenthion and inadvertent simultaneous pesticide application by the public; however, public notification about program treatments helps to minimize this risk.

c. Fumigation

(1) Methyl Bromide

(a) Hazard Assessment

Methyl bromide is an organic compound which contains the inorganic element bromine. Inorganic bromine occurs naturally in soils and food, and is also found in humans at varying concentrations. A blood-bromine level of 50 ppm is considered normal (Hayes and Laws, 1991). Levels above this may be indicative of methyl bromide exposure. Levels up to 1,500 ppm were achieved when inorganic bromide drugs were prescribed and no apparent ill effects were noted (Gay, 1962; as cited in Hayes and Laws, 1991).

The mode of toxic action of methyl bromide is not well understood. The central nervous system is the primary focus of toxic effects. There is evidence that the observed toxicity is caused by methyl bromide itself and not its metabolites or by-products (Honma *et al.*, 1985).

At low concentrations human symptoms of exposure appear slowly and include: dizziness, blurring vision, sluggishness, tiredness, staggering, slurred speech, nausea, vomiting, lack of appetite, and loss of muscle coordination. High concentrations of methyl bromide can cause more rapid onset of symptoms, including convulsions, and can result in lung damage. Chronic overexposure causes peripheral nerve damage. Prolonged skin and eye contact can cause burns (Great Lakes Chemical Corporation, 1989; Hayes and Laws, 1991).

The acute toxicity of methyl bromide has been determined by the oral and inhalation routes for several species. Acute lethal doses to humans have been determined to be 1,583 ppm in air for a 10- to 20-hour exposure and 7,890 ppm for a 1.5-hour exposure (EPA, ORD, 1986). The acute oral median lethal dose to rats was determined to be 214 mg/kg (Sax and Lewis, 1989). The acute inhalation median lethal doses to animals range from 1.2 ppm for 5 hours to guinea pigs (Sayers *et al.*, 1929; as cited in Alexeeff and Kilgore, 1983) to 2,700 ppm for 30 minutes in rats (EPA, ORD, 1986).

The subchronic and chronic toxicity studies of methyl bromide have also analyzed the oral and inhalation routes of exposure. The lowest NOEL determined for oral exposure was 0.4 mg/kg/day in a subchronic gavage study of rats based upon hyperplasia of the epithelium of the forestomach at the LEL of 2 mg/kg/day (Danse *et al.*, 1984). The lowest NOEL determined for inhalation exposure was 20 ppm in a chronic study of mice (EPA, OPP, 1990a). Decreased liver weights were noted at the LEL of 40 ppm in this study. No information was located about immunotoxic effects from methyl bromide exposure. Several studies found neurotoxic effects in rodents when exposed to methyl bromide over extended periods of time.

Unequivocal evidence of carcinogenicity has not been shown in any studies of methyl bromide. A study in rats receiving methyl bromide by gavage for 90 days found well-differentiated squamous cell carcinoma in 13 animals (Danse *et al.*, 1984), but a panel of the National Toxicology Program reviewed this study and determined that there was no evidence of carcinogenicity. Following procedures similar to Danse *et al.*, another study found that stomach lesions regressed in rats which had stopped receiving treatments (Boorman *et al.*, 1986). Oncogenicity was negative for rats exposed by inhalation for 29 months to concentrations as high as 90 ppm (EPA, OPP, 1990a).

Most researchers have found that the mutagenic potential of methyl bromide is low (Hayes and Laws, 1991). Methyl bromide can cause chromosomal aberrations in human lymphocytes *in vitro*, and in rat bone marrow *in vivo* (Garry *et al.*, 1990; Fujie *et al.*, 1990). Methyl bromide has been shown to cause sister chromatid exchange in human blood and human lymphocyte cultures (Tucker *et al.*, 1985; Garry *et al.*, 1990).

No adverse reproductive effects, including fetotoxicity and teratogenicity, were seen in rats and rabbits exposed to 20 to 70 ppm methyl bromide gas for 6 to 7 hours/day during gestation (Hardin *et al.*, 1981). Ninety-six percent of the rabbits died at the higher concentration, but there was no indication of maternal toxicity in the rabbits at 20 ppm (NOEL) and in the rats at both concentrations.

Based upon reduced maternal weight observed in pregnant rats at an inhalation LEL of 90 ppm, the maternal NOEL was determined to be 30 ppm (EPA, OPP, 1990a). Reduced rates of pregnancy set the reproductive LEL at 30 ppm. Based upon reduced pup weights and survival at 30 ppm (fetotoxic LEL), a fetotoxic NOEL was set at 3 ppm (EPA, OPP, 1990a). Hurtt and Working (1988) found only temporary effects on plasma testosterone levels in male rats exposed to 200 ppm for

6 hours/day for 5 days. No lasting effects on sperm quality or spermatogenesis were noted.

FIFRA data gaps exist for mutagenicity, rabbit teratology, subchronic inhalation in the rat and rabbit, and chronic feeding studies in the rat and dog (EPA, ORD, 1986), but adequate data are available to determine potential effects by quantitative and qualitative analyses for given environmental exposures.

(b) Exposure Analysis

The lack of both monitoring data on levels of exposure associated with fumigations using methyl bromide and air dispersion models designed to estimate levels of a gas in the area surrounding the fumigation apparatus have made it impossible to quantify the exposures that may occur during program use of methyl bromide. However, details regarding operating procedures and typical circumstances surrounding fumigations were considered in determining the potential for exposure to the public and workers. The safety procedures required of the personnel conducting the fumigation of regulated commodities are stringently enforced to prevent unacceptable risk to humans from exposure under routine conditions. Workers are required to wear protective clothing and maintain a 30-ft (10-m) restricted area around the fumigation chamber where access is limited to individuals with self-contained breathing apparatus. Although some fumigations are performed near the source of the commodity, fumigation operations generally are carried out in rural, or otherwise, remote locations, so that public exposures are very unlikely.

The possibility exists for accidental release of methyl bromide through a tear in a tarp, or a leak in a hose or canister. In the event of an accident, workers, and in extremely rare circumstances the public, may be exposed to levels of methyl bromide that exceed those minimums recommended to protect human health.

(c) Qualitative Risk Assessment

An RRV of 0.48 mg/m^3 for chronic exposure of the general population was adopted from the RfC established by EPA (EPA, ECAO, 1992). The RfC was based on a 29-month inhalation study in rats in which the lowest exposure caused degenerative lesions in the nasal cavity. Because this study was adjusted for a 6-hour exposure, and because the exposures projected in this risk assessment are likely to be much less than 6 hours, the chronic RRV was adjusted by a factor of 4 (24 ÷ 6) to yield an intermittent RRV of 1.92 mg/m^3 for the general population exposure.

The ACGIH (1992) recommends a TLV-TWA of 19 mg/m^3 with a notation that unprotected skin could exacerbate exposure. This value was adopted as the inhalation RRV for workers. This recommendation has been in effect since 1986. In the documentation for the TLV, ACGIH (1986) notes that the toxicological data are not adequate for recommendation of a short-term exposure limit. Following the general guidelines in ACGIH (1992), exposures of up to three times the TLV-TWA for no more than a total of 30 minutes are considered acceptable. Exposures greater than or equal to 5 times the TLV-TWA for any duration are considered unacceptable.

Because monitoring data and air dispersion models were determined to be inappropriate for characterizing exposures to either the general public or workers, a qualitative assessment of risk was performed. Fumigations with methyl bromide are conducted in a manner that prevents unacceptable risk to people. For fumigations conducted in locations without a wall to prevent access to the chamber, there is a 30-ft (10-m) area around the fumigation chamber where entry is restricted to individuals wearing self-contained breathing apparatus when a fumigation is being conducted. This restricted area allows dispersion and mixing of methyl bromide with ambient air which forms a buffer zone to assure safe concentrations in the surrounding areas. Thus, restricted access, buffer zones, and dissipation prevent risks of adverse effects to the public.

There may be unacceptable risks of adverse effects from exposures greater than the TLV within close proximity of the aeration outlet of the fumigation chamber during the initial phases of aeration. However, because regulatory fumigations require that unprotected individuals be kept out of the fumigation area until the level of methyl bromide drops below the TLV, these unacceptable risks should not be realized in any program-related fumigations.

Accidental worker exposures that are greater than the level/duration recommended by the ACGIH may cause serious clinical effects. This possibility does exist, especially since the methyl bromide used in these fumigations does not contain a marker chemical that warns workers of its presence through an odor. However, methyl bromide fumigations using the methods specified in the "Plant Protection and Quarantine Treatment Manual" (USDA, APHIS) have a long history of safe operation. Therefore, the likelihood of an accidental exposure resulting in severe illness is extremely remote.

Neurotoxicity

Unintentional or accidental occupational exposures of humans have resulted in a variety of adverse neurological manifestations (Behrens and Dukes, 1986; Anger *et al.*, 1986; Verberk *et al.*, 1979). The safety requirements of all program fumigations adequately prevent these exposures. The only possibility of neurotoxic effects from fumigations would be the result of an unprotected individual accidentally wandering into the restricted access area around the fumigation chamber. This should not occur if program personnel are properly monitoring the fumigation.

Immunotoxicity

No evidence was found to indicate that methyl bromide causes dermal sensitization, allergic hypersensitivity, or other immune function alteration in laboratory animals or humans.

Genotoxicity and Mutagenicity

Although the mutagenicity of methyl bromide has not been demonstrated in mammalian cells and intact mammals, methyl bromide is a mutagen to bacteria. Methyl bromide has been shown to cause chromosomal injury to mammalian cells and the inability to induce mutation in mammals probably relates to the greater physiological protection from mutagens in the mammalian system. Adherence to safety procedures for fumigations in agency programs prevents exposure to levels of methyl bromide that could cause chromosomal injury and the risks of an accidental exposure of the magnitude that could cause injury are very slight.

Carcinogenicity

The National Toxicology Program found no evidence of carcinogenicity in its review of a 13-week rat study (Danse *et al.*, 1984), which had reported a finding of squamous cell carcinomas in the forestomach of some animals tested. The panel determined that the reported lesions were inflammation and hyperplasia rather than oncogenic effects. The conclusion of the National Toxicology Program was verified by another study (Boorman *et al.*, 1986) where the same experimental design was used and all stomach lesions regressed when methyl bromide exposure ceased. Two chronic studies of rats (diet and inhalation) were both negative for carcinogenicity (Mitsumori *et al.*, 1990; EPA, OPP, 1990a). Methyl bromide is listed by EPA as a class D chemical in regards to carcinogenicity. This means that no firm decision has been made regarding the potential to cause cancer, but the results of these bioassays indicate that any risk of carcinogenic effects is unlikely.

Impurities in Formulations Applied

The toxic effects of methyl bromide exposure are considerably more critical than adverse effects from any metabolites or impurities (Honma *et al.*, 1985). No impurities of any toxicological consequence are associated with formulations of methyl bromide.

Synergistic Effects

There is some evidence that methyl chloride may be synergistic with methyl bromide, but this has not been specifically analyzed (Van Wambeke *et al.*, 1982). The use of methyl chloride occurs only in Europe. No studies were located that analyzed multiple exposures to determine synergistic or antagonistic effects. No risks from synergistic effects of methyl bromide are anticipated in this program.

d. Mass Trapping and Other Methods

The traps are placed out of the reach of the general public and are labeled as a hazard so individuals living in the treatment areas are not likely to be exposed to the pesticides used in the traps. In the unlikely event that a person were to open a trap, there would be no adverse human health effects anticipated except in the accidental case where the trap contents are ingested. The workers are more likely to be exposed to trap chemicals and their use of required safety precautions and protective clothing prevent any adverse health effects.

Male annihilation, using sticky yellow panels, is not expected to pose a risk to human health and safety. The panels kill fruit flies simply by trapping them in sticky substance, and although a chemical lure may be incorporated, the toxicity of the lure is very low. In addition, the public is not likely to be exposed to the panels, which are placed out of reach in host trees.

The usage pattern (small spots applied at locations out of reach of the general public and large untreated intervals) for bait stations and other male annihilation spot treatments rely on a bait to attract the target pest. Most humans would not come into contact with the pesticide used. Any random contact by humans with the treatment spots and chemical would not be expected to result in any adverse health effects. The application process might constitute some small risk to applicators who are encouraged to minimize their risk through adherence to APHIS standard operating procedures.

Cordelitos and wood fiberboard squares are only applied in rural and agricultural areas where most humans would not be exposed. They are attractive only to some of the fruit fly species and their appearance would not attract the attention of humans. The quantity of pesticide on any given cordelitos or wood fiberboard squares would not be expected to cause adverse human health effects except for the case of accidental ingestion, which is an unlikely route of exposure.

3. Principal Related Issues

a. Hypersensitivity

Hypersensitive humans experience toxicological symptoms and signs at dosage levels much lower than those that are required to produce the same symptoms in the majority of the population. Hypersensitive individuals constitute only a small portion of the total population. If the response of the population being studied follows the varying doses in a normal distribution (bell-shaped curve), the hypersensitive individuals would be expected to be on the left side of the curve. The increased genetic susceptibility of these individuals is quite variable. Although a margin of safety factor of 10 (uncertainty factor) has traditionally been used by regulatory agencies (National Academy of Sciences, 1977) to account for intraspecies variation or interindividual variability, human susceptibility to toxic substances has been shown to vary by as much as three orders of magnitude (Calabrese, 1984). Individual sensitivity to effects from chemical exposure is known to be strongly influenced by several factors including age, nutritional status, and disease status. Individuals with immune systems that are less developed or that are compromised physically are more likely to be more hypersensitive. The hypersensitive individuals, therefore, would be expected to include larger proportions of the populations of elderly and young children than the proportions of other subgroups of the general population. Calabrese examined several studies of human responses to chemicals and found that a safety factor of 10 was useful for predicted effects in 80 to 95% of a population. In APHIS fruit fly programs, pesticide rates and protection measures would result in a safety factor much greater than 10 for the general population.

There is no single established mechanism or measureable biological marker that is associated with the reported reactions of individuals who purportedly suffer from multiple chemical sensitivities. Thus, there is no clinical identity or established physiological relationship to individual chemical exposure. The etiology of multiple chemical sensitivity is, therefore, very subjective. The reactivity of this group cannot be effectively evaluated because there are no objective criteria to use to evaluate individual agents.

Based upon the current state of knowledge, individual susceptibility to toxic effects of the chemicals used in the Fruit Fly Cooperative Control Program cannot be specifically predicted. The approach used in this risk assessment takes into account much of the variation in human response (Calabrese, 1984). However, unusually sensitive individuals may experience effects even when the HQs indicate that there are no unacceptable risks. An association may exist between exposure to the protein bait and resulting dermal, respiratory, and other immunological responses. The program will assure that residents are notified if bait spray applications are to made in their neighborhood so sensitive individuals can prevent the possibility of adverse effects from exposure. Only limited amounts of the soil drench chemicals—chlorpyrifos, diazinon, and fenthion—are permitted to be applied to specific areas (to the drip line under infested trees) so that potential exposure is minimized. Exposures from trap chemicals, fruit fly male annihilation treatments, cordelito applications, and wood fiberboard square applications are expected to be minimal due to the limited usage and placement of chemicals. Because an extra effort is made to contact individuals on the lists of registered hypersensitive persons, those individuals can take extra precautions to avoid exposure to residues from program pesticide applications.

Methyl bromide exposure to the public is not expected because program procedures for fumigations preclude entry into restricted areas around the fumigation chambers, so potential hypersensitive responses from program fumigations should be prevented by the required safety procedures.

b. Environmental Justice

Executive Order (E.O.) 12898 places certain requirements on all Federal actions to address Environmental Justice issues in minority and low-income populations. Consistent with the requirements of this executive order, APHIS considers the potential for disproportionately high and adverse human health or environmental effects on minority populations and low-income populations for all programs.

The population of most sites in recent fruit fly eradication programs has been diverse and lacked any special characteristics that implicate greater risks of adverse effects for any minority or low-income populations. A review of the demographic characteristics of likely future program sites is provided in chapter 4. Those characteristics are expected to be representative of conditions for most site-specific fruit fly eradication actions.

The demographic review did reveal certain areas with large minority populations and some minority communities. In particular, some areas have large Spanish-speaking populations. To ensure that these individuals are informed of agency actions related to fruit fly eradication, pertinent documents (environmental documents, precautions, and/or warnings) are translated into Spanish for dissemination in these areas. Pesticide application schedules are provided to local radio stations and other communication media in Spanish to facilitate good communication of program activities in their area.

It is also recognized that some low income populations do not receive an adequate daily intake of protein and vitamins, which may contribute to the potential for adverse effects for these subgroups of the population. In particular, homeless populations would be expected to receive higher exposures and to have less adequate nutrition. The homeless are protected from disproportionately high and adverse human health or environmental effects through standard program mitigations and provisions of the Emergency Response Communication Plan.

c. Psychological Effects

Program actions, including pesticide applications, may elicit psychological effects in some members of the general population. During an eradication effort, the public is notified about the pesticide applications and informed that personnel and equipment will be in their neighborhoods to make those applications. Nevertheless, individuals are generally uncomfortable with actions that are not under their direct control. Literature from environmental and citizen groups that disapprove of the use of pesticides may influence the attitudes of the public and cause additional concern.

Some individuals have expressed a fear of malathion, branding it as a nerve gas. This fear stems from information about a German company, I.G. Farben, whose organophosphate pesticide development led to research into the development and production of nerve gases for the Nazis during World War II. Private individuals have circulated literature to a wide segment of the populations of program areas, implying that malathion is a nerve gas or can have the same effects as a nerve gas. Malathion and other organophosphate pesticides in this program are not nerve gases. Instead, there are chemical differences in the classes of compounds and there are vast magnitudes of difference in their effects. Nevertheless, misinformation or misperception could lead to unfounded distrust of the fruit fly programs.

Some people may be disturbed by the sight of the helicopters overhead during spraying of bait spray. Some individuals who have not seen the notifications may not be aware of the program and may wonder what the helicopters are for and what is being sprayed. Concerns have been raised on behalf of Vietnam veterans, especially those who have been diagnosed with posttraumatic stress syndrome, regarding the use of helicopters in the program. Some have speculated that the use of helicopters may trigger uncontrolled behavior because of memories of fighting in the jungles of Vietnam, but no evidence exists to indicate this has happened in previous programs.

The notification sent out to the affected population states that the public should remain indoors during the spraying operations, cars should be covered, and pets should be taken indoors. Adequate notification and education of the public should minimize the risk of individuals developing psychological traumas from the fruit fly programs.

d. Noise

The effects of noise from application procedures for the program pesticides have been considered. Aircraft noise and ground application equipment noise occur for only short durations of time and at low frequency of repetition, so that disturbances to humans from program actions are likely to be minimal and temporary. The potential use of large aircraft in fruit fly programs could increase the noise level, particularly close to the airport where loading, take-offs, and landings could occur at late hours in the night. Soil drench applications should not cause any noise disturbance other than minimal equipment noise and conversation of hand applicators. Noise is also expected to be minimal from conversation and equipment for fruit fly male annihilation treatments, trapping, cordelitos applications, and wood fiberboard squares applications. The disturbance of humans by noise from program fumigations with methyl bromide is likely to be minimal and mostly the result of setting up the fumigation stack, which is a temporary structure.

e. Socioeconomics

People potentially affected by fruit fly infestations or resulting fruit fly eradication efforts may belong to any of several major social groups: agricultural producers (producers of host crops, home gardeners, organic farmers, and beekeepers); pesticide applicators; residents; and consumers. Many other groups may be indirectly affected, but this discussion will be restricted to those groups immediately impacted. The program will result in both benefits and risks for people within these social groups.

The impact of a program on agricultural producers will be, for the most part, beneficial. Fruit flies represent a threat to numerous crops, and their establishment could lead to substantial losses of produce, income, and export markets. These losses could be most serious for small farmers and people dependent upon gardens for a substantial portion of their food. A fruit fly eradication program will protect both crops and income, as well as alleviating the need for (and cost of) uncoordinated farm-by-farm control programs.

There are some risks for agricultural producers from a program, particularly a program which uses pesticides. These risks include the potential mortality of biological control agents, the loss of "pesticide-free" status (and thus certain markets) for organic farmers, and potential mortality of honey bees. The risk to honey bees can be substantially reduced by early notification of beekeepers so that they can take precautions to protect their hives. With proper precautions there should be no loss of hives due to pesticide use (see program mitigative measures).

A program using pesticides will create both benefits and risks for pesticide applicators. The timely nature of an eradication program and its intensive work schedule will probably create additional income for pesticide applicators. There are some health risks for pesticide applicators, although the use of protective clothing greatly reduces these risks (see section on human health).

The residents of an area infested with fruit flies will receive both benefits and risks from a fruit fly eradication program. The benefits will include the protection of backyard and ornamental host plants from the fruit flies. The risks will be those associated with pesticide use, although only certain subpopulations of the area residents are at risk due to program pesticide use (see section on human health).

The largest group of program beneficiaries includes anyone who consumes produce that is a host of fruit flies. Because commercial farms and orchards ship produce to other States and countries, this group encompasses a wide spectrum of people. The Fruit Fly Cooperative Control Program benefits this social group by preserving the current availability and cost of certain produce. Federal regulations governing pesticide residues on produce protect the general public from any risks associated with pesticides used in a program (see section on human health).

The potential for the rapid spread of fruit fly infestations requires that programs be initiated soon after infestations are detected. Fruit fly outbreaks often occur first in urban/residential areas, thus nonagricultural areas are involved. Under these conditions, the distribution of benefits and risks of the program among various social groups can be somewhat inequitable. Even under the no action alternative (no Federal cooperation in eradication efforts), State and private eradication programs would create risks similar to those that might result from the fruit fly program. Because the potential distribution inequity of the program is unavoidable, every effort is made to reduce risks from the program to all social groups (see sections on mitigative measures and risk-reduction strategy).

f. Cultural and Visual Resources

(1) Nonchemical Control Methods

Nonchemical control methods are expected to have minimal effect on cultural and scenic resources of the program area. Equipment (aircraft or trucks) used to release sterile fruit flies may affect those resources only to the extent that the activity or noise may disturb visitors to these resources. Physical control methods may affect the appearance of public and private gardens; fruit stripping would not result in harm to plants, but host removal could change the appearance of gardens. Cultural control should not affect cultural resources because it involves agricultural lands that generally are not considered cultural resources. Neither physical control nor cultural control will be applicable in scenic areas such as national forests or wilderness areas because of the resources' large sizes and nonagricultural nature. The potential effects of biological and biotechnological control on cultural resources would depend on the species-specificity of the controls, the relative contribution of nontarget species to the particular resource, and the effect on the species. Mortality of insects is not likely to directly affect cultural resources but adverse effects on plants could change the appearance of gardens. The establishment of quarantine checkpoints under regulatory control, and the associated traffic, noise, and signboards, may affect nearby cultural resources such as Indian reservations. The effect of integrated pest management on cultural or scenic resources would depend on the component control methods used.

(2) Chemical Control Methods

Aerial bait spray applications have potential to adversely affect cultural and visual (scenic) resources through direct or indirect effects on nontarget species that are associated with or comprise the resources. The effect of aerial applications on cultural and scenic resources such as gardens, parks, zoos, arboreta, forests, and wildlife refuges will depend to a large extent on the animal and plant species they contain. Aerial applications of malathion bait spray tend to have more adverse effects on the desired wildlife than SureDye bait spray or spinosad bait spray (which are more selective). Standard operational procedures (such as notification of residents within a spray area and avoidance of recognized major bodies of water) generally help to limit the exposure of wildlife in zoos, arboreta, gardens, and the major bodies of water.

Bait spray applications are known to mark some surfaces. Malathion bait spray is known to affect some types of car paint. SureDye bait spray is known to give red or brown marks to external surfaces of some buildings. No data exist about the potential effects of bait spray formulations on the types of paint or exteriors found on historical buildings or Native American petroglyphs. However, archaeological sites are not likely to be treated, and the vertical walls and exposures of the petroglyphs would serve to minimize exposure to any bait spray. Cultural practices, such as wild food gathering by Native Americans on Indian reservations, could be temporarily halted due to aerial applications of bait spray.

Other chemical control methods will have little to no effect on cultural or scenic resources. The soil treatments and ground applications of bait spray may affect those resources if substantial mortality of nontarget species were to occur as a result of treatment. However, these applications are applied to limited areas and any resulting impacts would be minimal and localized. Methyl bromide fumigation should not have any impact on cultural or scenic resources because fumigation generally is not conducted in or near cultural or scenic resources. The use of traps in gardens or around historic sites may temporarily detract from the appearance of cultural and scenic resources. Use of fruit fly male annihilation technique, cordelitos, and wood fiberboard squares are generally not applied to areas of cultural or visual resources, but their limited application to specific areas ensures that any impacts would be minimal and localized.

D. Nontarget Species

This section summarizes the quantitative and qualitative risks to nontarget species associated with chemical, nonchemical, and combined control methods used or proposed for use in the Fruit Fly Cooperative Control Program. Those risks were based on scenarios that incorporated control methods which could be used across the broad program area, but may not be used in all areas; as such, the risks should be viewed as being very conservative and may even be interpreted by some as being "worst-case." In addition, potential environmental effects were considered for habitats or ecological associations of concern, endangered and threatened species, and biodiversity. Refer to the Nontarget Risk Assessment (APHIS, 1998b), and Spinosad Nontarget Risk Assessment (APHIS, 1999b), incorporated by reference.

1. Non-chemical Control Methods

This section qualitatively considers the potential effects of the nonchemical treatment methods.

a. Sterile Insect Technique

The release of sterile fruit flies (when not used in combination with other treatments) in agricultural and urban areas is unlikely to cause disturbance to domestic animal species. The noise and interruption from aircraft or vehicles dispensing sterile fruit flies should not interfere with animal or agricultural production, but could interfere with some sensitive native species or life stages, e.g., nesting birds. Any possible disruption should be transitory with no long term consequences because it is anticipated that most program areas already will be disturbed by human activity.

The sterile fruit flies will feed and oviposit on the host fruit, however, and will serve as a food source for insectivorous species. No extensive damage to wild host plants is anticipated from the introduced sterile fruit flies.

With the addition of the exotic, sterile fruit flies to a localized invertebrate fauna, a possibility exists for food competition with other fruit fly species and shifts in predator food selection. Because the sterile flies do not reproduce, the population will be short-lived and any such changes will be of short duration. The exception would be in the case of the unintentional release of nonsterile fruit flies. Although proper rearing and handling procedures required by the program preclude such releases, the presence of even one fertile female can lead to more than one site of infestation. If fertile flies were inadvertently released and a population to become established, the consequences would be far ranging.

b. Physical Control

Domestic animals and personnel could be affected when program personnel enter a property to strip fruit or eliminate host plants if the animals are agitated by the presence of strangers. Host plant removal could also affect domestic animals by reducing the amount of cover available to provide shelter on rangeland, or by increasing the possibility that weedy species unsuitable for forage could exploit the disturbed environment where trees and shrubs had been removed.

Domestic plants will not be affected by fruit stripping unless the stripping procedure also removes a portion of the vegetative material which reduces the plant's growth rate. Removal of vegetative material could also expose portions of the branch or trunk of woody plants, allowing the entry of bacteria, fungi, or plant pests.

Wild animals that utilize fruit fly host fruits as an energy source would be affected by both fruit stripping and host plant removal. These organisms would have to find an alternative source of food and might have to spend more time foraging. However, the ultimate effect of fruit stripping in a control program would be the preservation of the quality and quantity of the host fruit in the area, which would tend to benefit those species in the long run. Larger soil organisms (e.g., burrowing rodents, moles, earthworms, and insects) may be injured or killed during destruction operations, or populations may be reduced as a result of disturbed soil conditions.

Wildlife that use fruit fly hosts for shelter would be displaced and would need to locate other trees or shrubs in which to live. Host elimination over a large area would change the plant species in the area by creating patches of disturbed soil and would increase soil erosion, which increases turbidity in aquatic resources. Changes in the plant species in the area could affect animals dependent upon specific types of plants for food or shelter. Increased turbidity in aquatic resources could affect the ability of aquatic organisms to breathe and to find food.

Plants would be affected by fruit stripping due to loss of reproduction for the year. Host elimination would create patches of disturbed soil which could be exploited by weedy, herbaceous plants.

c. Cultural Control

Domestic plants, such as agricultural crops, may be affected by cultural control if crops are grown at different times of the season than usual. This could affect the growth rate of these crops. Domestic animals are not expected to be affected by cultural control.

Cultural control methods, such as clean culture methods, which involve fruit stripping and host plant removal would have the same consequences as those discussed above in the section on Physical Control. Growing fruit fly host crops at special times and using resistant varieties would not affect wild animals and plants. Trap cropping would increase the number of fruit flies and fruit fly predators in an area and would cause increased mortality to fruit fly predators when chemical treatments are used to control fruit fly populations. The consequences of chemical treatments are discussed in the chemical control section.

d. Biological Control

In general, domestic animals are unlikely to be affected by biocontrol agents. Predatory and parasitic invertebrate biocontrol agents for fruit flies generally affect only other invertebrates, and microorganisms used for biocontrol (e.g., Bt, NPV) are known to have essentially no negative impacts on domestic animals. Individual honey bees could potentially be at risk from some predators, but hives or colonies should not be considered at risk. Although honey bees are at risk from some parasitic invertebrates (i.e., mites), none of these species are considered as fruit fly biocontrol agents.

The primary risk to domestic plants is a disruption of pollination systems by predators and parasites that might be used for biocontrol of fruit flies. Most agricultural pollination depends on honey bees which are considered to be at low risk from fruit fly biocontrol agents. However, some agricultural pollination and pollination of most other plants (e.g., horticultural plantings) depend on the activities of feral bees and other species of insect pollinators. These pollination systems would be disrupted to the extent that the predators and parasites released for fruit fly control affect populations of natural pollinators. Few data on such complex systems exist for any natural systems; the effect that inundative releases of biocontrol agents for fruit fly control would have on pollination systems in program areas is unknown.

If they were available for use, release of biocontrol agents for fruit fly control could negatively impact populations of nontarget wild animals (primarily insects) and plants. Predators (including nematodes) would not be specific to fruit flies and could potentially damage populations of many species of nontarget insects. Parasites would be more host-specific, but could damage populations of insects related to fruit flies (e.g., other species of flies). Biological larvicides (Bt and viruses) could affect other species of insects, but would be less host-specific than parasites. Although these agents potentially could have a serious impact on local nontarget invertebrate populations, specific impacts are unknown.

e. Biotechnological Control

Biotechnological control methods are still under development. One potential biotechnological method for fruit fly control is bioengineering of domestic plants (i.e., use of bioengineered (transgenic) citrus trees that resist fruit flies). A concern with use of any transgenic organism is exchange of genetic material with nontarget organisms. However, before transgenic plants are released, their ability to exchange genetic material with native, feral, and weedy species in general is examined closely and steps are taken to avoid exchange of genetic material. This may include removal of flowers, bagging of flowers, or production of sterile transgenics. It is, therefore, unlikely that transgenic domestic plants could affect nontarget domestic plants because specific steps are taken to prevent exchange of genetic material.

Production and release of temperature-sensitive lethal (TSL) and combi-flies (genetically altered fruit flies) would be unlikely to have any direct impact on domestic nontargets. Impacts potentially could result from production facility operations and to predators from releases of large quantities of TSL flies and combi-flies.

Another potential method would be the use of genetically engineered microorganisms. Release of genetically improved microorganisms for fruit fly control could affect other nontarget invertebrates to the extent that the biological agent could kill species other than fruit flies. Because biological insecticides are not always species-specific, at least some other related species could be at serious risk. Species at greatest risk would include those most closely related to fruit flies.

Biotechnological applications that could be developed for Medfly control would be unlikely to impact domestic animals and plants because there is little opportunity for interaction among bioengineered agents of fruit fly control and domesticated species. Potential effects on native flora and fauna are unknown at present.

In conclusion, although current regulatory controls and practices make it unlikely that biotechnological controls would have more than a minimal impact on nontarget biological resources, the uncertainties surrounding the use of this technology for fruit fly control have resulted in a determination that its effects are largely unknown.

Should biological control or biotechnological control technologies be developed to the point where they can be effectively used in a control program, they would add to the overall risk. They may pose additional consequences including further losses in invertebrate populations and further effects on plant reproduction resulting from losses of pollinator species from biocontrol predators or genetically engineered biological insecticides.

f. Cold Treatment

All cold treatments are conducted in approved facilities under strict supervision. This treatment is only applicable to certain approved commodities. The necessary restrictions (duration of treatments and approval of facilities) and availability of facilities for cold treatment are likely to continue to limit the use of this treatment. The impacts on the nontarget species would not be expected to differ from those resulting from cold storage facilities of comparable size. The treatment chambers are sealed to prevent entry of nontarget species during cold treatment. The only nontarget species affected would be any additional organisms present on the commodity being treated. The use of cold treatment is expected to have negligible impact on nontarget species.

g. Irradiation Treatment

Irradiation treatments are conducted in approved facilities in accordance with stringent safety guidelines. The use of this treatment method is limited to certain approved commodities that are compatible with its application. The irradiation equipment is designed to release radiation to the regulated commodity only. There is negligible stray radiation from proper equipment use. The treated commodity does not retain any radioactivity from the exposure and poses no risks to nontarget species. The irradiation equipment is sealed to prevent entry of nontarget species to the irradiation chamber and therefore, there is no hazard to nontarget wildlife.

h. Vapor Heat Treatment

All vapor heat treatments are conducted in approved facilities under strict supervision. This treatment is only applicable to certain heat tolerant commodities. The necessary restrictions (duration of treatments and approval of facilities) and availability of facilities for vapor heat treatment are likely to continue to limit the use of this treatment. The treatment chambers are sealed to prevent entry of nontarget species during vapor heat treatment. The only nontarget species affected would be any additional organisms present on the commodity being treated. The use of vapor heat treatment is expected to have negligible impact on nontarget species.

2. Chemical Control Methods

The characterization of risks to nontarget species from fruit fly program pesticide applications was based on the well-accepted paradigm: hazard (toxicity) definition; exposure estimation to each potential receptor (nontarget species) based on program use of each chemical; and risk assessment. Benchmark toxicity values for terrestrial nontarget species were based on the LD_{50}. The LD_{50} is the dose (in milligrams per kilogram (mg/kg) of body weight) that is lethal to 50% of the population tested. Benchmark toxicity values for aquatic nontarget species were based on the LC_{50}. The LC_{50} is the concentration (in milligrams per liter (mg/L) of water) that is lethal to 50% of the population tested. These values allow comparison of toxicity to specific species among chemicals. EPA has categorized these values for ease of comparison (table 5–1).

ES-APHIS developed exposure models to compare treatment alternatives across ecoregions. This will facilitate planning on a regional scale. Environmental concentrations, which provided the basis of exposure estimates, were derived from transport and fate models (GLEAMS and the EAD-APHIS surface water model) and EPA pesticide residue data. All modeling was based on program application rates and treatment methods.

Risk was characterized by comparing the estimated dose and the benchmark toxicity value. The benchmark values were the LD_1 and the LC_1 (the calculated dose lethal to 1% of the population, usually for a surrogate species). These values were estimated from laboratory-derived LD/LC_{50}s (methodology detailed in the Nontarget Risk Assessment (APHIS, 1998b)). This level was chosen because a 1% population loss would not be a serious threat to most populations. In addition, the uncertainty associated with assessing risk, because of incomplete and unavailable information, necessitated a conservative approach. All species analyzed were assumed to be exposed to pesticides either directly or indirectly. Therefore , the analysis characterizes risk to the exposed population only.

Environmental monitoring data from previous fruit fly eradication efforts were considered and addressed qualitatively where possible. However, much of the monitoring data from past programs was inadequate for the estimation of risk because of incompleteness, lack of controls, lack of statistical validity, and inability to show an association between cause and effect. Additionally, program operational changes that have occurred limit the usefulness of much of the data. Differences between application methods and rates between different programs have also made applicability difficult. Comparisons were made between calculated risks and actual monitoring data for past programs with the same or similar methods. Some good monitoring data are available for the 1997 and 1998 Florida Medfly Eradication programs. In general, available monitoring data were consistent with the environmental risks calculated from the models. Literature and modeling data relative to effects on reptiles and amphibians is notably scarce, therefore modeling was the primary method of estimating risk to them.

Table 5–1. Toxicity Categories

Habitat	Category	Toxicity Criteria
Terrestrial	Severely toxic	LD_{50}[1] ▾ 50 mg/kg
	Moderately toxic	50 mg/kg < $LD_{50} \leq$ 500 mg/kg
	Slightly toxic	500 mg/kg < $LD_{50} \leq$ 5,000 mg/kg
	Very slightly toxic	5,000 mg/kg < $LD_{50} \leq$ 50,000 mg/kg
Aquatic	Very highly toxic	LC_{50}[2] ▾ 0.1 mg/L
	Highly toxic	0.1 mg/L < $LC_{50} \leq$ 1.0 mg/L
	Moderately toxic	1.0 mg/L < $LC_{50} \leq$ 10 mg/L
	Slightly toxic	10 mg/L < $LC_{50} \leq$ 100 mg/L
	Practically nontoxic	LC_{50} > 100 mg/L

[1] Dose lethal to 50% of test organisms.
[2] Concentration in water that is lethal to 50% of the test organisms.

ES-APHIS developed exposure models for terrestrial and aquatic habitats. The terrestrial model considered exposure during the first 24 hours after a single pesticide application. Because aquatic toxicities generally are based on 96-hour exposure, the aquatic model considered 96-hour exposure.

The models for estimating exposure of terrestrial nontarget species to program chemicals [malathion, SureDye, and spinosad (aerial and ground), chlorpyrifos, diazinon, and fenthion] considered dermal, ingestion, and inhalation exposure. The sum of exposures via all routes was the estimated dose. This approach tends to overestimate toxicity from exposures of invertebrates to SureDye and spinosad (which occur primarily by the oral route) but other exposures would be expected to accurately portray potential risk. Diet, grooming, activity patterns, and other species-specific parameters were estimated for two scenarios: routine and extreme. The routine scenario characterizes exposure that organisms would likely experience; the extreme scenario generally assumed the animal was more active, it spent more time in the treatment area, and a higher proportion of its diet items were contaminated with pesticide residues. Although exposure is assumed for most species in this analysis, it is important to note that not all individuals in populations will be exposed.

For aquatic species, exposure was equivalent to the concentration of pesticide in the organism's habitat. Four habitats were modeled for malathion, spinosad, and SureDye: stream, river, pond, and wetland. Pesticide concentrations in aquatic habitats were determined using a combination of the GLEAMS model and the ES-APHIS surface water model which estimated pesticide concentrations in lakes and ponds following a runoff-producing rainstorm. The routine exposure was the 96-hour average pesticide concentration in the aquatic habitat; the extreme exposure was the maximum concentration that occurred over the 96-hour postspray period. No routine exposure was assumed for soil drench pesticides because these chemicals are not routinely used in water bodies. For the extreme soil drench scenario, ES-APHIS modeled runoff from a treated orchard into an adjacent ditch. The model predicted movement of soil drench chemicals into the ditch in only the Mississippi Delta ecoregion (5) and Floridian ecoregion (6).

Risks to exposed nontarget species were calculated by comparing the exposure estimate to toxicity benchmark values, usually of a surrogate species. The benchmark toxicity value was extrapolated from the laboratory-derived dose lethal to half of the test organisms (LD_{50}) or, for aquatic organisms, the water concentration (LC_{50}). The benchmark toxicity values to which the estimated doses were compared were: the LD_1 for terrestrial species and the LC_1 for aquatic species exposure. The test organism selected as a surrogate for each species was the most taxonomically similar species or one of similar size and trophic level. Generally, the lowest literature toxicity value for this species was selected. Surrogate species and toxicity benchmarks are given in the

Nontarget Risk Assessment for Medfly Programs (APHIS, 1992b) and the Nontarget Risk Assessment for Fruit Fly Programs (APHIS, 1998b).

Tables 5–2 to 5–8 estimate the calculated mortality rates for populations of nontarget species that are exposed to the program pesticides. The tables are presented for each application method as a unit to facilitate comparison of data, that is, the tables for all bait spray applications follow that text section and the tables for all soil treatments follow that text section. Estimated mortality rates were calculated for each species and each chemical using the estimated dose predicted by the exposure model and the dose-response curve for the species or a surrogate species from a laboratory study (see the Nontarget Risk Assessments (APHIS, 1998b; APHIS, 1992b) for details on this method). Populations of any species for which estimated mortality exceeded 1% are considered at risk; species with mortality estimates exceeding 99% are considered to be at a high degree of risk. These values were calculated from the routine exposure estimates. It must be emphasized that the calculated mortality rates shown in the tables are for individuals that are exposed to the program pesticides; the tables are not intended to reflect and should not be interpreted to reflect mortality rates for nontarget species populations across the entire program area.

Information gaps in each step of the risk analysis lead to much inherent uncertainty. Toxicity information is primarily from laboratory studies on laboratory animals. The dose-response curve is undoubtedly different for wild populations under field conditions where other stressors could magnify or ameliorate the effect of the pesticide. These studies are conducted with a range of formulations, rarely those used in the fruit fly program. In addition, few studies have been conducted with bait spray. The protein hydrolysate undoubtedly would affect the toxicity in some way. Toxicity data are available for very few species, requiring the selection of surrogate species for analysis. This is particularly true for SureDye and spinosad which have only recently been developed for use as pesticides. Often there were no data for similar species, and selection was based primarily on sensitivity. The choice of a surrogate had a great effect on the assessment of risk. Information about surrogate species is given in the Nontarget Species Risk Assessment (USDA, APHIS, 1998b).

Because environmental fate is site-specific, the pesticides may not act as modeled at every site (i.e., may degrade more or less rapidly and travel farther). ES-APHIS exposure models required the estimation of a variety of characteristics for the species under analysis, e.g., diet and activity patterns. These input parameters cannot take into account the temporal and seasonal variability nor behavioral response characteristics within a species. Nonetheless, because a uniform approach was taken, the results allow comparison of relative risks across taxa and across ecoregions.

a. Bait Spray Applications

(1) Malathion Aerial Application

(a) Hazard Assessment

Malathion is an organophosphate insecticide whose mode of toxic action is primarily through AChE inhibition. The acute oral toxicity of malathion is slight for humans and very slight to moderate for other mammals. The acute toxicity of malathion by the dermal route is one of the lowest of the organophosphorus insecticides. Malathion is a very slight dermal irritant and a slight eye irritant.

Malathion is very slightly toxic to moderately toxic to mammals, slightly to moderately toxic to birds, moderately to severely toxic to terrestrial invertebrates, and of low phytotoxicity to most plants. Malathion is slightly to very highly toxic to fish, highly toxic to aquatic stages of reptiles and amphibians, and moderately to very highly toxic to aquatic invertebrates.

(b) Exposure Analysis

From modeling, the terrestrial invertebrates were anticipated to receive the highest total malathion doses of any of the terrestrial organisms (most species had total doses greater than 100 mg of malathion per kilogram of body weight). Vertebrate insectivorous species had higher total doses than other vertebrate omnivores, herbivores, or noninsect carnivores. Vertebrate nectar feeders (hummingbirds) and invertebrate nectar feeders (honey bees) also displayed high total doses of malathion. Predatory invertebrates (orb web spider, adult beetle, and parasitic wasp), invertebrates with high metabolic requirements (caterpillars and maggots), and invertebrates with high activity rates and frequent contact with malathion residues (ants and honey bees) had higher total doses than other terrestrial organisms.

Vertebrates exhibited exposures ranging from 10 mg/kg to 100 mg/kg. Smaller species tended to have higher total doses than larger species because small species have higher metabolic rates (and need to consume more food per body weight) and also are more active than large species (contacting malathion more frequently resulting in higher dermal exposures).

Total doses for all types of terrestrial organisms were higher in the western ecoregions (California Central Valley and Coastal, Southwestern Basin and Range, Lower Rio Grande Valley, and Marine Pacific Forest). This assumed that the sparse vegetative cover in these areas allowed a higher proportion of the malathion bait spray to penetrate the canopy to the level where the organism would be exposed.

Exposure was dependent upon the behavior of the organism. Ingestion was considered to be the dominant route of exposure for all but a few of the vertebrates. Inhalation was negligible for all taxa. Ingestion and dermal exposure were approximately equal for most of the invertebrates. However, dermal exposure was greater than ingestion for moths and butterflies due to limited grooming and dietary intake. Dermal exposure was also usually the dominant type of exposure for invertebrates living in the soil depending on the amount of time spent at the soil surface.

For aquatic organisms, exposure estimates were equivalent to the malathion concentration in the water body in which they occurred. Malathion concentration in water was correlated to water body depth; organisms living in shallow water bodies had higher total doses than those living in deeper habitats. The highest malathion concentrations, and thus the highest total doses, were observed in wetlands and shallow ponds. There were no differences in extreme exposure in wetlands and ponds. The highest total doses under the routine scenario for the pond and wetland were in the Southwestern Basin and Range ecoregion (2) and the Southeastern and Gulf Coastal Plain ecoregion (4), respectively.

Direct spray was assumed for all aquatic habitats. Some water bodies also received runoff from the treatment area. Malathion concentrations were dependent upon the amount of runoff expected following a rain storm and the soil-specific degradation rate. Ecoregion differences in total doses were noted for water bodies receiving runoff water (lakes and streams). Highest total doses in the stream and lake were predicted in the western ecoregions and in the Southwestern Basin and Range ecoregion (2), respectively.

(c) Risk Assessment

Table 5–2 summarizes the estimated risk to nontarget species resulting from aerial spraying of malathion bait. Terrestrial and aquatic invertebrates are at risk throughout the treatment area because of high exposures and toxicity. Exposed invertebrate populations would be expected to be severely reduced for aquatic species, such as mayflies, stoneflies, cadddisflies, scuds, water fleas, backswimmers, and aquatic beetles, and all terrestrial species.

The terrestrial invertebrates, particularly insects exposed to bait spray, are likely to have depressed populations for a given period of time following spraying. The treatment area and number of treatments will influence the ability of the population to become reestablished. The ability to reestablish the population is also influenced by the distance from the treatment area to similar, untreated habitats containing potential colonists, and the ability of these potential colonists to disperse. Limiting the bait spray either by selective applications to smaller, more critical areas or using only ground applications allows these populations better chances for earlier recovery to their previous population levels.

Dahlsten *et al.*, (1985) examined effects of malathion bait spray on nontarget invertebrates and concluded there was a biologically "significant effect of the Medfly malathion bait spray on several nontarget insects on urban and suburban trees." These effects included: direct knockdown (kill) of species such as flies, caterpillars, and small wasps; an increase in populations of pest species as a result of damage to populations of beneficial insects; and stimulation of pest reproduction (whiteflies). Although no specific information was provided concerning recovery of populations, the author stated that long-term residual effects were likely.

The elimination of predatory insects would allow insect pest populations to increase. These outbreaks have been observed and "were attributed to destruction of natural enemies by malathion. In general, concentrations of malathion bait sufficient to kill most adult parasites tested were less toxic to the pest species tested. These results indicate that future fruit fly eradication programs which employ numerous sequential applications of malathion bait spray can be expected to disrupt a substantial portion of the biological control which exists in the target zone" (Ehler and Endicott, 1984).

Troetschler (1983) compared nontarget arthropod populations in a Medfly eradication treatment area (Palo Alto, California) with unsprayed control areas (Hayward and Jasper Ridge, California). A variety of polyphagous and carnivorous arthropods were attracted by the baits, and in most cases fewer numbers were caught in treated than in control areas." Soil dwellers, polyphagous beetles, some fly species, ants, and wasps were reduced in the treated area; no spiders or predaceous beetles

Table 5–2. Estimates of Percentage Mortality to Exposed Individuals from Aerial Application of Malathion Bait[1]

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Terrestrial Mammals							
Opossum	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Shrew	19.5	31.8	26.1	12.5	6.1	9.2	N/A[2]
Bat	1.7	4.2	2.8	<1.0	<1.0	<1.0	2.95
Cottontail rabbit	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Squirrel	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Mouse	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Raccoon	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fox	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Coyote/Dog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Deer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Birds							
Pied-billed grebe	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great blue heron	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cattle egret	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Duck	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Turkey vulture	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-tailed hawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American kestrel	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Quail	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Killdeer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mourning dove	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great horned owl	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Burrowing owl	<1.0	<1.0	<1.0	<1.0	N/A	<1.0	<1.0
Nighthawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hummingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Belted kingfisher	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Northern flicker	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Kingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American robin	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Northern mockingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
European starling	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-winged blackbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Meadowlark	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
House sparrow	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Table 5–2, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Terrestrial Reptiles							
Desert iguana	<1.0	<1.0	N/A	N/A	N/A	N/A	N/A
Side-blotched lizard	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Carolina anole	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Eastern fence lizard	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Western fence lizard	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Canyon lizard	N/A	N/A	<1.0	N/A	N/A	N/A	N/A
Gopher snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Garter snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Desert tortoise	<1.0	<1.0	N/A	N/A	N/A	N/A	N/A
Eastern box turtle	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Western box turtle	N/A	<1.0	<1.0	<1.0	N/A	N/A	N/A
Hognose snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Terrestrial Amphibians							
Toad	36.9	52.4	46.2	28.1	15.5	21.8	44.7
Tree frog	54.1	68.9	61.6	42.1	27.9	36.0	61.5
Terrestrial Invertebrates							
Earthworm	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Slug	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sowbug	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Spider	91.7	96.3	94.5	81.1	61.6	70.7	94.0
Mayfly	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Dragonfly	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Grasshopper	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lacewing	99.5	99.9	99.8	99.1	97.5	98.7	99.7
Water strider	65.6	78.7	73.0	53.1	36.3	45.5	72.2
Beetle (grub)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Beetle (adult)	91.9	96.0	94.5	88.5	82.4	86.5	94.0
Butterfly	20.1	22.8	21.5	18.9	16.7	18.1	21.5
Moth	24.5	27.6	26.1	23.0	20.5	22.2	26.05
Caterpillar	30.8	33.9	32.4	28.7	25.8	27.5	32.35
Maggot (fly)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Fly (adult)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Ant	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Honey bee	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Wasp	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 5–2, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Fish (Habitat)							
Golden shiner (lake)	40.2	45.5	52.6	45.5	45.2	45.4	42.9
Golden shiner (pond)	66.9	18.13	62.8	72.4	71.6	71.9	60.6
Speckled dace (stream)	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Mexican tetra (stream)	N/A	N/A	<1.0	N/A	N/A	N/A	N/A
Silvery minnow (lake)	N/A	N/A	N/A	<1.0	<1.0	N/A	N/A
Goldfish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sheepshead minnow (stream)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Sheepshead minnow (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
California killifish (stream)	<1.0	N/A	N./A	N/A	N/A	N/A	N/A
California killifish (wetland)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Swamp darter (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Mosquito fish (stream)	2.6	2.6	2.3	2.6	2.6	2.6	2.6
Mosquito fish (pond)	11.7	15.3	9.7	15.2	14.6	<14.8	13.5
Rainbow trout (stream)	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Rainbow trout (lake)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Arroyo chub (stream)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Bluegill sunfish (stream)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Bluegill sunfish (lake)	<1.0	N/A	1.2	<1.0	<1.0	<1.0	<1.0
Bluegill sunfish (pond)	2.9	4.2	2.3	4.1	3.9	4.0	3.6
Largemouth bass (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Largemouth bass (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Channel catfish (stream)	N/A	N/A	<1.0	N/A	<1.0	<1.0	N/A
Channel catfish (lake)	N/A	N/A	N/A	N/A	<1.0	<1.0	<1.0
Yellow bullhead catfish (stream)	N/A	N/A	N/A	<1.0	<1.0	N/A	N/A
Yellow bullhead catfish (lake)	N/A	N/A	N/A	N/A	<1.0	N/A	N/A
Yellow bullhead catfish (pond)	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Longnose gar (lake)	N/A	N/A	<1.0	<1.0	<1.0	5.6	N/A
Longnose gar (pond)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Longnose gar (wetland)	N/A	N/A	N/A	N/A	N/A	5.6	N/A

Table 5–2, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Lake chubsucker (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Aquatic Reptiles							
Snapping turtle (wetland)	N/A	N/A	N/A	5.6	5.3	5.4	N/A
Western pond turtle (wetland)	4.0	N/A	N/A	N/A	N/A	N/A	4.0
Water snake (wetland)	N/A	N/A	N/A	5.6	5.3	5.4	N/A
Aquatic Amphibians–larval forms							
Bullfrog (wetland)	8.2	N/A	N/A	10.9	10.5	10.6	N/A
Tiger salamander (wetland)	8.2	N/A	N/A	10.9	10.5	N/A	8.2
Amphiuma (wetland)	N/A	N/A	N/A	10.9	10.5	10.6	N/A
Aquatic Invertebrates							
Sponge, freshwater (stream)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Sponge, freshwater (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sponge, freshwater (pond)	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hydra (wetland)	10.0	N/A	N/A	13.1	12.5	12.7	10.0
Leech (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Leech (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Leech (wetland)	10.0	N/A	N/A	13.1	12.6	12.7	10.0
Clam, freshwater (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Snail, freshwater (stream)	<1.0	<1.0	<1.0	13.1	12.5	12.7	<1.0
Snail, freshwater (wetland)	10.0	N/A	N/A	<1.0	<1.0	<1.0	10.0
Scud (pond)	99.9	99.9	99.8	99.9	99.9	99.9	99.9
Crayfish (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Crayfish (wetland)	10.0	N/A	N/A	13.1	12.6	12.7	10.0
Water flea (lake)	98.1	98.7	99.2	98.7	98.6	98.6	98.4
Dragonfly, larva (stream)	37.3	37.4	35.8	37.3	37.4	37.5	37.4
Dragonfly, larva (pond)	66.9	72.6	62.8	72.4	71.6	71.9	69.8
Dragonfly, larva (wetland)	94.9	N/A	N/A	96.2	96.3	96.2	94.9
Mayfly, larva (stream)	99.1	<1.0	<1.0	99.1	<1.0	<1.0	99.1
Mayfly, larva (lake)	99.3	99.5	99.7	99.5	99.5	99.5	99.4
Stonefly, larva (stream)	99.1	<1.0	<1.0	99.1	<1.0	<1.0	99.1

Table 5–2, continued.

Species	Ecoregion 1	Ecoregion 2	Ecoregion 3	Ecoregion 4	Ecoregion 5	Ecoregion 6	Ecoregion 7
Caddisfly, larva (stream)	64.7	<1.0	<1.0	64.6	<1.0	<1.0	64.7
Backswimmer (pond)	87.2	90.3	84.8	90.3	89.8	90.0	88.8
Backswimmer (wetland)	99.0	N/A	N/A	99.4	99.3	99.3	99.0
Beetle (pond)	87.2	90.3	84.8	90.3	89.8	90.0	88.8
Mosquito, larva (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mosquito, larva (wetland)	2.0	N/A	N/A	2.9	2.8	2.8	2.0

[1] Estimates are based on the routine exposure scenario; Ecoregions are: **1** - California Valley and Coastal; **2** - Southwestern Basin and Range; **3** - Lower Rio Grande Valley; **4** - Southeastern and Gulf Coastal Plain; **5** - Mississippi Delta; **6** - Floridian; **7** - Marine Pacific Forest

[2] N/A = Not applicable; species does not occur in area.

were trapped. Lepidopterous larvae and aphid and whitefly populations were higher in the spray zone. Populations of muscoid flies were not reduced. She concluded, "When bait sprays are applied full cover over many months over a wide area, recovery of some species may require 1 year or more."

ES-APHIS modeling predicts that lepidopterans (butterflies, moths, and caterpillars) are less affected than many other insects by malathion bait spray. The predicted loss of soil invertebrates could affect nutrient cycling rates in the ecosystem. Loss of earthworms could affect the physical characteristics of the soil by reducing pore space and aeration which could potentially affect plant growth.

Modeling also predicts honey bees are at risk throughout the treatment area in all of the ecoregions, with estimated exposures of 700 times the median lethal dose. Unprotected honey bee hives would be expected to suffer substantial mortality and this has been found to occur. Gary and Mussen (1984) state: "We conclude that the impact of Medfly malathion bait spray on honey bees is significant. Although colonies recovered satisfactorily after cessation of spraying during the spring and early summer when there is sufficient time for populations to return to normal levels before winter begins...Although Medfly malathion bait spray is a threat to honey bee colonies, we conclude that the overall economic benefits of controlling the destructive Medfly are far greater than the transient losses incurred by beekeepers." The notification process for beekeepers and mitigation measures for bees reduce potential adverse impacts to honey bee hives.

The timing and frequency of spraying have a great impact on the species alterations. Washburn *et al.*, (1983) found: "Few adult natural enemies survived one spray, but populations recovered quickly...Timing of spray regimes could qualitatively as well as quantitatively alter the community composition. Whether the balance of the system is shifted to favor the scale [pest species] or the natural enemies depends on the frequency and seasonal timing of the applications."

Some vertebrates may be at risk including insectivorous mammals (bat and shrew) and the terrestrial amphibians. Birds are not anticipated to suffer mortality in the program area due to malathion aerial spraying.

Species which depend upon invertebrates for part of their diet would be affected by the aerial spray program due to a reduction in food supply even if they suffer no direct mortality. Effects would be greatest for predators with restricted mobility. Field studies have shown that mammals, birds, reptiles, and terrestrial amphibians are unlikely to be affected by direct toxicity, but some species dependent upon insects for food (insectivore) or pollination of food plants could be stressed by environmental conditions that result from malathion applications. Plants dependent upon invertebrates for pollination would also be affected, as well as animals dependent upon the fruits of these plants.

In aquatic systems, fish in shallow water bodies, such as wetlands or ponds less than 1 ft deep, are at risk because of the elevated (more than 59 µg/L) malathion concentrations in these habitats. Individuals of sensitive species, such as bluegills or shiners, are also at risk in ponds, streams, and some lakes. Commercially reared crayfish and shrimp are at risk in shallow ponds less than 1 ft deep in every ecoregion. In deeper ponds, these species are not at risk.

Aquatic reptiles and amphibians are at risk in wetlands. Many aquatic insect larvae are anticipated to be affected.

Field studies of the 1981 Medfly eradication program in Santa Clara County, California, indicate that the total number of aquatic insects remained constant following spraying, but the species composition changed and diversity declined, favoring those insects more tolerant of malathion. Adverse effects to fish are localized and may be limited to only highly sensitive species if applications are limited to the dry season when runoff is not a major concern. Fish losses that were attributed to malathion use in the 1981 program occurred in shallow creeks during the dry season as well as in larger streams during the wet season (CDFG, 1982). Field monitoring of the 1997 Medfly Eradication Program in

Florida found some fish losses in shallow bodies of water that were associated with aerial applications of malathion (USDA, APHIS, 1997).

Exposure to malathion bait spray or to the noise made by aircraft could cause behavioral changes in some organisms causing them to leave the treatment area, become more susceptible to predation, or become unable to either reproduce or care for young. No pertinent studies are available relative to effects of fruit fly programs on such behavioral changes.

(2) Ground Applications of Malathion Bait

(a) Hazard Assessment

The toxicity and hazards of malathion have been discussed previously. The same formulation is used for both aerial and ground applications. Ground applications may range from spot treatments (part of a host tree) to full foliar coverage of the host plants. Hazards and resultant risks would be higher for full foliar coverage applications than for spot treatments because of the greater amount of pesticide used. Because of the potential for using full foliar coverage application in a future program, the risk assessment has been based on that type of application.

(b) Exposure Analysis

As with aerial application, the ES-APHIS model predicted small insectivores had the highest exposures of the mammals, the large herbivores and aquatic foraging species the least. The highest total invertebrate exposures were to predators (orb web spider, lacewing larva, and parasitic wasp) and to those with high dermal exposure, such as maggots.

Ingestion was the primary exposure route for the vast majority of vertebrate species. Estimated dermal and ingestion exposures were about equal for invertebrates, although dermal exposure was higher for fossorial invertebrates, spiders, butterflies, and moths (the latter feed little as adults). Total doses in the eastern ecoregions were, in general, higher than in western ecoregions. The ecoregion differences in total dose are related to differences in the malathion concentration in prey items, as the dermal dose did not differ greatly among ecoregions.

No aquatic exposure was assumed under routine ground applications of malathion bait. However, because of soil characteristics, runoff is anticipated in the Mississippi Delta ecoregion (5) and Floridian ecoregion

(6). This is predicted to result in aquatic concentrations ranging from 0.03 to 3.1 μg/L in less than 2 m (6 ft) deep habitat.

(c) Risk Assessment

Table 5–3 provides a summary of the estimated risk to nontarget terrestrial species from ground spraying of malathion bait on foliage. Of the nontarget terrestrial species, the invertebrate species are at most risk from this treatment method. All terrestrial invertebrates modeled under both routine and extreme scenarios have estimated mortality rates greater than 99% except spider, beetle, butterfly, moth, caterpillar, and water strider. Amphibians that have a high proportion of their diet items containing residues from malathion ground treatments are at lesser risk. No mammal, bird, or reptile species analyzed had doses that exceeded the LD_1 values.

Ground spraying of malathion poses less risk to populations of birds and mammals than aerial spraying because it is applied to small areas relative to the size of birds' and most mammals' home ranges. Animals that feed extensively beneath a sprayed tree, or nest or forage within it, would receive the highest doses.

Ichinohe *et al.*, (1977) treated foliage with malathion ground spray and concluded: "It is clearly evident from results that proteinaceous bait is effective against fruit flies and also against many insects belonging to Diptera, Blattaria, Orthoptera, Homoptera, and Psocoptera." The study lacked controls and had "no information on population density of each species." They detected secondary poisoning (from eating contaminated prey items) as the cause of mortality in spiders.

Aquatic organisms are not at risk from ground spraying of malathion under the routine scenario.

Nontarget organisms could be disturbed by the treatment. Mobile species could leave the area and would suffer no adverse effect unless survival resources could not be found elsewhere. Effects would be greater on species or life stages (e.g., nestlings) that could not relocate. Precautions should be taken to ensure domestic animals do not contact the treated area.

Table 5–3. Estimates of Percentage Mortality to Exposed Individuals from Ground Application of Malathion Bait[1]

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Terrestrial Mammals							
Opossum	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Shrew	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A[2]
Bat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cottontail rabbit	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Squirrel	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Mouse	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Raccoon	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fox	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Coyote/Dog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Deer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Birds							
Pied-billed grebe	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great blue heron	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cattle egret	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Duck	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Turkey vulture	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-tailed hawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American kestrel	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Quail	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Killdeer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mourning dove	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great horned owl	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Burrowing owl	<1.0	<1.0	<1.0	<1.0	N/A	<1.0	<1.0
Nighthawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hummingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Belted kingfisher	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Northern flicker	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Kingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American robin	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Northern mockingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
European starling	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-winged blackbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Meadowlark	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
House sparrow	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Table 5–3, continued.

Species	Ecoregion 1	Ecoregion 2	Ecoregion 3	Ecoregion 4	Ecoregion 5	Ecoregion 6	Ecoregion 7
Terrestrial Reptiles							
Desert iguana	<1.0	<1.0	N/A	N/A	N/A	N/A	N/A
Side-blotched lizard	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Carolina anole	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Eastern fence lizard	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Western fence lizard	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Canyon lizard	N/A	N/A	<1.0	N/A	N/A	N/A	N/A
Gopher snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Garter snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Desert tortoise	<1.0	<1.0	N/A	N/A	N/A	N/A	N/A
Eastern box turtle	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Western box turtle	N/A	<1.0	<1.0	<1.0	N/A	N/A	N/A
Hognose snake	N/A	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Terrestrial Amphibians							
Toad	<1.0	<1.0	<1.0	1.3	2.8	2.8	<1.0
Tree frog	1.7	1.7	1.4	3.0	5.3	5.3	1.7
Terrestrial Invertebrates							
Earthworm	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Slug	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sowbug	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Spider	95.8	95.8	95.8	96.1	96.5	96.5	95.8
Mayfly	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Dragonfly	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Grasshopper	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lacewing	98.6	98.6	98.6	99.7	99.9	99.9	98.6
Water strider	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Beetle (grub)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Beetle (adult)	39.7	39.9	40.0	70.3	85.2	85.1	39.8
Butterfly	13.4	13.4	13.4	19.1	23.0	23.0	13.4
Moth	17.1	17.1	17.1	23.6	28.0	28.0	17.1
Caterpillar	31.3	31.3	31.3	34.6	37.3	37.3	31.3
Maggot (fly)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Fly (adult)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Ant	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Honey bee	99.7	100.0	99.7	99.7	99.7	99.7	99.9
Wasp	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 5–3, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Fish (Habitat)							
Golden shiner (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Golden shiner (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Speckled dace (stream)	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Mexican tetra (stream)	N/A	N/A	<1.0	N/A	N/A	N/A	N/A
Silvery minnow (lake)	N/A	N/A	N/A	<1.0	<1.0	N/A	N/A
Goldfish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sheepshead minnow (stream)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Sheepshead minnow (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
California killifish (stream)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
California killifish (wetland)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Swamp darter (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Mosquito fish (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mosquito fish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Rainbow trout (stream)	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Rainbow trout (lake)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Arroyo chub (stream)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Bluegill sunfish (stream)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Bluegill sunfish (lake)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Bluegill sunfish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Largemouth bass (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Largemouth bass (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Channel catfish (stream)	N/A	N/A	<1.0	N/A	<1.0	<1.0	N/A
Channel catfish (lake)	N/A	N/A	N/A	N/A	<1.0	<1.0	<1.0
Yellow bullhead catfish (stream)	N/A	N/A	N/A	<1.0	<1.0	N/A	N/A
Yellow bullhead catfish (lake)	N/A	N/A	N/A	N/A	<1.0	<1.0	N/A
Yellow bullhead catfish (pond)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Longnose gar (lake)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Longnose gar (pond)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Longnose gar (wetland)	N/A	N/A	N/A	N/A	N/A	<1.0	N/A

Table 5–3, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Lake chubsucker (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Aquatic Reptiles							
Snapping turtle (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Western pond turtle (wetland)	<1.0	N/A	N/A	N/A	N/A	N/A	<1.0
Water snake (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Aquatic Amphibians–larval forms							
Bullfrog (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	N/A
Tiger salamander (wetland)	<1.0	N/A	N/A	<1.0	<1.0	N/A	<1.0
Amphiuma (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Aquatic Invertebrates							
Sponge (freshwater)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hydra	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Leech	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Clam (freshwater)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Snail (freshwater)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Scud	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Crayfish	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Water flea	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dragonfly (nymph)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mayfly (larva)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Stonefly (larva)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Caddisfly (larva)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Backswimmer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Beetle	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mosquito (larva)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1

[1] Estimates are based on the routine exposure scenario for Terrestrial Organisms; extreme exposure scenario for Aquatic Organisms; Ecoregions are: **1** - California Valley and Coastal; **2** - Southwestern Basin and Range; 3 - Lower Rio Grande Valley; **4** - Southeastern and Gulf Coastal Plain; **5** - Mississippi Delta; **6** - Floridian;**7** - Marine Pacific Forest.
[2] N/A = Not applicable; species does not occur in area.

(3) Spinosad Aerial Application

(a) Hazard Assessment

Spinosad is a mixture of two compounds–spinosyn factor A and spinosyn factor D. The hazard relates to the combined exposures and toxicity of both factors. Unlike malathion and organophosphate insecticides which cause intoxication through multiple routes of exposure, the route of intoxication of spinosad occurs primarily through ingestion. Since the mechanism of intoxication for both compounds is the same, the hazards of exposure to each compound are combined to determine overall risk. Acute toxicity of spinosad to mammals and birds is low by all routes of exposure. The acute oral toxicity of spinosad is very slight to mammals (Dow Agrosciences, 1998; EPA, 1998a). The low metabolism, low toxicity, and rapid excretion in mammals probably account for a lack of observed adverse effects. The mechanism of intoxication occurs through persistent activation of nicotinic acetylcholine receptors and prolongation of acetylcholine responses (Salgado *et al.*, 1997). This prolonged response leads to involuntary muscle contractions and tremors. Spinosad is practically nontoxic to birds (Borth *et al.*, 1996; Dow Agrosciences, 1998). It is expected that acute toxicity to reptiles and amphibians is also low. Phytotoxic effects may be observed on some plants, but most plants are not expected to show adverse effects at the low rates of application.

Toxicity to terrestrial invertebrate from exposure to spinosad occurs primarily through ingestion, but some effects from contact exposure are possible. Spinosad is particularly effective against caterpillars (Lepidoptera) and all stages of flies (Diptera) (Adan *et al.*, 1996). The mode of toxic action of spinosad against insects has been shown to relate to the widespread excitation of isolated neurons in the central nervous system (Salgado *et al.*, 1997). The symptoms of intoxication to terrestrial invertebrates are unique and are typified by initial flaccid paralysis followed by weak tremors and continuous movement of crochets and mandibles (Thompson *et al.*, 1995). The effects occur rapidly and there is little to no recovery.

The toxicity of spinosad to invertebrates is dependent upon the species. Spinosad is very highly toxic to native budworm caterpillars, but only slightly toxic to cotton leafworm caterpillars (Sparks *et al.*, 1995; Thompson *et al.*, 1995). The median lethal dose to house flies is 0.9 mg/kg. Ants such as the Argentine ant (LD_{50} = 185.6 mg/kg) are very tolerant of spinosad. Other Hymenoptera such as honey bees (LD_{50} = 11.5 mg/kg) and the red headed pine sawfly (LD_{50} = 2.8 mg/kg) are more sensitive (Borth *et al.*, 1996; Thompson *et al.*, 1995). Spinosad is slightly toxic to parasitic wasps such as *Encarsia formosa* (LD_{50} = 29.1 mg/kg). Beetles, fleas, lacewings, minute pirate bugs, and cockroaches are quite tolerant of spinosad. Although spinosad is moderately toxic to the 2-spotted spider mite (LD_{50} = 2.1 mg/kg), it is practically nontoxic to the mite, *Phytoseiulus persimilis* (LD_{50}>200 mg/kg). Beneficial arthropods observed to not be affected by spinosad in treated cotton fields include trichogrammatid wasps, minute pirate bugs, assassin bugs, ladybird beetles, predatory mites, fire ants, big-headed bugs, damsel bugs, green lacewings, and spiders (Peterson *et al.*, 1996). Another field study found (1) no adverse effects from spinosad on populations of predators; (2) some decreases in parasitic Hymenoptera populations, some pest species plant bugs, cotton aphids, and spur-throated grasshoppers; and (3) substantial decreases of Lepidoptera caterpillars (Murray and Lloyd, 1997). Spinosad was found nontoxic to bees at the program's proposed concentrations.

Spinosad is slightly to moderately toxic to fish. The 96-hour median lethal concentrations of spinosad determined for fish species are as follows: bluegill = 5.9 mgL, rainbow trout = 30 mg/L, carp = 5 mg/L, and sheepshead minnow = 7.9 mg/L (Borth *et al.*, 1996). A 21-day median lethal concentration of spinosad was determined for rainbow trout to be 4.8 mg/L.

Spinosad is slightly to moderately toxic to most aquatic invertebrates. The median lethal concentration of spinosad to daphnia was determined to be 92.7 mg/L (Borth *et al.*, 1996). Grass shrimp were more sensitive and had a 96-hour median lethal concentration for spinosad of 9.76 mg/L (Dow Agrosciences, 1998). Spinosad was found to be highly toxic to marine molluscs with a median lethal concentration of spinosad at 0.295 mg/L for eastern oyster.

Spinosad is of slight to moderate acute toxicity to algae. The median lethal concentration of spinosad was determined to be 106 mg/L for green algae and 8.09 mg/L for blue green algae (Borth *et al.*, 1996).

(b) Exposure Analysis

From modeling, the terrestrial invertebrates and vertebrate insectivorous species were anticipated to receive the highest total spinosad doses of the terrestrial organisms (most species had total doses greater than 0.1 mg/kg of spinosad). Predatory invertebrates (orb web spider, adult beetle, and parasitic wasp), invertebrates with high metabolic requirements (caterpillars and maggots), and invertebrates with high activity rates and frequent contact with spinosad residues (ants and honey bees) had higher total doses than other terrestrial organisms.

Vertebrates exhibited exposures to spinosad ranging from less than 0.01 mg/kg to 1.561 mg/kg. Smaller species tended to have higher total doses than larger species because small species have higher metabolic rates (and need to consume more food per body weight) and also are more active than large species (contacting spinosad more frequently resulting in higher dermal exposures).

Total doses for all types of terrestrial organisms were higher in the western ecoregions (California Central Valley and Coastal, Southwestern Basin and Range, Lower Rio Grande Valley, and Marine Pacific Forest). This assumed that the sparse vegetative cover in these areas allowed a higher proportion of the spinosad bait spray to penetrate the canopy to the level where the organism would be exposed.

Ingestion was considered to be the dominant route of exposure for all but a few of the vertebrates. Inhalation was negligible for all taxa. Ingestion and dermal exposure were approximately equal for most of the invertebrates, although dermal exposure poses risk primarily to those invertebrates that groom themselves. For invertebrates living in the soil, dermal was usually the dominant type of exposure depending on the amount of time spent at the soil surface.

For aquatic organisms, exposure estimates were equivalent to the spinosad concentrations in the water body in which they occurred. Concentration in water was correlated to water body depth; organisms living in shallow water bodies had higher total doses than those living in deeper habitats. The highest spinosad concentrations, and thus the highest total doses, were observed in wetlands and shallow ponds. There were no ecoregion differences in extreme exposure in wetlands and ponds. The highest total doses under the routine scenario for the pond and wetland were in the Southwestern Basin and Range and the Southeastern and Gulf Coastal Plain ecoregions, respectively.

Inadvertent direct spray was assumed for all aquatic habitats. Some water bodies also received runoff from the treatment area. Spinosad concentrations were dependent upon the amount of runoff expected following a rain storm and the soil-specific degradation rate. Ecoregion differences in total doses were noted for water bodies receiving runoff water (lakes and streams). Highest total doses in the stream and lake were predicted in the western ecoregions and in the Southwestern Basin and Range ecoregion, respectively.

(c) Risk Assessment

Table 5–4 summarizes the estimated risk to nontarget species resulting from aerial spraying of spinosad bait.

The potential exposure of nontarget organisms to spinosad is less than either malathion or SureDye. The toxicity of the active ingredients in spinosad bait spray is less than malathion to mammals, birds, reptiles, fish, and amphibians. As a result of low exposure and low toxicity, few, if any, adverse effects are expected to mammals, birds, amphibians, reptiles, and fish from spinosad bait spray applications. The reductions in insect populations are limited and not expected to affect most species, so insectivorous mammals (bat and shrew) and birds are expected to have minimal, if any, increase in foraging effort. Mortality is very unlikely, particularly for routine exposure scenarios.

Some terrestrial invertebrates are at risk throughout the treatment area because of high exposures and toxicity. Since the primary route of spinosad intoxication occurs through ingestion, those insects attracted to the bait to feed are predicted to have higher mortality. In particular, this includes the exposed invertebrate populations of midges and gnats, pomace flies, other acalypterate muscoid flies, and some soil mites (Troetschler, 1983). Other insects attracted to the bait may not be affected due to high tolerance for spinosad. This includes ground beetles and ants. Seed-feeding ants and other species not attracted to the bait are not expected to be adversely affected. However, there are some other terrestrial invertebrates that are predicted to have exposure and suffer mortality. This includes all species that consume a leaf (or other surface) with spinosad residues, some sensitive predatory species that consume an exposed invertebrate, and all species that vigorously groom after exposure to spray residues. This includes orb web spiders, dragonflies, caterpillars, and other species that fit these categories. The pollinators (honey bees) are likely to be affected if program precautions are not taken, but parasitic wasps are not expected to have appreciable exposure and little, if any, mortality are anticipated for these species. The number of species and the number of individual invertebrates adversely affected by spinosad bait spray is considerably less than those affected by malathion bait spray and is comparable to those affected by SureDye bait spray. The limited effects on these species relate primarily to the more limited route of intoxication from spinosad than from malathion and the greater tolerance of some invertebrate species.

Some terrestrial invertebrates, particularly insects exposed to bait spray, are likely to have depressed populations for a given period of time following spraying. The treatment area and number of treatments will influence the ability of the population to become reestablished. The ability to reestablish the population is also influenced by the distance from the treatment area to similar, untreated habitats containing potential

Table 5–4. Estimates of Percentage Mortality to Exposed Individuals from Aerial Application of Spinosad Bait[1]

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Terrestrial Mammals							
Opossum	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Shrew	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A[2]
Bat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cottontail rabbit	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Squirrel	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Mouse	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Raccoon	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fox	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Coyote/Dog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Deer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Birds							
Pied-billed grebe	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great blue heron	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cattle egret	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Duck	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Turkey vulture	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-tailed hawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American kestral	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Quail	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Killdeer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mourning dove	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great horned owl	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Burrowing owl	<1.0	<1.0	<1.0	<1.0	N/A	<1.0	<1.0
Nighthawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hummingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Belted kingfisher	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Northern flicker	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Kingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American robin	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Northern mockingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
European starling	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-winged blackbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Meadowlark	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
House sparrow	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Table 5–4, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Terrestrial Reptiles							
Desert iguana	<1.0	<1.0	N/A	N/A	N/A	N/A	N/A
Side-blotched lizard	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Carolina anole	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Eastern fence lizard	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Western fence lizard	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Canyon lizard	N/A	N/A	<1.0	N/A	N/A	N/A	N/A
Gopher snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Garter snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Desert tortoise	<1.0	<1.0	N/A	N/A	N/A	N/A	N/A
Eastern box turtle	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Western box turtle	N/A	<1.0	<1.0	<1.0	<1.0	N/A	N/A
Hognose snake	N/A	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Terrestrial Amphibians							
Toad	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tree frog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Invertebrates							
Earthworm	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Slug	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sowbug	<1.0	2.14	1.24	<1.0	<1.0	<1.0	<1.0
Spider	9.0	13.4	11.2	4.8	1.9	3.1	N/A
Mayfly	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Dragonfly	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Grasshopper	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Lacewing	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Water strider	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Beetle, grub	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Beetle, adult	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Butterfly	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Moth	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Caterpillar	100	100	100	100	100	100	100
Maggot	100	100	100	100	100	100	100
Fly	100	100	100	100	100	100	100
Ant	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Honey bee	100	100	100	100	100	100	100
Wasp	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Table 5–4, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Fish (Habitat)							
Golden shiner (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Golden shiner (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Speckled dace (stream)	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Mexican tetra (stream)	N/A	N/A	<1.0	N/A	N/A	N/A	N/A
Silvery minnow (lake)	N/A	N/A	N/A	<1.0	<1.0	N/A	N/A
Goldfish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sheepshead minnow (stream)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Sheepshead minnow (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
California killifish (stream)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
California killifish (wetland)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Swamp darter (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Mosquito fish (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mosquito fish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Rainbow trout (stream)	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Rainbow trout (lake)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Arroyo chub (stream)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Bluegill sunfish (stream)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Bluegill sunfish (lake)	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Bluegill sunfish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Largemouth bass (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Largemouth bass (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Channel catfish (stream)	N/A	N/A	<1.0	N/A	<1.0	<1.0	N/A
Channel catfish (lake)	N/A	N/A	N/A	N/A	<1.0	<1.0	<1.0
Yellow bullhead catfish (stream)	N/A	N/A	N/A	<1.0	<1.0	N/A	N/A
Yellow bullhead catfish (lake)	N/A	N/A	N/A	N/A	<1.0	N/A	N/A
Yellow bullhead catfish (pond)	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Longnose gar (lake)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Longnose gar (pond)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Longnose gar (wetland)	N/A	N/A	N/A	N/A	N/A	<1.0	N/A

Table 5–4, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Lake chubsucker (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Aquatic Reptiles							
Snapping turtle (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Western pond turtle (wetland)	<1.0	N/A	N/A	N/A	N/A	N/A	<1.0
Water snake (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Aquatic Amphibians–larval forms							
Bullfrog (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	N/A
Tiger salamander (wetland)	<1.0	N/A	N/A	<1.0	<1.0	N/A	<1.0
Amphiuma (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Aquatic Invertebrates							
Sponge, freshwater (stream)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Sponge, freshwater (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sponge, freshwater (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hydra (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Leech (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Leech (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Leech (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Clam, freshwater (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Snail, freshwater (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Snail, freshwater (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Scud (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Crayfish (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Crayfish (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Water flea (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dragonfly, larva (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dragonfly, larva (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dragonfly, larva (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Mayfly, larva (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mayfly, larva (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Stonefly, larva (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Table 5–4, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Caddisfly, larva (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Backswimmer (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Backswimmer (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Beetle (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mosquito, larva (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mosquito, larva (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0

[1] Estimates are based on the routine exposure scenario.
[2] N/A = Not applicable; species does not occur in area.

colonists, and the ability of these potential colonists to disperse. Limiting the bait spray either by selective applications to smaller, more critical areas or using only ground applications allows these populations better chances for earlier recovery to their previous population levels. These effects on insect populations are anticipated to be less pronounced from spinosad bait than from malathion bait. The timing and frequency of spraying have a great impact on the species alterations. Recolonization following these population effects from spinosad bait spray is likely to begin within a few days after application because the residual pesticide readily degrades in the treated areas.

Aquatic species are at very low risk of adverse effects. The concentration of spinosad in water is several orders of magnitude less than any concentrations known to adversely affect aquatic organisms. The water solubility assures that residues would not bioconcentrate in tissues, so adverse effects would not be expected from the short residual exposures. The short half-life in water indicates that adverse effects from spinosad would have to occur within a few hours of application and the concentration in water is lower than would ever be expected to adversely affect these species. Some aquatic species in very shallow ditches (1 cm deep) could be affected, but these isolated circumstances are not expected to affect aquatic populations.

Exposure to spinosad bait spray or to the noise made by aircraft could cause behavioral changes in some organisms causing them to leave the treatment area, become more susceptible to predation, or become unable to either reproduce or care for young. No pertinent studies are available relative to effects of fruit fly programs on such behavioral changes.

(4) Ground Applications of Spinosad Bait

(a) Hazard Assessment

The toxicity and hazards of spinosad have been discussed previously in the section on aerial application. The same formulation is used for both aerial and ground applications. Ground applications may range from spot treatments (part of a host tree) to full foliar coverage of the host plants. Hazards and resultant risks would be higher for full foliar coverage applications than for spot treatments because of the greater amount of pesticide used. Because of the potential for using full foliar coverage application in a future program, the risk assessment has been based on that type of application.

(b) Exposure Analysis

As with aerial application, the ES-APHIS model predicted small insectivores had the highest exposures of the mammals, the large herbivores and aquatic foraging species the least. The highest total invertebrate exposures were to predators (orb web spider, lacewing larva, and parasitic wasp).

Ingestion was the primary exposure route for the vast majority of vertebrate species. Ingestion exposure was also the primary route for invertebrates because intoxication occurs primarily through ingestion for most species and other than exposures through behavioral grooming, dermal exposures are of lesser consequence. Total doses in the eastern ecoregions were, in general, higher than in western ecoregions. The ecoregion differences in total dose are related to differences in the spinosad concentration in prey items, as the dermal dose did not differ greatly among ecoregions.

No aquatic exposure was assumed under routine ground applications of spinosad bait. However, because of soil characteristics, runoff is anticipated in the Mississippi Delta and Floridian ecoregions. This is predicted to result in aquatic concentrations ranging from 0.008 to 0.05 µg/L spinosad in less than 2 m (6 ft) deep habitat.

(c) Risk Assessment

Table 5–5 provides a summary of the estimated risk to nontarget terrestrial species from ground spraying of spinosad bait on foliage. Of the nontarget terrestrial species, the invertebrate species are at most risk

Table 5–5. Estimates of Percentage Mortality to Exposed Individuals from Ground Application of Spinosad Bait[1]

Species	Ecoregion 1	Ecoregion 2	Ecoregion 3	Ecoregion 4	Ecoregion 5	Ecoregion 6	Ecoregion 7
Terrestrial Mammals							
Opossum	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Shrew	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A[2]
Bat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cottontail rabbit	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Squirrel	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Mouse	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Raccoon	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fox	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Coyote/Dog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Deer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Birds							
Pied-billed grebe	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great blue heron	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cattle egret	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Duck	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Turkey vulture	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-tailed hawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American kestrel	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Quail	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Killdeer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mourning dove	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great horned owl	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Burrowing owl	<1.0	<1.0	<1.0	<1.0	N/A	<1.0	<1.0
Nighthawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hummingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Belted kngfisher	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Northern flicker	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Kingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American robin	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Nothern mockingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
European starling	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-winged blackbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Meadowlark	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
House sparrow	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Table 5–5, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Terrestrial Reptiles							
Desert iguana	<1.0	<1.0	N/A	N/A	N/A	N/A	N/A
Side-blotched lizard	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Carolina anole	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Eastern fence lizard	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Western fence lizard	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Canyon lizard	N/A	N/A	<1.0	N/A	N/A	N/A	N/A
Gopher snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Garter snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Desert tortoise	<1.0	<1.0	N/A	N/A	N/A	N/A	N/A
Eastern box turtle	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Western box turtle	N/A	<1.0	<1.0	<1.0	N/A	N/A	N/A
Hognose snake	N/A	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Terrestrial Amphibians							
Toad	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tree frog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Invertebrates							
Earthworm	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Slug	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sowbug	<1.0	1.57	1.12	<1.0	<1.0	<1.0	N/A
Spider	5.0	7.2	6.1	2.9	1.5	2.1	N/A
Mayfly	13.0	13.0	13.0	13.0	13.0	13.0	13.0
Dragonfly	13.0	13.0	13.0	13.0	13.0	13.0	13.0
Grasshopper	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Lacewing	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Water strider	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Beetle, grub	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Beetle, adult	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Butterfly	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Moth	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Caterpillar	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Maggot	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Fly	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Ant	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Honey bee	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Wasp	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Table 5–5, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Fish (Habitat)							
Golden shiner (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Golden shiner (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Speckled dace (stream)	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Mexican tetra (stream)	N/A	N/A	<1.0	N/A	N/A	N/A	N/A
Silvery minnow (lake)	N/A	N/A	N/A	<1.0	<1.0	N/A	N/A
Goldfish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sheepshead minnow (stream)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Sheepshead minnow (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
California killifish (stream)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
California killifish (wetland)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Swamp darter (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Mosquito fish (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mosquito fish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Rainbow trout (stream)	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Rainbow trout (lake)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Arroyo chub (stream)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Bluegill sunfish (stream)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Bluegill sunfish (lake)	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Bluegill sunfish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Largemouth bass (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Largemouth bass (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Channel catfish (stream)	N/A	N/A	<1.0	N/A	<1.0	<1.0	N/A
Channel catfish (lake)	N/A	N/A	N/A	N/A	<1.0	<1.0	<1.0
Yellow bullhead catfish (stream)	N/A	N/A	N/A	<1.0	<1.0	N/A	N/A
Yellow bullhead catfish (lake)	N/A	N/A	N/A	N/A	<1.0	N/A	N/A
Yellow bullhead catfish (pond)	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Longnose gar (lake)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Longnose gar (pond)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A

Table 5–5, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Longnose gar (wetland)	N/A	N/A	N/A	N/A	N/A	<1.0	N/A
Lake chubsucker (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Aquatic Reptiles							
Snapping turtle (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Western pond turtle (wetland)	<1.0	N/A	N/A	N/A	N/A	N/A	<1.0
Water snake (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Aquatic Amphibians–larval forms							
Bullfrog (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	N/A
Tiger salamander (wetland)	<1.0	N/A	N/A	<1.0	<1.0	N/A	<1.0
Amphiuma (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Aquatic Invertebrates							
Sponge, freshwater	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hydra	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Leech	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Clam, freshwater	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Snail, freshwater	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Scud	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Crayfish	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Water flea	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dragonfly, nymph	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mayfly, larva	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Stonefly, larva	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Caddisfly, larva	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Backswimmer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Beetle	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mosquito, larva	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

[1] Estimates are based on the routine exposure scenario for Terrestrial Organisms; extreme exposure scenario for Aquatic Organisms.
[2] N/A = Not applicable; species does not occur in area

from this treatment method. This is largely the result of selective toxicity of this compound to those species and exposure occurring primarily through ingestion. This exposure may occur through grooming of the body or direct ingestion of the bait spray. Other than fruit flies, the only invertebrates known to be attracted in large numbers to feed upon the bait spray include the plant bugs (miridae), ground beetles (carabidae), midges and gnats (nematocerous Diptera), pomace flies, other acalypterate muscoid flies, some ants (formicidae), and soil mites (acari) (from a malathion bait spray study–Troetschler, 1983). Of the species attracted, plant bugs, ground beetles, and ants are highly tolerant of exposure to spinosad and the exposures would probably not adversely affect these organisms. Most terrestrial invertebrates modeled under both routine and extreme scenarios had estimated mortality rates less than 1% except sowbugs, orb web spiders, mayflies, dragonflies, caterpillars, maggots, flies, and honey bees. No mammal, bird, reptile, or amphibian species analyzed had doses that exceeded the LD_1 values.

Estimated mortality rates for ground applications are much lower than for aerial applications because of the more limited nature of ground applications, even though the maximum was modeled. Insects have a high reproductive rate and most are ubiquitous. Because ground application of foliar sprays cover small areas, sufficient interspersion of unaffected areas which support invertebrates would provide a population base for repopulating treated areas. Except for populations characterized by low numbers, there should be sufficient numbers from neighboring untreated areas. However, depending on the time of year, some commercially important species, such as predators, could experience some population reductions. Severe reductions in predatory insect populations have resulted in an increase in some pest species. Because spinosad ground spraying is localized, however these effects are unlikely to be widespread.

Phytotoxic effects are not expected from the low application rates of spinosad bait. Indirect impacts on vegetation could occur because spinosad is potentially toxic to some pollinators and some insect predators. Effects would be expected to be limited and local, and long-term reductions in any insect populations are not anticipated from ground spraying due to recruitment of populations from unsprayed areas.

(5) SureDye Aerial Application

(a) Hazard Assessment

SureDye bait is a formulation of a red xanthene dye (phloxine B) and hydrolyzed protein bait. Unlike malathion and other organophosphate insecticides which cause intoxication through multiple routes of exposure, the route of intoxication of xanthene dyes occurs primarily, if not entirely, through ingestion. Acute toxicity of phloxine B to mammals and birds is low by all routes of exposure. The acute oral toxicity of phloxine B is very slight to mammals (Hansen *et al.*, 1958; Webb *et al.*, 1962; Industrial Bio-Test Laboratories, 1962a, 1962b). The low metabolism, low toxicity, and rapid excretion in mammals probably account for the low mortality observed (Webb *et al.*, 1962; Hansen *et al.*, 1958). The mode of toxic action and metabolism indicate low toxicity of phloxine B to birds, reptiles, and amphibians (Heitz, 1982). Phytotoxic effects may be observed on some plants, but most plants are not expected to show adverse effects at the low rates of application (Perry, 1993).

The toxicity of phloxine B to invertebrates results from the ingestion of the compound and its subsequent photoactivation under natural or artificial light. The compound is activated within the body of the invertebrate where it destroys tissues through an oxidation process. Intoxication to terrestrial invertebrates has been shown for many species including some insects with opaque exoskeletons such as boll weevil (Broome *et al.*, 1975; Callaham *et al.*, 1975; Callaham *et al.*, 1975a; Clement *et al.*, 1980; Fondren and Heitz, 1978; Fondren and Heitz, 1979). The limited route of exposure (ingestion only) means that only insects that ingest the SureDye bait will suffer mortality. This includes all species that are attracted to the bait and feed, all species that consume a leaf with SureDye residues, and all species that vigorously groom after exposure to spray residues. Other than fruit flies, the only invertebrates known to be attracted in large numbers to feed upon the bait spray include the plant bugs (miridae), ground beetles (carabidae), midges and gnats (nematocerous Diptera), pomace flies, other acalypterate muscoid flies, some ants (formicidae), and soil mites (acari) (from a malathion bait spray study–Troetschler, 1983). The hazards to these species that feed on bait exceed those of all other terrestrial invertebrates.

Phloxine B is practically nontoxic to fish (Tonogai *et al.*, 1979; Marking, 1969; Pimprikar *et al.*, 1984). The toxicity of phloxine B to aquatic invertebrates is also very low (Schildmacher, 1950) and the low concentrations entering water from SureDye bait spray applications would pose low hazards to all aquatic invertebrates.

(b) Exposure Analysis

From modeling, the terrestrial invertebrates were anticipated to receive the highest total SureDye doses of any of the terrestrial organisms (most species had total doses greater than 10 mg/kg of phloxine B). Vertebrate insectivorous species had higher total doses than other vertebrate omnivores, herbivores, or noninsect carnivores. Predatory invertebrates (orb web spider, adult beetle, and parasitic wasp), invertebrates with high metabolic requirements (caterpillars and maggots), and invertebrates with high activity rates and frequent contact with SureDye residues (ants and honey bees) had higher total doses than other terrestrial organisms.

Vertebrates experienced exposures to phloxine B ranging from less than 1 mg/kg to 10 mg/kg. Smaller species tended to have higher total doses than larger species because small species have higher metabolic rates (and need to consume more food per body weight) and also are more active than large species (contacting SureDye more frequently resulting in higher dermal exposures).

Total doses for all types of terrestrial organisms were higher in the western ecoregions (California Central Valley and Coastal, Southwestern Basin and Range, Lower Rio Grande Valley, and Marine Pacific Forest). This assumed that the sparse vegetative cover in these areas allowed a higher proportion of the SureDye bait spray to penetrate the canopy to the level where the organism would be exposed.

Ingestion was considered to be the dominant route of exposure for all but a few of the vertebrates. Inhalation was negligible for all taxa. Ingestion and dermal exposure were approximately equal for most of the invertebrates, although dermal exposure only poses risk to those invertebrates that groom themselves.

For invertebrates living in the soil, dermal was usually the dominant type of exposure, depending on the amount of time spent at the soil surface.

For aquatic organisms, exposure estimates were equivalent to the phloxine B concentrations in the water body in which they occurred. Dye concentration in water was correlated to water body depth; organisms living in shallow water bodies had higher total doses than those living in deeper habitats. The highest SureDye concentrations, and thus the highest total doses, were observed in wetlands and shallow ponds. There were no ecoregion differences in extreme exposure in wetlands and ponds. The highest total doses under the routine scenario for the pond and wetland were in the Southwestern Basin and Range (2) and the Southeastern and Gulf Coastal Plain ecoregion (4), respectively.

Direct spray was assumed for all aquatic habitats. Some water bodies also received runoff from the treatment area. SureDye concentrations were dependent upon the amount of runoff expected following a rain storm and the soil-specific degradation rate. Ecoregion differences in total doses were noted for water bodies receiving runoff water (lakes and streams). Highest total doses in the stream and lake were predicted in the western ecoregions and in the Southwestern Basin and Range ecoregion (2), respectively.

(c) Risk Assessment

Table 5–6 summarizes the estimated risk to nontarget species resulting from aerial spraying of SureDye bait. Some terrestrial invertebrates are at risk throughout the treatment area because of high exposures and toxicity. Since the route of intoxication of this xanthene dye occurs primarily through ingestion, those insects attracted to the bait to feed are predicted to have higher mortality. This includes the exposed invertebrate populations of adult ground beetles, plant bugs, midges and gnats, pomace flies, other acalypterate muscoid flies, some scavenging ant species, and soil mites (Troetschler, 1983). Seed-feeding ants and other species not attracted to the bait are not expected to be adversely affected. However, there are some other terrestrial invertebrates that are predicted to have exposure and suffer mortality. This includes all species that consume a leaf (or other surface) with SureDye residues, all predatory species that consume an exposed invertebrate, and all species that vigorously groom after exposure to spray residues. This includes slugs, orb web spiders, grasshoppers, dragonflies, water striders, some beetle adults, caterpillars, some ants, and other species that fit these categories. The pollinators (honey bees) and parasitic wasps are not expected to have exposure by ingestion in appreciable amounts and little if any mortality are anticipated for these species (Dowell, 1996). The number of species and the number of individual invertebrates adversely affected by SureDye bait spray is considerably less than those affected by malathion bait spray. This relates primarily to the more limited route of intoxication from SureDye than from malathion.

The terrestrial invertebrates, particularly insects exposed to bait spray, are likely to have depressed populations for a given period of time following spraying. The treatment area and number of treatments will influence the ability of the population to become reestablished. The ability to reestablish the population is also influenced by the distance from the treatment area to similar, untreated habitats containing potential colonists, and the ability of these potential colonists to disperse.

Limiting the bait spray either by selective applications to smaller more critical areas or using only ground applications allows these populations better chances for earlier recovery to their previous population levels. These effects on insect populations are anticipated to be less pronounced from SureDye bait than from malathion bait. The timing and frequency of spraying have a great impact on the species alterations. Recolonization following these population effects from SureDye bait spray are likely to begin within a few days after application because the residual dye readily degrades in the treated areas.

Table 5–6. Estimates of Percentage Mortality from Exposure to Aerial Application of SureDye Bait[1]

Species	Ecoregion 1	Ecoregion 2	Ecoregion 3	Ecoregion 4	Ecoregion 5	Ecoregion 6	Ecoregion 7
Terrestrial Mammals							
Opossum	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Shrew	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A[2]
Bat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cottontail rabbit	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Squirrel	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Mouse	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Raccoon	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fox	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Coyote/Dog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Deer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Birds							
Pied-billed grebe	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great blue heron	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cattle egret	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Duck	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Turkey vulture	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-tailed hawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American kestrel	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Quail	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Killdeer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mourning dove	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great horned owl	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Burrowing owl	<1.0	<1.0	<1.0	<1.0	N/A	<1.0	<1.0
Nighthawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hummingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Belted kingfisher	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Northern flicker	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Kingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American robin	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Northern mockingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
European starling	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-winged blackbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Meadowlark	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
House sparrow	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Table 5–6, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Terrestrial Reptiles							
Desert iguana	<1.0	<1.0	N/A	N/A	N/A	N/A	N/A
Side-blotched lizard	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Carolina anole	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Eastern fence lizard	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Western fence lizard	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Canyon lizard	N/A	N/A	<1.0	N/A	N/A	N/A	N/A
Gopher snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Garter snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Desert tortoise	<1.0	<1.0	N/A	N/A	N/A	N/A	N/A
Eastern box turtle	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Western box turtle	N/A	<1.0	<1.0	<1.0	<1.0	N/A	N/A
Hognose snake	N/A	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Terrestrial Amphibians							
Toad	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tree frog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Invertebrates							
Earthworm	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Slug	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Sowbug	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Spider	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Mayfly	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dragonfly	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Grasshopper	25	25	25	25	25	25	25
Lacewing	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Water strider	12.5	12.5	12.5	12.5	12.5	12.5	25
Beetle (grub)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Beetle (adult)	25	25	25	25	25	25	25
Butterfly	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Moth	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Caterpillar	25	25	25	25	25	25	25
Maggot (fly)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fly (adult)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ant	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Honey bee	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Wasp	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Table 5–6, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Fish (Habitat)							
Golden shiner (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Golden shiner (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Speckled dace (stream)	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Mexican tetra (stream)	N/A	N/A	<1.0	N/A	N/A	N/A	N/A
Silvery minnow (lake)	N/A	N/A	N/A	<1.0	<1.0	N/A	N/A
Goldfish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sheepshead minnow (stream)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Sheepshead minnow (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
California killifish (stream)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
California killifish (wetland)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Swamp darter (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Mosquito fish (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mosquito fish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Rainbow trout (stream)	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Rainbow trout (lake)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Arroyo chub (stream)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Bluegill sunfish (stream)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Bluegill sunfish (lake)	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Bluegill sunfish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Largemouth bass (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Largemouth bass (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Channel catfish (stream)	N/A	N/A	<1.0	N/A	<1.0	<1.0	N/A
Channel catfish (lake)	N/A	N/A	N/A	N/A	<1.0	<1.0	<1.0
Yellow bullhead catfish (stream)	N/A	N/A	N/A	<1.0	<1.0	N/A	N/A
Yellow bullhead catfish (lake)	N/A	N/A	N/A	N/A	<1.0	N/A	N/A
Yellow bullhead catfish (pond)	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Longnose gar (lake)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Longnose gar (pond)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Longnose gar (wetland)	N/A	N/A	N/A	N/A	N/A	<1.0	N/A
Lake chubsucker (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A

Table 5–6, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Aquatic Reptiles							
Snapping turtle (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Western pond turtle (wetland)	<1.0	N/A	N/A	N/A	N/A	N/A	<1.0
Water snake (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Aquatic Amphibians–larval forms							
Bullfrog (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	N/A
Tiger salamander (wetland)	<1.0	N/A	N/A	<1.0	<1.0	N/A	<1.0
Amphiuma (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Aquatic Invertebrates							
Sponge, freshwater (stream)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Sponge, freshwater (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sponge, freshwater (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hydra (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Leech (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Leech (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Leech (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Clam, freshwater (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Snail, freshwater (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Snail, freshwater (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Scud (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Crayfish (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Crayfish (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Water flea (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mayfly, larva (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mayfly, larva (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Stonefly, larva (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Caddisfly, larva (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Backswimmer (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Backswimmer (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Beetle (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Table 5–6, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Mosquito, larva (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mosquito, larva (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0

[1] Estimates are based on the routine exposure scenario;Ecoregions are: **1** - California Valley and Coastal; **2** - Southwestern Basin and Range; **3** - Lower Rio Grande Valley; **4** - Southeastern and Gulf Coastal Plain; **5** - Mississippi Delta; **6** - Floridian; **7** - Marine Pacific Forest.

[2] N/A = Not applicable; species does not occur in area.

Terrestrial vertebrates are not expected to be at risk of intoxication from SureDye bait spray applications. The reductions in insect populations are limited and not expected to affect most species, so insectivorous mammals (bat and shrew) and birds are expected to have minimal, if any, increase in foraging effort. Birds are not anticipated to suffer mortality in the program area due to SureDye aerial spraying.

In aquatic systems, fish and aquatic invertebrates are not expected to be at risk because the concentration of dye will be very low and the toxicity of the dye is low to most species in these habitats. Some aquatic species in very shallow ditches (1 cm deep) could be affected, but these isolated circumstances are not expected to affect most individuals and most populations.

Exposure to SureDye bait spray or to the noise made by aircraft could cause behavioral changes in some organisms causing them to leave the treatment area, become more susceptible to predation, or become unable to either reproduce or care for young. No pertinent studies are available relative to effects of fruit fly programs on such behavioral changes.

(6) Ground Applications of SureDye Bait

(a) Hazard Assessment

The toxicity and hazards of SureDye have been discussed previously. The same formulation is used for both aerial and ground applications. Ground applications may range from spot treatments (part of a host tree) to full foliar coverage of the host plants. Hazards and resultant risks would be higher for full foliar coverage applications than for spot treatments because of the greater amount of pesticide used. Because of the potential for using full foliar coverage application in a future program, the risk assessment has been based on that type of application.

(b) Exposure Analysis

As with aerial application, the ES-APHIS model predicted small insectivores had the highest exposures of the mammals, the large herbivores and aquatic foraging species the least. The highest total invertebrate exposures were to predators (orb web spider, lacewing larva, and parasitic wasp).

Ingestion was the primary exposure route for the vast majority of vertebrate species. Ingestion exposures were also the primary route for invertebrates, because intoxication occurs only through ingestion for most species and other than exposures through behavioral grooming, dermal exposures are of lesser consequence. Total doses in the eastern ecoregions were, in general, higher than in western ecoregions. The ecoregion differences in total dose are related to differences in the SureDye concentration in prey items, as the dermal dose did not differ greatly among ecoregions.

No aquatic exposure was assumed under routine ground applications of SureDye bait. However, because of soil characteristics, runoff is anticipated in the Mississippi Delta ecoregion (5) and Floridian ecoregion (6). This is predicted to result in aquatic concentrations ranging from 0.02 to 1.54 µg/L phloxine B in less than 2 m (6 ft) deep habitat.

(c) Risk Assessment

Table 5–7 provides a summary of the estimated risk to nontarget terrestrial species from ground spraying of SureDye bait on foliage. Of the nontarget terrestrial species, the invertebrate species are at most risk from this treatment method. This is largely the result of selective toxicity of this compound to only those invertebrates that ingest the bait spray.

This exposure may occur through grooming of the body or direct ingestion of the bait spray. Other than fruit flies, the only invertebrates known to be attracted in large numbers to feed upon the bait spray include the plant bugs (miridae), ground beetles (carabidae), midges and gnats (nematocerous Diptera), pomace flies, other acalypterate muscoid flies, some ants (formicidae), and soil mites (acari) (Troetschler, 1983). Most terrestrial invertebrates modeled under both routine and extreme scenarios had estimated mortality rates less than 1% except slugs, orb web spiders, grasshoppers, water striders, adult ground beetles, and caterpillars. No mammal, bird, reptile, or amphibian species analyzed had doses that exceeded the LD_1 values.

Table 5–7. Estimates of Percentage Mortality to Exposed Individuals from Ground Application of SureDye Bait[1]

Species	Ecoregion 1	Ecoregion 2	Ecoregion 3	Ecoregion 4	Ecoregion 5	Ecoregion 6	Ecoregion 7
Terrestrial Mammals							
Opossum	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Shrew	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A[2]
Bat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cottontail rabbit	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Squirrel	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Mouse	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Raccoon	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fox	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Coyote/Dog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Deer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Birds							
Pied-billed grebe	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great blue heron	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cattle egret	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Duck	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Turkey vulture	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-tailed hawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American kestrel	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Quail	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Killdeer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mourning dove	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great horned owl	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Burrowing owl	<1.0	<1.0	<1.0	<1.0	N/A	<1.0	<1.0
Nighthawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hummingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Belted kingfisher	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Northern flicker	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Kingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American robin	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Northern mockingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
European starling	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-winged blackbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Meadowlark	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
House sparrow	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Table 5–7, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Terrestrial Reptiles							
Desert iguana	<1.0	<1.0	N/A	N/A	N/A	N/A	N/A
Side-blotched lizard	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Carolina anole	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Eastern fence lizard	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Western fence lizard	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Canyon lizard	N/A	N/A	<1.0	N/A	N/A	N/A	N/A
Gopher snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Garter snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Desert tortoise	<1.0	<1.0	N/A	N/A	N/A	N/A	N/A
Eastern box turtle	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Western box turtle	N/A	<1.0	<1.0	<1.0	N/A	N/A	N/A
Hognose snake	N/A	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Terrestrial Amphibians							
Toad	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Tree frog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Invertebrates							
Earthworm	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Slug	6.25	6.25	6.25	6.25	6.25	6.25	6.25
Sowbug	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Spider	6.25	6.25	6.25	6.25	6.25	6.25	6.25
Mayfly	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dragonfly	6.25	6.25	6.25	6.25	6.25	6.25	6.25
Grasshopper	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Lacewing	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Water strider	6.25	6.25	6.25	6.25	6.25	6.25	6.25
Beetle (grub)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Beetle (adult)	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Butterfly	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Moth	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Caterpillar	12.5	12.5	12.5	12.5	12.5	12.5	12.5
Maggot (fly)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fly (adult)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Ant	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Honey bee	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Wasp	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Table 5–7, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Fish (Habitat)							
Golden shiner (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Golden shiner (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Speckled dace (stream)	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Mexican tetra (stream)	N/A	N/A	<1.0	N/A	N/A	N/A	N/A
Silvery minnow (lake)	N/A	N/A	N/A	<1.0	<1.0	N/A	N/A
Goldfish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sheepshead minnow (stream)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Sheepshead minnow (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
California killifish (stream)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
California killifish (wetland)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Swamp darter (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Mosquito fish (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mosquito fish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Rainbow trout (stream)	<1.0	<1.0	N/A	N/A	N/A	N/A	<1.0
Rainbow trout (lake)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Arroyo chub (stream)	<1.0	N/A	N/A	N/A	N/A	N/A	N/A
Bluegill sunfish (stream)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Bluegill sunfish (lake)	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Bluegill sunfish (pond)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Largemouth bass (stream)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Largemouth bass (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Channel catfish (stream)	N/A	N/A	<1.0	N/A	<1.0	<1.0	N/A
Channel catfish (lake)	N/A	N/A	N/A	N/A	<1.0	<1.0	<1.0
Yellow bullhead catfish (stream)	N/A	N/A	N/A	<1.0	<1.0	N/A	N/A
Yellow bullhead catfish (lake)	N/A	N/A	N/A	N/A	<1.0	N/A	N/A
Yellow bullhead catfish (pond)	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Longnose gar (lake)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Longnose gar (pond)	N/A	N/A	<1.0	<1.0	<1.0	<1.0	N/A
Longnose gar (wetland)	N/A	N/A	N/A	N/A	N/A	<1.0	N/A
Lake chubsucker (lake)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A

Table 5–7, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Aquatic Reptiles							
Snapping turtle (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Western pond turtle (wetland)	<1.0	N/A	N/A	N/A	N/A	N/A	<1.0
Water snake (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Aquatic Amphibians–larval forms							
Bullfrog (wetland)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	N/A
Tiger salamander (wetland)	<1.0	N/A	N/A	<1.0	<1.0	N/A	<1.0
Amphiuma (wetland)	N/A	N/A	N/A	<1.0	<1.0	<1.0	N/A
Aquatic Invertebrates							
Sponge (freshwater)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hydra	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Leech	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Clam (freshwater)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Snail (freshwater)	<1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0
Scud	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Crayfish	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Water flea	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dragonfly (nymph)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mayfly (larva)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Stonefly (larva)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Caddisfly (larva)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Backswimmer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Beetle	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Mosquito (larva)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

[1] Estimates are based on the routine exposure scenario for Terrestrial Organisms; extreme exposure scenario for Aquatic Organisms; Ecoregions are: **1** - California Valley and Coastal; **2** - Southwestern Basin and Range; **3** - Lower Rio Grande Valley; **4** - Southeastern and Gulf Coastal Plain; **5** - Mississippi Delta; **6** - Floridian; **7** - Marine Pacific Forest.
[2] N/A = Not applicable; species does not occur in area.

Estimated mortality rates for ground applications are much lower than for aerial applications because of the more limited nature of ground applications, even though the maximum was modeled. Insects have a high reproductive rate and most are ubiquitous. Because ground application of foliar sprays cover small areas, sufficient interspersion of unaffected areas which support invertebrates would provide a population base for repopulating treated areas.

Except for populations characterized by low numbers, there should be sufficient numbers from neighboring untreated areas. However, depending on the time of year, some commercially important species, such as predators, could experience some population reductions. Severe reductions in predatory insect populations have resulted in an increase in some pest species. Because SureDye ground spraying is localized, however, these effects are unlikely to be widespread.

Potential direct impacts on vegetation are limited because SureDye is only phytotoxic to a few species at the application rates used by fruit fly programs. Most plants are not affected at these rates of application (Perry, 1993). Indirect impacts on vegetation could occur, because SureDye is potentially toxic to insect predators. Effects would be expected to be limited and local, and long-term reductions in any insect populations are not anticipated from ground spraying due to recruitment of populations from unsprayed areas.

Aquatic organisms are not at risk from ground spraying of SureDye under the routine or extreme exposure scenarios. The predicted concentrations in water are well below those associated with any mortality to fish or aquatic invertebrates.

Nontarget organisms could be disturbed by the treatment. Mobile species could leave the area and would suffer no adverse effect unless survival resources could not be found elsewhere. Effects would be greater on species or life stages (e.g., nestlings) that could not relocate. Precautions should be taken to ensure domestic animals do not contact the treated area.

Aquatic organisms are not at risk from ground spraying of spinosad under the routine or extreme exposure scenarios. The predicted concentrations in water from runoff are well below those associated with any mortality to fish or aquatic invertebrates.

Nontarget organisms could be disturbed by noise from the treatment applications. Mobile species could leave the area and would suffer no adverse effect unless survival resources could not be found elsewhere. Effects would be greater on species that could not relocate (e.g., nestlings). Precautions should be taken to ensure domestic animals do not contact the treated area.

b. Soil Treatments

(1) Chlorpyrifos

(a) Hazard Assessment

Chlorpyrifos is an organophosphate insecticide whose mode of toxic action is primarily through AChE inhibition. AChE inhibition can cause muscle tremors, convulsions, behavioral changes, and many other symptoms. Death usually occurs from respiratory failure, although death of wild animals may also be indirect, the result of behavioral changes such as loss of ability to evade predators. EPA's 1989 registration standard for chlorpyrifos identifies environmental toxicity data gaps for active ingredient, typical end-use product, and degradate as well as environmental fate.

Chlorpyrifos is moderately toxic to mammals, moderately to severely toxic to birds, slightly to moderately toxic to adult reptiles and amphibians, slightly to very highly toxic to tadpoles, and severely toxic to terrestrial invertebrates. Chlorpyrifos is particularly toxic to earthworms, bees, some other beneficial insects, and some birds including the European starling and ring-necked pheasant. Field studies have shown that wild bees, such as the alfalfa leafcutting bee and alkali bee, are even more sensitive to chlorpyrifos than honey bees (Johansen, 1977).

Chlorpyrifos is very highly toxic to fish and aquatic invertebrates. Important fish food species, such as scuds (*Gammarus* sp.) and stonefly naiads, are the most sensitive aquatic invertebrates tested. Early instar larvae may be even more sensitive than adults. Marine fish (striped bass and Atlantic silverside) seem to be slightly more sensitive than freshwater species (bluegill sunfish and rainbow trout). Field tests of chlorpyrifos in ponds, streams, and wetlands have confirmed its toxicity to mosquitofish, killifish, and aquatic invertebrates (Smith, 1987). Cyanobacteria and fish bioaccumulate or bioconcentrate chlorpyrifos up to 1,000 times, which means that secondary poisoning could be a problem although it has not been documented.

(b) Exposure Analysis

Exposure of nontarget organisms to chlorpyrifos depends on the proximity of the individual organism to the limited area in which the soil drench chemical is applied. Because the chlorpyrifos-treated area is small, the majority of individuals in a program area are unlikely to come into contact with this chemical.

For terrestrial vertebrate species who feed in, traverse, or inhabit areas treated with chlorpyrifos, the primary route of exposure is ingestion, usually of insects killed or incapacitated by the chemical. For the insects themselves, both dermal exposure as well as ingestion of contaminated plant materials or prey contribute substantially to the chlorpyrifos dose. Among the various groups of terrestrial organisms, invertebrates and small mammals received the highest doses. Exposure of terrestrial species to chlorpyrifos is generally higher in the eastern ecoregions.

Aquatic organisms will have extremely limited exposure to chlorpyrifos because it is not used in aquatic areas. In an extreme case modeled (a ditch adjacent to an orchard treated with chlorpyrifos), rainfall washed some chlorpyrifos into aquatic areas in two of the seven ecoregions. In the Mississippi Delta ecoregion (5) and Floridian ecoregion (6), fish, invertebrates, and other aquatic species could be exposed to substantial concentrations of chlorpyrifos (35.5 to 221.8 μg/L) washed into a ditch.

(c) Risk Assessment

Chlorpyrifos represents a risk (greater than 1% mortality) to: small mammals (shrews, mice, and bats); birds except for aquatic feeders and higher predators; and all terrestrial reptiles, amphibians, and terrestrial invertebrates (table 5–8). Population mortality is projected to be low for all species in the treatment area because of the limited use of the pesticide.

Chlorpyrifos represents more of a risk to aquatic species than does diazinon or fenthion. All aquatic species exposed via runoff into a ditch, in the extreme scenario, are at risk except for fish exposed to the lower application rate in the Floridian ecoregion (6).

If chlorpyrifos were part of the fruit fly program, its applications would most likely be subject to the same restrictions that apply to diazinon. Because of the limited use, it is projected that a maximum of 0.14% of the program area could be treated. Although chlorpyrifos represents a substantial risk to exposed individuals, nontarget populations as a whole are not at risk. Local conditions determine degradation and affect the time required for repopulation.

Table 5–8. Estimates of Percentage Mortality to Exposed Individuals from Chlorpyrifos Soil Treatment[1]

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Terrestrial Mammals							
Opossum	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Shrew	98.2	98.5	98.6	99.1	99.6	99.5	N/A[2]
Bat	<1.0	<1.0	<1.0	11.1	22.6	22.6	<1.0
Cottontail rabbit	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Squirrel	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Mouse	32	33.3	34.1	34.1	45.5	39.9	32.7
Raccoon	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fox	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Coyote/Dog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Deer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Birds							
Pied-billed grebe	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great blue heron	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cattle egret	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Duck	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Turkey vulture	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-tailed hawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American kestrel	70.6	70.6	N/A	71.8	73	73	70.6
Quail	7.5	12.5	31.4	32.5	33.5	33.5	N/A
Killdeer	66.9	66.9	66.9	66.9	66.9	66.9	66.9
Mourning dove	36.8	36.8	36.8	36.8	36.8	36.8	36.8
Great horned owl	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Burrowing owl	<1.0	<1.0	<1.0	<1.0	N/A	<1.0	<1.0
Nighthawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hummingbird	20.8	20.8	20.8	32.9	43.8	43.8	20.8
Belted kngfisher	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Northern flicker	38.1	37.1	N/A	41.7	46	45.9	37.1
Kingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American robin	98.9	99	99.1	99	99.2	99.1	99
Nothern mockingbird	96.3	96.3	96.3	96.8	97.2	97.2	96.3
European starling	96.8	96.8	96.8	97.4	97.8	97.8	96.8
Red-winged blackbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Meadowlark	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
House sparrow	94.3	94.3	94.3	95.9	97	97	94.3

Table 5–8, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Terrestrial Reptiles							
Desert iguana	65.2	65.3	N/A	N/A	N/A	N/A	N/A
Side-blotched lizard	98.6	98.6	N/A	N/A	N/A	N/A	98.6
Carolina anole	N/A	N/A	98.5	99.2	99.5	99.5	N/A
Eastern fence lizard	N/A	N/A	99.4	99.7	99.9	99.8	N/A
Western fence lizard	99.1	99.2	N/A	N/A	N/A	N/A	99.2
Canyon lizard	N/A	N/A	98.5	N/A	N/A	N/A	N/A
Gopher snake	13.3	18.3	13.6	6	6.3	6.2	15.8
Garter snake	24.3	24.4	24.4	26.6	28.8	28.8	24.4
Desert tortoise	29.5	29.5	N/A	N/A	N/A	N/A	N/A
Eastern box turtle	N/A	N/A	N/A	97.4	98.2	97.9	N/A
Western box turtle	N/A	83.3	83.3	89.9	N/A	N/A	N/A
Hognose snake	N/A	73.8	74.2	73.4	74.3	73.7	N/A
Terrestrial Amphibians							
Toad	12.3	13	14.4	13.8	15.9	14.9	12.7
Tree frog	3.9	3.9	3.2	4.1	5.1	5.1	3.9
Terrestrial Invertebrates							
Earthworm	100	100	100	100	100	100	100
Slug	100	100	100	100	100	100	100
Sowbug	100	100	100	100	100	100	100
Spider	97.4	97.4	97.4	97.6	97.8	97.8	97.4
Mayfly	98.7	98.7	98.7	99.4	99.6	99.6	98.7
Dragonfly	94.5	94.5	94.5	93.2	95.2	95.2	94.5
Grasshopper	100	100	100	100	100	100	100
Lacewing	99.8	99.8	99.8	99.9	99.9	99.9	99.8
Water strider	34.8	34.8	34.8	39.4	42.9	42.9	34.8
Beetle, grub	98.6	98.6	98.6	98.9	99.1	99.1	98.6
Beetle, adult	98.2	98.3	98.3	98.7	99	99	98.3
Butterfly	100	100	100	100	100	100	100
Moth	100	100	100	100	100	100	100
Caterpillar	100	100	100	100	100	100	100
Maggot	100	100	100	100	100	100	100
Fly	100	100	100	100	100	100	100
Ant	100	100	100	100	100	100	100
Honey bee	100	100	100	100	100	100	100
Wasp	100	100	100	100	100	100	100
Fish							
Mosquito fish	<1.0	<1.0	<1.0	<1.0	60.9	41.4	<1.0

Table 5–8, continued.

Species	Ecoregion 1	Ecoregion 2	Ecoregion 3	Ecoregion 4	Ecoregion 5	Ecoregion 6	Ecoregion 7
Aquatic Reptiles							
Snapping turtle	<1.0	<1.0	<1.0	<1.0	100	100	N/A
Water snake	<1.0	<1.0	<1.0	<1.0	100	100	N/A
Aquatic Amphibians–larval forms							
Bullfrog	<1.0	<1.0	<1.0	<1.0	100	100	N/A
Tiger salamander	<1.0	<1.0	<1.0	<1.0	100	100	<1.0
Amphiuma	<1.0	<1.0	<1.0	<1.0	100	100	N/A
Aquatic Invertebrates							
Leech	<1.0	<1.0	<1.0	<1.0	100	100	<1.0
Snail, freshwater	<1.0	<1.0	<1.0	<1.0	100	100	<1.0
Crayfish	<1.0	<1.0	<1.0	<1.0	100	100	<1.0
Dragonfly, nymph	<1.0	<1.0	<1.0	<1.0	100	100	<1.0
Mosquito, larva	<1.0	<1.0	<1.0	<1.0	100	100	<1.0

[1] Estimates are based on the routine exposure scenario for Terrestrial Organisms; extreme exposure scenario for Aquatic Organisms; Ecoregions are: **1** - California Valley and Coastal; **2** - Southwestern Basin and Range; **3** - Lower Rio Grande Valley; **4** - Southeastern and Gulf Coastal Plain; **5** - Mississippi Delta; **6** - Floridian; **7** - Marine Pacific Forest.
[2] N/A = Not applicable; species does not occur in area.

(2) Diazinon

(a) Hazard Assessment

Diazinon is an organophosphate insecticide whose mode of toxic action is primarily through AChE inhibition. AChE inhibition can cause muscle tremors, convulsions, behavioral changes, and other symptoms. Death usually occurs due to respiratory failure, but death of wild animals may also be the result of behavioral changes (i.e., loss of ability to evade predators).

Diazinon is very slightly to moderately toxic to mammals, severely toxic to birds, slightly toxic to reptiles and terrestrial amphibians, severely toxic to terrestrial invertebrates, and of low phytotoxicity to most plants. Field studies have shown that all birds are sensitive to diazinon including songbirds and other birds commonly found in backyard settings (Smith, 1987).

Diazinon is moderately to highly toxic to fish and very highly toxic to aquatic invertebrates. Field studies of fish communities exposed to diazinon are few.

The aquatic invertebrate populations as a whole have been shown to remain constant in numbers following spraying, but the species diversity shifts in favor of those insects more tolerant of diazinon.

Diazinon degrades rapidly on plants with a typical half-life of less than 14 days. Diazinon can translocate from soil into roots and leaves, but due to its rapid degradation, bioaccumulation is not generally a concern in plants.

(b) Exposure Analysis

Exposure of nontarget organisms to diazinon depends on one major factor—whether or not the individual organism is in or near the limited area in which the soil drench chemical is applied. Because the area treated with diazinon is small, the majority of individuals in a program area will not contact this chemical.

For those terrestrial species that feed in, traverse, or inhabit areas treated with diazinon, the primary route of exposure is ingestion (usually of insects killed or incapacitated by the chemical). For insects, both dermal exposure and ingestion of contaminated plant material or prey contribute substantially to diazinon dose. Invertebrates and small mammals received the highest doses and the carnivorous birds received the lowest doses. Exposures of terrestrial species to diazinon were generally higher in the eastern ecoregions.

Aquatic organisms will have extremely limited exposure to diazinon because it is not used in aquatic areas. Even under the extreme scenario (a ditch adjacent to an orchard treated with diazinon), rainfall will not wash any appreciable amount of diazinon into aquatic areas in five ecoregions. However, in the Mississippi Delta ecoregion (5) and Floridian ecoregion (6), fish, invertebrates, and other aquatic species in an adjacent ditch could be exposed to low concentrations (0.1 to 12.2 μg/L) of diazinon due to runoff.

(c) Risk Assessment

Diazinon presented a risk (greater than 1% mortality) to most of the exposed populations that were considered under the assumptions of this analysis. Exposed terrestrial species within this analysis that were at risk from diazinon include many mammals, most of the birds, all of the terrestrial reptiles and amphibians, and all terrestrial invertebrates. Insects, small mammals, insectivorous lizards, and insectivorous birds are likely to suffer the highest mortality of those individuals exposed to diazinon (table 5–9). However, population mortality in the treated area is not anticipated to be high for any species analyzed. Aquatic invertebrate species are at risk from diazinon washed into a ditch in the Mississippi Delta ecoregion (5) and Floridian ecoregion (6) only under the extreme scenario.

Diazinon use in most recent programs has been restricted (by EPA) to no more than 10 gallons per year per State; actual usage has been substantially less in most programs. Opportunity for exposure is minimal and only species that use or traverse treated areas are exposed. Those include territorial birds, tree lizards, small mammals with limited mobility, and insects. The primary effect of diazinon on nontarget species is high mortality of soil invertebrate fauna, possibly resulting in lower fertility and soil aeration. Effects would be localized.

(3) Fenthion

(a) Hazard Assessment

Fenthion is an organophosphate insecticide whose mode of toxic action is primarily through AChE inhibition. AChE inhibition can cause muscle tremors, convulsions, behavioral changes, and other symptoms. Death usually occurs due to respiratory failure, but death of wild animals may also be the result of behavioral changes (i.e., loss of ability to evade predators). EPA's registration standard for fenthion (1988) lists data gaps for environmental fate, acute and chronic toxicity, and environmental toxicity for active ingredient, typical end-use product, and degradation product.

Fenthion is moderately toxic to mammals, severely toxic to birds, and severely toxic to terrestrial invertebrates. Its toxicity to reptiles and amphibians is uncertain, but it is probably moderately toxic. Animals such as bullfrog tadpoles and carp can bioaccumulate fenthion up to 2,300 times and retain about half of that residue for several weeks. Fenthion is most toxic to birds, aquatic invertebrates and honey bees. Of particular concern with respect to birds is the demonstrated capacity for secondary poisoning via treated or poisoned diet items.

Fenthion is highly toxic to fish and very highly toxic to aquatic invertebrates. Of the aquatic invertebrates, mysid and pink shrimp as well as first instar larvae of water fleas are the most sensitive. Field studies in Florida estuaries have confirmed fenthion's toxicity to aquatic invertebrates (Clark *et al.*, 1987a).

Table 5–9. Estimates of Percentage Mortality to Exposed Individuals from Diazinon Soil Treatment[1]

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Terrestrial Mammals							
Opossum	9.5	11.3	9.9	10.5	15.2	11.8	10.4
Shrew	99.8	99.9	99.8	100.0	100.0	100.0	N/A[2]
Bat	48.7	48.7	48.7	75.0	87.4	87.4	48.7
Cottontail rabbit	15.4	15.4	13.0	13.0	13.0	13.0	N/A
Squirrel	49.6	N/A	49.6	61.4	70.4	70.4	49.6
Mouse	80.1	81.2	80.3	76.7	85.1	77.6	80.7
Raccoon	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fox	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Coyote/Dog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Deer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Birds							
Pied-billed grebe	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great blue heron	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cattle egret	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Duck	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Turkey vulture	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-tailed hawk	2.9	2.9	2.9	3.6	4.6	4.6	2.9
American kestrel	100.0	100.0	N/A	100.0	100.0	100.0	100.0
Quail	100.0	100.0	100.0	100.0	100.0	100.0	N/A
Killdeer	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Mourning dove	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Great horned owl	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	7.4
Burrowing owl	<1.0	<1.0	<1.0	<1.0	N/A	<1.0	<1.0
Nighthawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hummingbird	2.6	2.6	2.6	8.0	16.0	16.0	2.6
Belted kingfisher	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Northern flicker	100.0	100.0	N/A	100.0	100.0	100.0	100.0
Kingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American robin	59.6	62.8	60.4	62.7	<1.0	65.8	61.2
Northern mockingbird	64.1	64.1	64.1	67.4	68.6	70.3	64.1
European starling	62,8	62.8	74.5	68.2	72.6	72.6	62.8
Red-winged blackbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Meadowlark	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
House sparrow	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table V-9, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Terrestrial Reptiles							
Desert iguana	43.9	44.0	N/A	N/A	N/A	N/A	N/A
Side-blotched lizard	94.7	94.7	N/A	N/A	N/A	N/A	94.7
Carolina anole	N/A	N/A	94.8	96.4	97.5	97.5	N/A
Eastern fence lizard	N/A	N/A	92.4	94.8	96.6	96.3	N/A
Western fence lizard	90.5	91.2	N/A	N/A	N/A	N/A	90.9
Canyon lizard	N/A	N/A	94.4	N/A	N/A	N/A	N/A
Gopher snake	10.4	11.4	10.1	9.4	9.5	9.5	10.9
Garter snake	27.5	27.5	27.5	29.4	31.2	31.2	27.5
Desert tortoise	11.7	10.5	N/A	N/A	N/A	N/A	N/A
Eastern box turtle	N/A	N/A	N/A	73.2	79.6	77.1	N/A
Western box turtle	N/A	74.2	74.2	81.8	N/A	N/A	N/A
Hognose snake	N/A	63.0	62.8	62.7	63.1	62.8	N/A
Terrestrial Amphibians							
Toad	5.1	5.5	5.8	6.3	7.4	6.8	5.3
Tree frog	3.8	3.8	3.2	4.1	5.0	5.0	3.8
Terrestrial Invertebrates							
Earthworm	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Slug	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sowbug	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Spider	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Mayfly	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Dragonfly	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Grasshopper	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lacewing	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Water strider	<1.0	<1.0	<1.0	3.2	7.5	7.5	<1.0
Beetle (grub)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Beetle (adult)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Butterfly	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Moth	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Caterpillar	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Maggot (fly)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Fly (adult)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Ant	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Honey bee	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Wasp	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Fish							
Mosquito fish	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Table V-9, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Aquatic Reptiles							
Snapping turtle	<1.0	<1.0	<1.0	<1.0	27.6	<1.0	N/A
Water snake	<1.0	<1.0	<1.0	<1.0	27.6	<1.0	N/A
Aquatic Amphibians–larval forms							
Bullfrog	<1.0	<1.0	<1.0	<1.0	27.6	<1.0	N/A
Tiger salamander	<1.0	<1.0	<1.0	<1.0	27.6	<1.0	<1.0
Amphiuma	<1.0	<1.0	<1.0	<1.0	27.6	<1.0	N/A
Aquatic Invertebrates							
Leech	<1.0	<1.0	<1.0	<1.0	99.7	1.8	<1.0
Snail (freshwater)	<1.0	<1.0	<1.0	<1.0	99.7	1.8	<1.0
Crayfish	<1.0	<1.0	<1.0	<1.0	100.0	24.2	<1.0
Dragonfly (nymph)	<1.0	<1.0	<1.0	<1.0	23.4	<1.0	<1.0
Mosquito (larva)	<1.0	<1.0	<1.0	<1.0	23.4	<1.0	<1.0

[1] Estimates are based on the routine exposure scenario for Terrestrial Organisms; extreme exposure scenario for Aquatic Organisms; Ecoregions are: **1** - California Valley and Coastal; **2** - Southwestern Basin and Range; **3** - Lower Rio Grande Valley; **4** - Southeastern and Gulf Coastal Plain; **5** - Mississippi Delta; **6** - Floridian; 7 - Marine Pacific Forest.
[2] N/A = Not applicable; species does not occur in area.

(b) Exposure Analysis

Exposure of nontarget organisms to fenthion depends on one major factor—whether or not the individual organism is in or near the limited area in which the soil drench chemical is applied. Because the area treated with fenthion is small, the majority of individuals in a program area will not be exposed.

For those terrestrial vertebrate species who do feed in, traverse, or inhabit areas treated with fenthion, the primary route of exposure is ingestion, usually of insects killed or incapacitated by the chemical. Both dermal exposure as well as ingestion of contaminated plant material or prey contribute substantially to fenthion dose to insects. Among the various groups of terrestrial organisms, invertebrates and small mammals received the highest doses, whereas the carnivorous birds received the lowest doses (our exposure modeling did not include bioconcentration). Exposure of terrestrial species to fenthion is generally higher in the eastern ecoregions.

Aquatic organisms will have extremely limited exposure to fenthion because it is not used in aquatic areas. Under the extreme scenario, rainfall will wash some fenthion into aquatic areas in two of the seven ecoregions from a ditch adjacent to a treated orchard. In the Mississippi

Delta ecoregion (5) and Floridian ecoregion (6), fish, invertebrates, and other aquatic species could be so exposed to moderate concentration of fenthion (8.1 to 22.1 µg/L).

(c) Risk Assessment

Fenthion may represent a greater risk to birds than chlorpyrifos or diazinon (table 5–10). Other exposed terrestrial species at high risk from fenthion include all reptiles, amphibians, and most terrestrial invertebrates modeled. Fenthion represents a risk to fewer aquatic species than does chlorpyrifos if exposure occurs.

If fenthion were a part of the fruit fly program, its use could be subject to the same restrictions that apply to diazinon. For fenthion and all soil drenches, soil fauna in treated areas are at great risk. Actual disturbances and time to return to pre-treatment conditions are site-specific. Although fenthion represents a substantial risk to exposed individuals, the nontarget species populations as a whole are not at risk because of the limited use of soil drenches.

c. Fumigation

(I) Methyl Bromide

(a) Hazard Assessment

Methyl bromide is acutely toxic. Although the mode of action is not well understood, methyl bromide is an alkylating agent, a substance that deactivates enzymes and disrupts nucleic acid synthesis. A NOEL of 0.065 mg/L (17 ppm) was determined for an 8-hour daily inhalation exposure over 6 months for the rabbit, the most sensitive laboratory animal species tested (Alexeeff and Kilgore, 1983). The rat LD_{50} is 2,700 ppm for a 30-minute exposure. The Colorado potato beetle LD_{50} is 1,058 ppm for a 2-hour exposure at 25 ºC (Bond and Svec, 1977).

Because methyl bromide is heavier than air, the gas can collect in isolated pockets, which could create hazardous conditions when there is little air circulation. Data on the concentrations of methyl bromide in the air outside of a fumigation site are few, and a qualitative risk assessment follows.

Table 5–10. Estimates of Percentage Mortality to Exposed Individuals from Fenthion Soil Treatment[1]

Species	Ecoregion 1	Ecoregion 2	Ecoregion 3	Ecoregion 4	Ecoregion 5	Ecoregion 6	Ecoregion 7
Terrestrial Mammals							
Opossum	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Shrew	83.0	87.6	83.3	91.8	96.9	95.8	N/A[2]
Bat	<1.0	<1.0	<1.0	6.7	15.2	15.2	<1.0
Cottontail rabbit	91.5	91.5	90.6	90.6	90.6	90.6	N/A
Squirrel	<1.0	N/A	<1.0	<1.0	<1.0	<1.0	<1.0
Mouse	11.9	13.7	12.0	10.2	16.9	11.0	12.8
Raccoon	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fox	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Coyote/Dog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cat	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Deer	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Terrestrial Birds							
Pied-billed grebe	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Great blue heron	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cattle egret	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Duck	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Turkey vulture	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Red-tailed hawk	2.6	2.6	2.6	2.9	4.0	4.0	<1.0
American kestrel	99.9	100.0	N/A	100.0	100.0	100.0	100.0
Quail	76.9	76.8	96.8	97.0	97.1	97.1	N/A
Killdeer	99.8	99.8	99.8	99.8	99.8	99.8	99.8
Mourning dove	99.3	99.3	99.3	99.3	99.3	99.3	99.3
Great horned owl	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Burrowing owl	<1.0	<1.0	<1.0	<1.0	N/A	<1.0	<1.0
Nighthawk	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Hummingbird	96.0	96.0	96.0	98.2	99.1	99.1	96.0
Belted kingfisher	<1.0	<1.0	N/A	<1.0	<1.0	<1.0	<1.0
Northern flicker	97.8	97.8	N/A	98.4	98.7	98.7	97.8
Kingbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
American robin	98.7	99.0	98.7	98.9	99.3	99.0	98.9
Northern mockingbird	98.8	98.8	98.8	98.9	99.1	99.1	98.8
European starling	98.9	98.9	98.9	99.1	99.3	99.3	98.9
Red-winged blackbird	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Meadowlark	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
House sparrow	91.0	91.0	91.0	93.2	94.7	94.7	91.0

Table V-10, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Terrestrial Reptiles							
Desert iguana	99.7	99.7	N/A	N/A	N/A	N/A	N/A
Side-blotched lizard	100.0	100.0	N/A	N/A	N/A	N/A	100.0
Carolina anole	N/A	N/A	100.0	100.0	100.0	100.0	N/A
Eastern fence lizard	N/A	N/A	100.0	100.0	100.0	100.0	N/A
Western fence lizard	100.0	100.0	N/A	N/A	N/A	N/A	100.0
Canyon lizard	N/A	N/A	100.0	N/A	N/A	N/A	N/A
Gopher snake	91.6	93.9	91.6	84.8	85.2	84.9	92.8
Garter snake	96.5	96.5	96.5	96.9	97.3	97.3	96.5
Desert tortoise	97.4	97.4	N/A	N/A	N/A	N/A	N/A
Eastern box turtle	N/A	N/A	N/A	100.0	100.0	100.0	N/A
Western box turtle	N/A	99.9	99.9	100.0	N/A	N/A	N/A
Hognose snake	N/A	99.8	99.8	99.8	99.8	99.8	N/A
Terrestrial Amphibians							
Toad	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Tree frog	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Terrestrial Invertebrates							
Earthworm	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Slug	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Sowbug	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Spider	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Mayfly	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Dragonfly	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Grasshopper	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Lacewing	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Water strider	32.5	32.5	32.5	52.8	67.6	67.6	32.5
Beetle (grub)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Beetle (adult)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Butterfly	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Moth	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Caterpillar	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Maggot (fly)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Fly (adult)	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Ant	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Honey bee	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Wasp	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Fish							
Mosquito fish	<1.0	<1.0	<1.0	<1.0	1.1	<1.0	<1.0

Table V-10, continued.

Species	Ecoregion **1**	Ecoregion **2**	Ecoregion **3**	Ecoregion **4**	Ecoregion **5**	Ecoregion **6**	Ecoregion **7**
Aquatic Reptiles							
Snapping turtle	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Water snake	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Aquatic Amphibians–larval forms							
Bullfrog	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Tiger salamander	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Amphiuma	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	N/A
Aquatic Invertebrates							
Leech	<1.0	<1.0	<1.0	<1.0	83.6	48.5	<1.0
Snail (freshwater)	<1.0	<1.0	<1.0	<1.0	83.6	48.5	<1.0
Crayfish	<1.0	<1.0	<1.0	<1.0	20.5	3.3	<1.0
Dragonfly (nymph)	<1.0	<1.0	<1.0	<1.0	94.6	72.4	<1.0
Mosquito (larva)	<1.0	<1.0	<1.0	<1.0	94.6	72.4	<1.0

[1] Estimates are based on the routine exposure scenario for Terrestrial Organisms; extreme exposure scenario for Aquatic Organisms; Ecoregions are: **1** - California Valley and Coastal; **2** - Southwestern Basin and Range; **3** - Lower Rio Grande Valley;**4** - Southeastern and Gulf Coastal Plain;**5** - Mississippi Delta; **6** - Floridian; **7** - Marine Pacific Forest.
[2] N/A = Not applicable; species does not occur in area.

(b) Exposure Analysis

The highest concentrations of methyl bromide will occur when the gas is expelled from a fumigation chamber through a vent and allowed to disperse into open air. This process is facilitated by fans (capable of blowing 5,000 cubic feet per minute). The majority of the gas will be expelled within the first 5 minutes, but some pockets of gas may be partially trapped and will take longer to dissipate. When expelled, the gas is diluted by the ambient air. Concentrations will be greatest near the source. Standard operating procedures require a barrier for 30 feet (about 10 m) around the fumigation site to protect the general public from exposure to unsafe levels of fumigant. This barrier also helps keep out many nontarget species.

(c) Qualitative Risk Assessment

Fumigations will have little effect on vertebrate nontarget species because methyl bromide is likely to dilute rapidly outside the fumigation chambers. Human noise and activity involved in setting up the fumigation are expected to repel most vertebrate nontarget animals from the vicinity of the fumigation site. The safety precautions for methyl bromide fumigations make exposures possible for only those species in close proximity to the venting area outside the fumigation chamber or stack. The high acute toxicity of methyl bromide gas makes it likely that any nontarget organisms near the vent opening would be at risk of mortality. This is likely to include some aboveground arthropods and soil invertebrates near the vent to the fumigation chambers.

d. Mass Trapping and Other Methods

The sticky, bright colored panel traps used for attracting and entrapping male fruit flies should pose little threat to nontarget plants and animals. The surface is coated with a sticky substance and lure, both of which pose a negligible toxicologic risk to nontargets. The panels are placed at elevated locations out of reach of the public, usually in trees. Other than a few arthropod species that are attracted to the panels and get caught, most nontargets are unlikely to even contact the panels. The small number of arthropods that are caught on these traps is anticipated to have minimal effect on the overall populations of these species with only temporary decreases in populations following placement of panels in program areas.

Exposures to trap chemicals are most likely for insects or small birds that enter the traps. Quantitative assessment of the exposures to birds would not be meaningful, because birds are not routinely attracted by the traps or trap contents. Unless the bird chose to nest in the trap, the exposure would not be expected to adversely affect the animal. The small number of insects lured and trapped would not be expected to result in any substantial changes in the overall population of these species.

The usage pattern (small spots applied, with large untreated intervals) for male annihilation spot treatments relies on a bait to attract the target pest. Most nontarget species of insects would not come into contact with the pesticide. Other than the target fruit flies, the attracted insect species would be very few and no substantial changes in the overall population of these species would be expected. Any random contact by mammals, birds, reptiles, or amphibians would not be expected to adversely affect their survival. The amount of chemical washed off the applied spots would not be sufficient to accumulate in any bodies of water, so aquatic species would not be affected by these treatments.

Cordelitos and wood fiberboard squares are attractive only to some of the fruit fly species and a few other insects. The small number of nontarget insects attracted to these baited materials would not be expected to have any substantial effect on the overall population size. The random exposure to other organisms would not be expected to affect their populations.

3. Principal Related Issues

a. Habitats or Ecological Associations of Concern

The analysis gave special consideration to habitats or ecological associations of concern. These habitats or ecological associations are important in that they: (1) are unique and valuable resources, (2) serve as indicators of environmental quality, (3) are being diminished through human exploitation, and (4) may be the subject of special regulations and conservation initiatives. This section considers the potential effects of the control methods on habitats or ecological associations of concern.

(1) Nonchemical Control Methods

(a) Sterile Insect Technique

The release of sterile fruit flies should cause little disruption to plant or vertebrate animal communities. The addition of large numbers of fruit flies should also cause little disruption to the insect community; any population composition changes are likely to be of short duration. Debris from the releases could be a visual disturbance, but is unlikely to cause problems in sensitive habitats because the containers biodegrade. Noise from vehicles or aircraft dispensing the flies could disrupt sensitive nesting birds, but a single disturbance is unlikely to have major consequences.

(b) Physical Control

Host elimination could affect sensitive habitats such as tropical tree hammocks and areas adjacent to the Everglades if host removal were required in such areas.

(c) Cultural Control

Because cultural control would be restricted to the agricultural areas and not natural ecosystems, it is not likely that any habitats or ecological associations will be affected.

(d) Biological Control

Damage by biological control agents for fruit fly control would be limited to invertebrate prey items, hosts of insect parasites, and organisms susceptible to insecticidal microorganisms. Habitat, per se, would probably not be at risk, but ecological associations could be at risk to the extent that trophic interactions or pollination systems are disrupted. It is unlikely that any species critical to the structure of ecological communities would be at serious risk (see Biodiversity subsection), but precise effects are not known.

(e) Biotechnological Control

Effects of biotechnological methods for fruit fly control are specifically designed to impact either agricultural crops or insects. As such, habitats are not at risk. However, as with biocontrol agents, biotechnological agents place ecological associations at risk to the extent that they disrupt community structure.

(f) Cold Treatment

All cold treatments are conducted in approved facilities under strict supervision. This treatment is only applicable to certain approved commodities. The necessary restrictions (duration of treatments and approval of facilities) and availability of facilities for cold treatment are likely to continue to limit the use of this treatment. The treatment chambers are sealed to prevent entry of nontarget species during cold treatment. Habitats or ecological associations of concern are not expected to be affected by program cold treatments.

(g) Irradiation Treatment

Irradiation treatments are conducted in approved facilities in accordance with stringent safety guidelines. The use of this treatment method is limited to certain approved commodities that are compatible with its application. The irradiation equipment is designed to release radiation to the regulated commodity only. There is negligible stray radiation from proper equipment use. Monitoring for stray radiation at facilities has demonstrated only ambient background radiation levels at plant boundaries. The treated commodity does not retain any radioactivity from the exposure and poses no risks to nontarget species. The irradiation equipment is sealed to prevent entry of species of nontarget wildlife to the irradiation chamber. Habitats or ecological associations of concern are not expected to be affected by program irradiation treatments.

(h) Vapor Heat Treatment

All vapor heat treatments are conducted in approved facilities under strict supervision. This treatment is only applicable to certain heat tolerant commodities. The necessary restrictions (duration of treatments and approval of facilities) and availability of facilities for vapor heat treatment are likely to continue to limit the use of this treatment. The treatment chambers are sealed to prevent entry of nontarget species during vapor heat treatment. Habitats or ecological associations of concern are not expected to be affected by program vapor heat treatments.

(2) Chemical Control Methods

(a) Bait Spray Applications

Shallow aquatic habitats, such as wetlands, are of concern for applications of malathion bait spray. Small shallow ponds, ditches, and canals prevalent in some of the ecoregions could receive high concentrations of malathion (e.g., an estimated 59.17 µg/L in southeastern wetlands) if they are located within a treatment area. The lower application rate and lower toxicity of SureDye and spinosad make it less likely that applications of these formulations would affect these habitats. Loss of invertebrates and fish from these habitats from malathion toxicity could affect the many organisms dependent upon these fish and invertebrates species for food. Acidic water habitats, such as saltwater marshes, are of particular concern because malathion does not degrade as rapidly in acidic waters as in alkaline waters, and could affect the habitat for a longer period of time. Migratory bird refuges, where large concentrations of birds could be expected to consume invertebrates, are also of concern.

Terrestrial habitats of concern include scrub, South Florida rockland forests, and riparian areas because of the high concentration of invertebrates and species depending on invertebrates for pollination or food. Adverse effects to these areas are of greater concern for applications of malathion bait spray with multiple routes of toxic action than SureDye and spinosad bait spray which require ingestion to affect the species present.

(b) Soil Treatments

The three soil drench chemicals—chlorpyrifos, diazinon, and fenthion—have the potential to affect sensitive areas because of the toxicity of these chemicals to a number of nontarget species. However, these chemicals are used only in limited areas and are not very mobile in the environment. The adverse effects are anticipated to be limited to those soil organisms in the treated areas under the host plants. Therefore, a sensitive area would only be affected in the unlikely event of a soil drench chemical being applied to that area.

(c) Fumigation

Fumigations associated with the fruit fly program are normally conducted where commodities are gathered or stored. These areas are usually in disturbed habitats that are not near sensitive sites. Fumigation activities are not anticipated to pose any risk to sensitive habitats or ecological associations of concern.

(d) Trapping Chemicals and Other Methods

Trapping chemicals are designed to attract certain fruit fly species. The small number of other species that are trapped or exposed to trap chemicals is not anticipated to affect the long-term species composition of the local site or present any impact to sensitive areas. The slight disruption of sensitive plants and nesting birds during servicing of traps is not expected to have lasting adverse effects.

The fruit fly male annihilation spot treatments and traps have lures that are designed to specifically attract certain fruit fly species. The small number of other species that contact the lure is not anticipated to affect the species composition of the local site or present any impact to sensitive areas. The slight disruption of sensitive plants and nesting birds during treatments or servicing of traps is not expected to have lasting adverse effects.

Cordelitos and wood fiberboard squares are designed to attract only certain fruit fly species. As with male annihilation and trapping chemicals, the small number of other species that are affected is not anticipated to affect the species composition of the local site or present any impact to sensitive areas. The slight disruption of sensitive plants and nesting birds during treatments is not expected to have lasting adverse effects.

b. Endangered and Threatened Species

The Endangered Species Act of 1973 (ESA) as amended (16 U.S.C. 1531 *et seq*.), mandates that "all Federal departments and agencies shall seek to conserve endangered species and threatened species." Its purpose, in part, is "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved." Under ESA, the Secretary of the Interior or Commerce is required to determine which species are endangered or threatened and to issue regulations to protect those species.

Section 7 of ESA required Federal agencies to consult with the U.S. Department of the Interior's Fish and Wildlife Service (FWS) or the U.S. Department of Commerce's National Marine Fisheries Service (NMFS) to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of its critical habitat (16 U.S.C. 1536(a)(2)).

The endangered and threatened (E&T) species within the potential program areas include plants, birds, fish, mammals, amphibians, reptiles, crustaceans, mollusks, and insects. The number of listed species in potential program areas currently exceeds 200 and will continue to grow. APHIS has worked closely with FWS to ensure that these species will not be affected by fruit fly programs. APHIS will continue to consult with FWS as part of the ongoing process.

A Biological Assessment (BA) (APHIS, 1993) was prepared for the Medfly Cooperative Eradication Program. The BA constitutes APHIS' programmatic evaluation of the potential consequences to E&T species and is incorporated by reference in this EIS. It provides protection measures to ensure the E&T species will not be adversely affected by the program activities. These measures have allowed APHIS to determine that E&T species will not be affected by the Medfly program. FWS concurred with the BA with the understanding that, before implementing a program, APHIS will confer with FWS to ensure that the protective measures provided in the BA remain sufficient to eliminate any potential adverse effect on an E&T species. Comparable consultation is underway for the Fruit Fly Cooperative Control Program.

c. Biodiversity

(1) Nonchemical Control Methods

(a) Sterile Insect Technique

Sterile insect releases are unlikely to have an effect on biodiversity because the fruit flies are infertile and are short-lived. Biodiversity could be affected, however, if fertile flies were released unintentionally. An established exotic fruit fly population could affect not only insect diversity, but plant and perhaps vertebrate diversity as well.

(b) Physical Control

Fruit stripping is not expected to affect biodiversity. Host elimination could affect terrestrial and aquatic biodiversity if hosts were eliminated from a large area. Depending on the magnitude of the affected area, landscape diversity could be affected. Aquatic biodiversity would decline as turbidity and siltation from soil erosion associated with host elimination increased. Terrestrial biodiversity would change as well, as more species of plants invaded disturbed areas created by host removal.

(c) Cultural Control

Cultural controls would alter cultivated species diversity in agricultural areas. Indirect effects to those species utilizing this disturbed habitat could occur and alter species diversity locally. Trap cropping could have effects on biodiversity similar to some chemical controls.

(d) Biological Control

Potential effects of biological control on biodiversity may not be predicted with great accuracy, given the present state of fruit fly biocontrol technology. Although the biocontrol agents considered for use against fruit flies could damage populations of a variety of invertebrate species, it is highly unlikely that any of these biocontrol agents would be capable of eliminating populations or causing major fluctuations in community structures. Biodiversity of nontarget plant species would be at risk to the extent that pollination systems may be disrupted.

(e) Biotechnological Control

Potential effects of biotechnological control on biodiversity also may not be predicted with great accuracy, given the present state of fruit fly biotechnological control. It is not likely that biotechnological control methods, should they become available to the program, will have a recognizable or major impact on biodiversity.

(f) Cold Treatment

All cold treatments are conducted in approved facilities under strict supervision. This treatment is only applicable to certain approved commodities. The necessary restrictions (duration of treatments and approval of facilities) and availability of facilities for cold treatment are likely to continue to limit the use of this treatment. The treatment chambers are sealed to prevent entry of nontarget species during cold treatment. Biodiversity is not expected to be affected by program cold treatments.

(g) Irradiation Treatment

Irradiation treatments are conducted in approved facilities in accordance with stringent safety guidelines. The use of this treatment method is limited to certain approved commodities that are compatible with its application. The irradiation equipment is designed to release radiation to the regulated commodity only. There is negligible stray radiation from proper equipment use. Monitoring for stray radiation at facilities has demonstrated only ambient background radiation levels at plant boundaries. The treated commodity does not retain any radioactivity from the exposure and poses no risks to nontarget species. The irradiation equipment is sealed to prevent entry of nontarget species to the irradiation chamber. Biodiversity is, therefore, not expected to be affected by program irradiation treatments.

(h) Vapor Heat Treatment

All vapor heat treatments are conducted in approved facilities under strict supervision. This treatment is only applicable to certain heat tolerant commodities. The necessary restrictions (duration of treatments and approval of facilities) and availability of facilities for vapor heat treatment are likely to continue to limit the use of this treatment. The treatment chambers are sealed to prevent entry of nontarget species during vapor heat treatment. Biodiversity is not expected to be affected by program vapor heat treatments.

(2) Chemical Control Methods

(a) Bait Spray Applications

Invertebrate species diversity is anticipated to decrease within the treatment area following applications of malathion bait and to a lesser extent, SureDye and spinosad bait. Insectivorous mammals and amphibians are predicted to experience declines as a result of aerial applications of malathion bait spray, but not aerial applications of SureDye and spinosad bait spray. Changes in macroinvertebrate species composition to favor more tolerant species could be expected in areas receiving malathion-containing runoff (CDFG, 1982). Depending on site-specific circumstances, the effects could be brief or protracted. Loss of pollinator species would decrease the number of offspring produced by some species of plants. Because the program is temporary, no plant species should be eliminated from the treatment area, although genetic diversity may be affected. Although individuals of many taxa may be lost from malathion bait spray applications, vertebrate population reductions are anticipated to be minor, except for perhaps amphibians. The loss of any individual can reduce biodiversity, but at the anticipated rate, differences between program losses and natural mortality would be difficult to detect for noninsectivorous vertebrates.

Invertebrate taxa would experience the greatest effects, particularly with malathion bait spray. Community structure alterations have been observed and, depending on the aerial spraying regime, could last 1 year or more (Troetschler, 1983). Genetic diversity has been altered by the use of pesticides as evidenced by resistance: malathion is less toxic to mosquitoes than to most other invertebrate taxa. Effects on biodiversity, at all levels, will be less with ground spraying than aerial spraying and will be less with SureDye than malathion. The lesser effect of ground applications relates directly to less exposure of invertebrates due to application directly to fruit fly host plants. SureDye and spinosad will affect those species that are attracted by the bait and feed, but most invertebrate are not attracted by the bait. There will be some phytophagous invertebrate species that consume leaves with residue from SureDye and spinosad bait spray applications. These insects will also have higher mortality, but the number of individuals that feed on treated leaves will be considerably less than those attracted by the bait and the few individual phytophagous invertebrates lost from this feeding are not expected to have permanent effects on species survival or biological diversity.

(b) Soil Treatments

The three soil drench chemicals—chlorpyrifos, diazinon, and fenthion—have the potential to affect biodiversity because of the toxicity of these chemicals to a number of nontarget species. However, these chemicals are used only in limited areas and are not very mobile in the environment. Under these limited-use conditions, alterations in biodiversity would be limited. For example, the diversity of the soil invertebrate population in the treated areas would most likely be severely decreased, but untreated areas would still be a source of species for repopulation.

(c) Fumigation

Methyl bromide fumigation associated with the program is unlikely to impact species diversity except in the immediate vicinity of the vent for the fumigation chambers. On rare occasions where invertebrates might be exposed to lethal concentrations of methyl bromide (as in flying through a fumigation chamber's aeration plume), loss of individuals should not affect diversity at the species or population level.

(d) Mass Trapping and Other Methods

Trapping chemicals will affect those species attracted by the lure and the local populations of these species may be temporarily eliminated. Repopulation from untreated surrounding areas is anticipated for these species. The small number of other species that are trapped or unintentionally get exposed to trap chemicals is not anticipated to affect the survival of local populations of those species. The slight disruption of sensitive plants and nesting birds during servicing of traps is not expected to have lasting adverse effects.

The fruit fly male annihilation spot treatments, bait stations, and traps have lures that are designed to specifically attract certain fruit fly species. The biodiversity within the program area will be temporarily decreased by those species attracted by the lure. Repopulation from untreated surrounding areas is anticipated for these species. The small number of other species that unintentionally contact the lure is not anticipated to affect the survival of the local populations of those species. The slight disruption of sensitive plants and nesting birds during treatments or servicing of traps is not expected to have lasting adverse effects on biodiversity.

Cordelitos and wood fiberboard squares are attractive to only a few invertebrate species. The biodiversity within the program area will be decreased by those species attracted, but repopulation from untreated surrounding areas is anticipated for these species. The small number of other species that unintentionally contact the cordelitos or wood fiberboard squares is not anticipated to affect the survival of the local populations of those species. The slight disruption of sensitive plants and nesting birds during treatments is not expected to have lasting adverse effects.

E. Cumulative Effects

1. Non-chemical Control Methods

The effects of nonchemical control methods on human health and safety have been evaluated and found to have little, if any, impact. Therefore, long-term or cumulative impacts are not expected. Some of the nonchemical control methods may cause temporary disturbances to nontarget habitats or ecological associations, but because the effects are of short duration and reversible, long-term or cumulative effects on populations are unlikely. Because immediate effects of biological control and biotechnological control are not well established, it is impossible to predict cumulative impacts to nontarget species from these control methods.

The potential cumulative effects of the combined control methods would depend on the component control methods used, but are substantially influenced by the use of control methods using pesticides. These components have been analyzed separately.

2. Chemical Control Methods

Cumulative effects or impacts are defined as those effects or impacts that result from the incremental impact of a program action when added to other past, present, and reasonably foreseeable future actions. Cumulative effects may result from direct effects which are caused by the action and occur at the same time and place, or are later in time or farther removed in distance, but are still reasonably foreseeable. The potential cumulative effects of the Fruit Fly Cooperative Eradication Program are related principally to the program's use of chemical control methods. Such effects could result from accumulation of pesticide(s) in the environment or within organisms, interactions of program pesticides with other pesticides or chemicals, or repeated exposures of humans or nontarget organisms to pesticides (incremental effects).

No environmental accumulation or bioaccumulation is foreseen for program use of malathion; malathion degrades readily and the interval between expected treatments is such that little residue of malathion from previous applications would remain or have the potential to exacerbate the risk of subsequent applications. Although soil drench pesticides are expected to have limited usage over a minimal portion of the treatment area, short-term accumulation in soil is possible (half-lives in soil range from 1 day for fenthion to as long as 10 weeks for diazinon); however, residues should not persist long in the environment under usual conditions. Methyl bromide is volatile and is not expected to accumulate in the vicinity of treatments, although there is concern that halogens (including bromine) may accumulate in the atmosphere and contribute to ozone depletion in the stratosphere. However, the small amounts of bromine in the atmosphere are not believed to be important causes of ozone depletion.

Cumulative chemical risks may include synergistic toxic effects resulting from the adverse effects of exposure to pesticides that have combined with the adverse effects of other pesticides or chemicals. Although organophosphates may have the potential to interact, the program organophosphate pesticides usually are not applied simultaneously. Even though an individual may be exposed to two organophosphates within the same exposure interval, the implications of such an exposure are unclear. There also is some potential for synergistic effects resulting from the combination of program pesticides and pesticides or chemicals used by the public. Chemicals routinely used by the public include pesticides, household cleaners, lawn and garden chemicals, amd home maintenance products. There is no way to predict with certainty the use of such products, the extent of their synergism, the potential for exposure to synergistic products, or the consequences of that exposure. Public notification will help to minimize exposure and resultant risk of any synergistic effects.

Exposure to chemicals can lead to allergy or hypersensitivity (EPA, 1984; Calabrese, 1978). Effects, such as hypersensitivity, often depend on cumulative or multiple exposures. Groups that may be hypersensitive to organophosphate pesticides include: individuals with immature enzyme detoxification systems (embryos, fetuses, neonates, and children to 3 months of age), pregnant females, individuals with highly sensitive cholinesterase variants, individuals low in dietary protein, individuals with liver disease or impaired immune function, alcoholics, and drug users. All people at some time during their lives are at increased risk from one or more commonly encountered environmental contaminants. Effects that could result from repeated exposures to environmental contaminants include dermal sensitivities, respiratory effects, and (rarely) some life-threatening conditions. In order to minimize exposure for individuals who could be sensitive or become sensitive to the organophosphate pesticides, program operational procedures are designed to protect sensitive areas (including hospitals) and provide public notification of planned applications.

Cumulative effects may result from the incremental use of program pesticides. Other pesticides have been implicated in the decline of amphibian and bird species. Theoretically, adverse effects on nontarget species' populations may be exacerbated and the population permanently impacted if the treatment intervals are shorter than the time required for regeneration and the population cannot recover. Long-term effects to nontarget species could also result from minor population changes from treating the same area in different programs in successive years; the long-term effects of individual losses from a population are difficult to predict. Also, even though the program pesticides are not persistent, their temporary presence could contribute to the overall pesticide load of an area, especially if nonprogram pesticide use is involved.

FQPA has placed responsibility on EPA to review potential pesticide exposure to assess the overall aggregate chemical risk of pesticides based upon all of their approved uses as well as the common mechanisms of toxic action (same class of pesticides). The regulation of individual pesticides by EPA will, therefore, be determined partly by the aggregate chemical risks associated with all potential exposures to the pesticide or the specific class of pesticide. The future approval by EPA of specific use patterns for given pesticides is expected to be based upon the overall aggregate chemical risk for the pesticide class. The aggregate chemical risk is generally referred to as the "risk cup" and FQPA calls for EPA to regulate use patterns to ensure that risks from exposures do not exceed the safety thresholds delimited by the "risk cup." Although exposures to pesticides from APHIS program applications may pose low risks and may not add substantially to the overall risk, FQPA generally requires new registrations or exemptions to meet the aggregate risk safety standard. It is the responsibility of EPA to ascertain if the cumulative chemical risk is within safety thresholds and their decisions determine the registration and availability of future pesticides for program uses. It is uncertain what effect this issue will have on the registration and regulation of future program chemical uses. EPA is currently reviewing the organophosphate pesticide class for regulation under FQPA guidelines. Several program chemicals (malathion, chlorpyrifos, diazinon, fenthion, naled, dichlorvos) are in this class. Many of the regulatory decisions at EPA about how to implement FQPA for cumulative chemical risk and aggregate chemical risk standards are still under review. Ultimately, the decision to support registration of a given use pattern for these chemicals is generally made by the manufacturers or registrants. The registrants' decision is usually based upon economic considerations, and the cost of externalities, such as registration support, are important factors. It is beyond the scope of this document to determine whether the implementation of any or all program use patterns will maintain exposures within the aggregate risk standard under FQPA, but it is APHIS policy to continue to seek safer and more effective pesticide use patterns to mitigate any potential for adverse human health effects from implementation of agency programs.

3. Principal Related Issues

a. Cumulative Effects of Increasing Travel and Trade

The primary factor in the decision to begin a fruit fly eradication program is the detection of the introduction of a non-native fruit fly in the mainland United States. The recent increases in international travel and the pressure to increase world trade result in greater movement of host commodities which have the potential to introduce quarantine-significant species of fruit flies. Although the exclusion methods may prevent outbreaks from occurring most of the time, adherence to required inspections and confiscation of regulated host commodities by APHIS inspectors does not ensure that all introductions will be prevented. There will always be some infested host commodities that are not stopped before entry. The increasing amounts of travel and trade result in greater pressure on existing inspection resources to prevent entry of infested host materials. Although the failure to prevent entry of infested host commodities has probably remained fairly constant on a per inspection basis, the cumulative impact of greater trade and travel has resulted in more frequent introductions of quarantine-significant species of fruit flies.

Although most of the more recent introductions can be attributed to passenger travel, the increasing trade (whether the commodities are regulated or not) poses certain risks of pest introduction. The constant risk of pest introduction is cumulative, in that the frequency of introductions of quarantine-significant species of fruit flies can be expected to increase commensurate with the increases in frequency of travel and trade. This increase is expected to occur whether these introductions result from accidental or intentional (smuggling) human interventions. This trend toward increasing pest risk can be expected to increase, particularly with increasing efforts toward free trade agreements and duty-free zones. There has been recent concern raised about the potential for increased pest risk from increased movement of regulated commodities. Although the risks from regulated commodities are diminished through inspection procedures and regulatory control methods, the cumulative risk of pest introduction does increase commensurate with increasing movement of potentially infested commodities. This continuing increase in pest risk through the growth of trade and travel is acknowledged as an ongoing challenge to APHIS, which can only be addressed qualitatively with the knowledge that exclusion of quarantine-significant species of fruit flies will depend heavily on the stringency of phytosanitary regulations.

F. Unavoidable Environmental Effects

1. Non-chemical Control Methods

Use of the nonchemical control methods may result in localized unavoidable environmental effects, such as inducing flight in some birds due to use of vehicles. Minimal physical habitat alteration may occur from vehicular traffic and equipment employed to implement program treatments. Some soil compaction and erosion and aquatic habitat disruption could result if physical controls are widespread. Although not immediately applicable to the program, biological and biotechnological controls are usually not species-specific and could have unintended effects.

Regulatory controls will result in noise and air pollution and will add to the waste stream. Chemical components of regulatory control will have the effects described above. Integrated pest management will combine effects from chemical controls and nonchemical controls and will have all the effects thus far described.

The combination of control techniques anticipated in the program are not unlike many agricultural activities, and the effects will be similar. Unavoidable effects from chemical control methods have been identified above. An important earlier consideration is the rapid implementation of these activities. The earlier an infestation is detected and treatments started, the fewer the environmental effects will be. If, on the other hand, an infestation covers a broad area, many techniques may have to be employed over a larger area for a longer time period, with subsequent increases in detrimental effects.

2. Chemical Control Methods

Unavoidable environmental consequences of the program chemical control methods would vary with the pesticide, the pesticide's mode of action, the pesticide's application rate and regime, the size of the treatment area, site-specific environmental factors, and temporal considerations including timing and length of the program. Program pesticide usage will increase pesticide load to the environment. Effects may vary according to pesticide residence time, persistence, and transmigration, but because those pesticides used in the program are not fruit fly-specific, many nontarget species will be affected.

Individual humans exposed to pesticides vary with respect to their responses. People who are sensitive to pesticides could be affected from even small quantities of pesticides in the environment if they do not take measures to minimize their exposure. Similarly, applicators who do not follow established safety procedures could be affected from repeated exposures.

Aerial spraying of malathion bait has the potential for the most unavoidable effects because of its broadscale application. Many invertebrate species may suffer high mortality and secondary pest outbreaks, which have occurred in the past, are anticipated in future efforts. Insect species diversity will be reduced. Without proper protective measures, honey bee and other pollinator losses would occur. Some indirect effects to plant species may result from effects on invertebrate pollinators (including possible reduction in genetic diversity), but those consequences are restricted spatially and should diminish over time and with repopulation from surrounding areas.

Vertebrate insectivores would also be affected due to loss of food supply and secondary poisonings which could occur, particularly in immature populations and other susceptible life stages.

Aerial applications of SureDye and spinosad bait have the potential for some unavoidable effects, but those effects are considerably less than for malathion bait spray. All species of invertebrates that are attracted to the bait and feed can be expected to suffer high mortality. There are some plant species that are known to show signs of phytotoxic effects from exposure to the dyes at application rates, so some leaf markings and leaf fall can be expected for sensitive plants. Other nontarget species would not be expected to show adverse effects from the applications of SureDye and spinosad bait.

The physical aspects of aerial application, including noise, will disrupt activities of some populations of nontarget species. Although the effects should be temporary, nest abandonment may occur with more sensitive avian species. A segment of the human population is also greatly disturbed by the physical aspects of the treatment and opposition will be voiced in many areas. Vehicular emissions from engine combustion will contribute to air pollution.

Although larger water bodies are avoided during aerial application, smaller ponds and riparian zones usually are sprayed or receive drift. Depending on the amount of spray reaching these aquatic habitats, water quality criteria may be exceeded and invertebrates, fish, and amphibians will be affected. Repeated sprays will increase the adverse consequences.

Although soil drenches are hazardous to many vertebrate species, few individuals will be exposed because of the limited nature of those treatments. Localized alterations in populations of soil microorganisms are unavoidable with soil drenches. Depending on soil characteristics, soil drench chemicals can be relatively persistent. Wild and domestic animals that utilize the treated area could be affected for weeks to months after treatment. Humans, particularly children, who contact treated soil also will be affected. Although runoff is not predicted in most regions, where it occurs, aquatic habitats could receive concentrations that exceed water quality criteria (chlorpyrifos).

Methyl bromide fumigations will release bromine into the atmosphere. Organisms that enter the fumigation chamber during treatment will suffer mortality.

There will be a small number of nontarget invertebrates that will be adversely affected when they are attracted to lures in traps, fruit fly male annihilation spots, cordelitos, and wood fiberboard squares. Most nontarget species will not be attracted or affected by these control techniques. Minor unavoidable effects (e.g., soil disturbance) are anticipated from these control methods.

VI. Risk Reduction

A. Introduction

The increasing frequency and greater magnitude of outbreaks of exotic species of fruit flies in the United States in recent years are placing an increasing burden on program resources to accomplish basic objectives and limit risks. The continuing need to resolve issues related to cooperative fruit fly control programs suggests that additional efforts are needed in fruit fly programs to address potential risks. Standard program protective measures historically have provided good risk reduction for control aspects of fruit fly programs. Improved communication of program activities, potential risks, and risk reduction remains a high priority of APHIS. APHIS recently has begun to focus more efforts on exclusion and early detection to reduce the need for control methods. Consistent with its ongoing goal of preventing fruit fly infestations, APHIS is committed to continually reexamine the fruit fly programs for the purpose of achieving maximum risk reduction. APHIS intends to improve the efforts of exclusion and early detection of fruit flies so as to minimize or reduce the need for control measures. The risk reduction strategies are directed toward improved risk communication and implementation of other options designed to reduce risks from program activities.

The pesticide malathion has been used effectively against fruit flies for many years. It has been a mainstay in many recent fruit fly eradication programs because of its proven ability to quickly eliminate pest populations and thereby reduce the likelihood that the infestations would grow larger or be transported to other locations. It also has been used as a means of reducing the wild pest populations to a level where SIT could then be effective. As a result of their review of the 1997 Cooperative Medfly Eradication Program in Central Florida, EPA has communicated to APHIS its concerns relative to the program use of malathion bait. The basis for this concern related primarily to their concerns about potential risks to human health and the environment. APHIS has been seeking and working toward development of alternatives to malathion for use in fruit fly programs for several years, but the development of other effective, lower risk chemicals and techniques requires considerable investment in time, effort, and research funds. There are, however, certain strategies that can be applied to program activities to reduce potential risks from program actions and these are considered carefully in this chapter.

An overview of potential risk reduction activities is provided in table 6–1 to assist the reader. The ability to apply any of these will depend primarily upon their development, availability, effectiveness, and funding resources.

Table 6–1. Potential Risk Reduction Activities At A Glance

Exclusion Strategy	More X-ray Equipment More Canine Detector Teams Improved Computer Tracking Technology Increased Airline Inspection Caribbean Basin Plant Protection Initiative Enhancement of Plant Quarantine Laws Pathway Study Improved Cooperative Funding
Detection and Prevention Strategy	Strengthened Detection Trapping Improved Cooperative Program NEFFTP Guideline Adherence Strengthened Delimitation Trapping Permanent Infrastructure Integrated Control Technologies Broad Prophylactic SIT Program
Control Strategy	Sterile Release Program (SIT) Increased SIT Production New Sources of Funding for SIT Malathion Re-evaluate Uses if a Carcinogen Expanded Research into Replacements Chemical Alternatives to Malathion Registration for Use Against fruit flies Use as Substitute for Malathion Bait Restrict to Ground Operations, Where Appropriate
Communication Strategy	Comprehensive Package Risk Communication Information Resources Communicated Description of Program's Planned Response Actions Notification Procedures Complaint Processing

B. Standard Program Protective Measures

APHIS has developed standard program protective measures as part of an ongoing effort to eliminate or reduce environmental impacts of its fruit fly programs. These measures include standard operational procedures and recommended program mitigative measures. Standard operational procedures are routine procedures that are required of the program and its employees for the purpose of safeguarding human health and the natural environment. Program mitigative measures are recommended for the purpose of avoiding, reducing, or remediating environmental impact.

The standard operational procedures (table 6–2) reflect: (1) the emphasis that APHIS and the program cooperators place on establishing and maintaining technical competency in their personnel, (2) the degree of control that must be exercised over program operations, and (3) the monitoring that is done to ensure the environmental soundness of the program. Through a combination of technical competency and environmental awareness, program personnel minimize the potential for environmental impact.

Program mitigative measures (table 6–3) have been recommended to negate or reduce potential impact on humans, nontarget species, and the physical environment. In general, the mitigative measures represent modifications to the control program or extra steps taken to negate or reduce environmental impact.

C. Options for Further Risk Reduction

None of the program alternatives considered in this EIS (no action, the nonchemical program, and the integrated program) are without risk. The no action alternative would be likely to cause substantial damage to the agricultural industry, with collateral damage to the environment from the uncoordinated use of pesticides. The nonchemical program alternative would involve methods acceptable to the public and causing minimal direct impact, but would result in substantial indirect impact to industry and the environment. The integrated program alternative would protect the agricultural industry and minimize net impact to the environment, but use chemical control methods that many of the public deem unacceptable.

The objective of reducing risk appears best attained through a program modification that would vary program components (and add new ones) within an overall program strategy. By putting more resources into exclusion, it is more likely that fruit flies would be kept out of the United States and, thus, control methods would never have to be employed. However, because it is not possible to eliminate all risk of fruit fly introductions, control methods would have to remain a part of the strategy. Control methods would be rearranged and minimized in a way designed to greatly reduce risk. An emergency response communication plan (employed in previous programs) also ensures that the members of the public remain fully aware of program operations and are capable of reducing their personal risk.

Table 6–2. Standard Operational Procedures

A. General

1. All applicable environmental laws and regulations will be followed.

2. All program personnel will be instructed on procedures and proper use of equipment and materials. Field supervisors will emphasize these procedures and monitor the conduct of program personnel.

3. All materials will be used, handled, stored, and disposed of according to applicable laws so as to minimize potential impacts to human health and the environment.

4. All applications will be made and timed in such a manner as to minimize potential impact to the public and nontarget organisms, including endangered and threatened species.

5. Environmental monitoring of fruit fly programs will be according to individual site-specific monitoring plans that take into account the characteristics of the specific program areas. Monitoring components may vary from program to program.

B. Chemical Applications

1. All pesticides will be applied by certified applicators according to label instructions and applicable quarantine or emergency exemptions.

2. All pesticides will be stored according to U.S. Environmental Protection Agency guidelines and local regulations. Pesticide storage areas will be inspected periodically.

3. All mixing, loading, and unloading will be in an area where an accidental spill will not contaminate a stream or other body of water.

4. To the degree possible, pesticides will be delivered and stored in sealed bulk tanks, and then pumped directly into the tank of the aircraft or ground equipment.

5. Any pesticide spills will be cleaned up immediately and disposed of in a manner consistent with the label instructions and applicable environmental regulations.

6. All program personnel will be instructed on emergency procedures in the event of accidental pesticide exposure. Equipment necessary for emergency washing procedures will be available.

7. All APHIS employees who plan, supervise, recommend, or perform pesticide treatments are also required to know and meet any additional State and local qualifications or requirements of the area where they perform duties involving pesticide use.

8. All pesticide applicators will meet State licensing requirements for the program area State; reciprocal Federal/State licensing agreements may be honored for this program.

9. Pilots, loaders, and other personnel handling pesticides will be advised to wear proper safety equipment and protective clothing.

10. Manufacturers' Safety Data Sheets for program pesticides will be made available for program personnel.

11. Program officials will notify hospitals and public health facilities of pesticide treatment schedules and the types of pesticides used.

C. Aerial Operations

1. Prior to beginning operations, aerial applicators will be briefed by program staff regarding operational procedures, application procedures, treatment areas, local conditions, and safety considerations.

2. All lead aircraft will use loran RNAV-R-40 guidance systems or an equivalent system to assure the accurate placement of insecticide. All aircraft used in aerial insecticide application will use the Pathlink System or an equivalent system which provides a permanent record of the flight and applications.

3. Program personnel will use dye cards (cards sensitive to malathion bait spray), as needed, to determine swath width during calibration and monitoring. Dye cards are used in monitoring to validate swath width and droplet size, and for evaluation of the potential for drift.

4. Aircraft, dispersal equipment, and pilots that do not meet all contract requirements will not be allowed to operate.

D. Ground Operations

1. Ground applications of chemical pesticides will be made to fruit fly host environments only.

Table 6–3. Recommended Program Mitigative Measures

A. Protection of Human Health

Workers

1. Applicators, mixers, and loaders of chemical pesticides will be advised to have periodic cholinesterase testing.

2. Unprotected agricultural workers will be advised of the respective reentry periods following treatment in agricultural crop areas.

The Public

1. Program personnel shall notify area residents by at least 24 hours (but in practice, often as much as 1 week) in advance of the date and time of planned pesticide treatment.

a. Notifications will be in English, Spanish, or other languages as necessary, based on the ethnic structure of the community.

b. The notification shall include basic information about the program and, if applicable, procedures to prepare residents for the presence of aircraft.

2. Any residents within the treatment area who are listed on State public health registries as hypersensitive to chemical exposure will be informed of the planned times and locations of all applications of malathion bait spray. They will also be advised that they may contact their physicians regarding ways to minimize their exposure to program chemicals.

3. Residents will be advised to remain indoors, take pets indoors (or provide cover for them), and cover garden fish ponds during spraying operations.

4. Residents will be advised to cover cars to protect them from possible damage caused by the bait spray.

5. A telephone hot line will be established before an eradication program and maintained during the program to keep the public informed of the most current and complete information available.

B. Protection of Nontarget Species

1. Honey Bee Protection

a. APHIS or a State cooperator will notify registered beekeepers of program treatments before chemical applications are conducted.

b. Information describing protection measures which can be taken by beekeepers to protect their colonies will be made available through beekeeper associations and State Agricultural Extension Agents.

c. The telephone hot line will describe protective procedures for beekeepers in addition to its primary function of informing the general public and answering questions concerning the fruit fly eradication program.

2. Beneficial species

a. Program managers will consult with State plant protection officials regarding programs involving the use or release of beneficial species and biocontrol agents and will adhere to any recommendations provided by the State officials.

3. Endangered and Threatened Species

a. APHIS or its designated non-Federal representative will consult with the U.S. Department of Interior's Fish and Wildlife Service, under the provisions of the Endangered Species Act, Section 7, for the protection of endangered and threatened species.

b. APHIS will implement measures mutually agreed upon with the Fish and Wildlife Service for the protection of endangered and threatened species.

4. Wildlife, Livestock, and Pets

a. All control operations will be conducted with appropriate concern for potential impact on nontarget organisms, including wildlife, livestock, and pets.

b. Homeowners and agriculturalists will be advised by written notification and telephone hot line of the ways in which they can protect livestock and pets.

C. Protection of the Physical Environment

1. Program activities will take into account site-specific aspects of the program area and will be tailored accordingly to maximize program efficiency and minimize potential adverse effects.

2. Treatment areas will be inspected before any treatment to determine the presence, location, and nature of sensitive areas. Where aerial applications could result in an unacceptable potential risk to a sensitive area, the program manager(s) will determine the need for approved alternative controls, as described in this analysis.

3. Aerial chemical applications will not be made where water contamination poses a major concern. Buffers with no aerial treatment (i.e., ground applications only) will be maintained around "major" water bodies (those named on 1:24,000 USGS Quadrangles) unless monitoring results and/or consultations with the State and EPA conclude otherwise.

4. Applications may be made by helicopters to enhance accurate delivery of pesticides, as well as increase safety for applicator pilots.

5. To minimize drift, volatilization, and runoff, pesticide applications will not be made when any of the following conditions exist in the treatment area: wind velocity exceeding 10 mph (or less if required by State law), rainfall or imminent rainfall, foggy weather, air turbulence that could seriously affect the normal spray pattern, or temperature inversions that could lead to off-site movement of spray.

6. Sensitive areas (including reservoirs, lakes, parks, zoos, arboretums, schools, churches, hospitals, recreation areas, refuges, and organic farms) near treatment areas will be identified. The program will take appropriate action to ensure that these areas are not adversely affected.

7. To the maximum extent possible, program managers will coordinate with other programs to reduce potential for cumulative impacts.

The potential risk reduction "Activities" described next identify components that can be varied or added so as to reduce risk, and identify which of those components are likely to have the greatest relative benefit in reducing risk. To a certain degree, site-specific factors will influence the ability to choose from these components in the future, and operational triggers will have to be devised in response to the situation.

It is not possible, at this time and within the context of this EIS, to identify those triggers.

1. Exclusion Strategy

Consideration of the distances involved leads to an immediate conclusion that fruit fly introductions to the United States are wholly the result of human activities. In the United States, the opportunity for those introductions increases as a consequence of high volume international travel, smuggling (in commercial or private shipments), agricultural product marketing and importation strategies, agricultural industry demands, and international trade agreements. Unfortunately, we seem unable to maintain a corresponding increase in new technologies, legal authorities, funding or staffing, in a timely manner to keep up with the continuous and increasing movement of potentially infested host material.

Fruit fly introductions occur at ports of entry and outbreaks frequently occur in metropolitan areas. Exclusion activities, either prior to arriving or at the first port of entry, are the primary line of defense against fruit flies. Risk may be reduced by applying more resources to exclusion activities and by "working smarter." Introductions of exotic pests from Caribbean countries could be reduced if cooperative relationships with those countries were effective in diminishing their pest problems and tightening their exclusion capabilities. Similarly, the risk of some fruit fly introductions has already been reduced by a cooperative partnership between the United States, Mexico, and Guatemala. That partnership, MOSCAMED (Spanish for Medfly), has eradicated Medfly from Mexico and is working on eradicating it from Guatemala.

In general, resources and inspection technologies can be improved at the ports of entry. Additional X-ray machines, inspectors, detector dogs, and other resources will reduce risk. Heavier fines to smugglers and additional restrictions on host material imports would also reduce risk. However, much additional resources would improve risk reduction, those resource needs must be weighed in balance with the resource needs of other important programs in an atmosphere of government streamlining and cost-cutting.

Figure 6–1. X-ray machines are used to screen passenger baggage at some of the larger air terminals. (Photo credit USDA, APHIS)

Activities

- Purchase and deploy X-ray equipment to check baggage at high-risk ports of entry.
- Increase anti-smuggling efforts at U.S. border stations (on U.S./Canada and U.S./Mexico borders).
- Establish and maintain canine teams at high-risk ports of entry.
- Develop and maintain computer technology for tracking illegal importations.
- Increase inspection on low-risk flights (e.g., Canadian flights that could include transshipped host material).
- Develop and improve plant protection technologies and infrastructure (such as the Caribbean Basin Initiative) for foreign countries, thereby lowering the risk of exotic fruit fly importations from them.
- Explore cooperative funding with industry for fruit fly exclusion efforts.
- Complete a pathway study to identify the most likely avenue of introduction for fruit flies and commit resources and improve the technology to block those pathways.

- Maintain efforts and cooperation to suppress and eradicate global fruit fly populations, to further reduce risk of their introduction into the United States.

2. Detection and Prevention Strategy

a. Strengthened Detection Trapping Program

Effective detection programs are required to limit the impacts to industry and the environment from the introduction of fruit flies and other exotic pests. International travel, trade, and pest interceptions at ports of arrival all show upward trends.

The National Exotic Fruit Fly Detection Program is a cooperative program between APHIS and several States that are susceptible to fruit fly establishment. A network of traps and attractants are used to detect Mediterranean, Mexican, Queensland, guava, melon, oriental, and other exotic fruit flies. APHIS and State officials developed the "National Exotic Fruit Fly Trapping Protocol" (NEFFTP), a set of guidelines that provides information on fly biology, traps to use, type and dosage of the attractants, trap density, trap inspection, baiting interval, trapping season, selection of trap site, and host plants. Although the Protocol is comprehensive and considered adequate by most experts, it needs to be revised to include new information and to add quality assurance guidelines.

Activities

- Enhance the current cooperative/co-managed detection program for fruit flies and other pests to provide an appropriate level of protection.
- Ensure that NEFFTP guidelines are followed, in that the appropriate number of traps are placed and inspected, and that the trapping program is managed properly.

b. Strengthened Delimitation Trapping Program

To the extent possible, the delimitation trapping program (trapping to determine the boundaries of the infestation) should be strengthened by shortening the time frame for implementation, ensuring that Emergency Response Guidelines are met with respect to trap density and management, and implementing newly developed control and detection technologies. A program infrastructure must be maintained that can mobilize as rapidly as possible to deploy delimitation traps. Also, any regulatory controls (quarantines, inspection, and regulatory treatments) should be brought to bear as quickly as possible. Finally, delimitation trapping may be combined with other types of control technologies (such as male annihilation) to minimize the opportunity for the infestation to grow or move.

Activities

- Cooperatively establish and maintain resources for a permanent infrastructure to implement a biologically sound delimitation trapping program.
- Explore use of mass trapping (male annihilation, "cordelitos," or other control technologies) that can be implemented along with delimitation trapping

c. Broad Prophylactic Sterile Release (SIT) Program

There are three possible ways in which to use SIT: (1) in prophylactic (preventative) area-wide release programs, (2) in suppression programs, and (3) in emergency eradication programs. There are advantages, disadvantages, and constraints associated with each. At this time, SIT techniques have been developed for and applied only to the most serious and frequent of fruit fly pests—the Medfly and Mexican fruit fly. There are technical and economic issues to be overcome before the technology can be applied for control of other species.

Using SIT in a prophylactic area-wide release program could greatly reduce the potential for fruit fly infestations. Such programs would blanket an area with enough sterile fruit flies to provide competition in mating that, through attrition, results in the elimination of fruit fly introductions while they are still small. However, such area-wide SIT programs are costly and probably could not be implemented in all areas of the country that are susceptible to fruit fly invasion. The use of SIT in all susceptible areas becomes even more complicated when one realizes that there are susceptible areas in each of our 50 States that should be protected from fruit flies. Accordingly, such area-wide release programs probably should be limited to high risk areas (areas where fruit flies are detected on a recurring basis).

The availability of sterile insects for such programs is severely limited by production technologies, geographical constraints, and program logistics. Laboratory insect populations must be reared and checked for quality before their release. APHIS is extremely concerned about the danger of accidental release from sterile insect production facilities and only allows sterile fly production in areas of the U.S. where the fruit fly species is established, such as Medfly in Hawaii or Mexican fruit fly in the Lower Rio Grande Valley of Texas. Facilities also must be maintained in high risk areas to facilitate the management and rapid distribution of sterile fruit flies.

Activities

- Develop and refine SIT technology, and develop more effective and efficient strains for use in preventative programs.
- Develop and approve broad, prophylactic SIT programs for areas where fruit flies are detected often on a recurring basis.
- Increase fruit fly production at SIT insect production facilities.
- Explore and secure new sources of funding for prophylactic programs.

3. Control Strategy

a. Sterile Release Program (SIT)

In addition to prophylactic area-wide release programs (discussed above), SIT can also be used in suppression programs or in emergency eradication programs. SIT has been used successfully for many years to suppress populations of the Mexican fruit fly that exist in the Lower Rio Grande Valley. It is also integrated into many emergency eradication programs, such as the Medfly eradication programs in California and Florida.

The same constraints apply to suppression and eradication SIT programs that apply to prophylactic area-wide SIT programs. The technology is expensive and complex, it is difficult to produce the quantities required for large-scale programs, and special precautions must be taken for sterile production laboratories.

Activities

- Develop and refine SIT technology for additional species of fruit flies.
- Increase sterile fruit fly production for suppression and emergency response activities.
- Explore and secure new sources of funding for SIT suppression and emergency eradication programs.

b. Use of Malathion Only When Appropriate

The pesticide malathion has been used effectively against fruit flies for many years. It has been a mainstay in most recent Medfly eradication programs because of its proven ability to quickly eliminate pest populations and thereby reduce the likelihood that the infestations would grow larger or be transported to other locations. It also has been used as a means of reducing the wild pest populations to a level where SIT could then be effective.

EPA has communicated their concerns to APHIS that malathion bait aerial applications should be used only as a last resort. In typical eradication programs, where infestions were small and focused, APHIS has successfully limited the use of malathion and maximized the use of SIT. The 1997 Florida Medfly Cooperative Eradication Program constituted an unusual emergency situation in which the initial use of less effective control measures was not appropriate. APHIS program officials acknowledge the concerns of EPA and of the public over the use of malathion and will employ suitable discretion regarding its use.

Activities

- Consider all options prior to using aerially-applied malathion in emergency eradication programs.
- Re-evaluate the uses of malathion (aerial and ground), if registration status of malathion is reclassified.
- Accelerate research into replacement emergency eradication tools for fruit flies.

c. Chemical Alternatives to Malathion

APHIS and the USDA's Agricultural Research Service (ARS) have committed substantial resources and personnel to fruit fly research and methods development work. Research has been done on a variety of alternative chemicals, including: plant-derived pesticides (pyrethrins), permethrin, horticultural oils (d-Limonene), gibberellic acid, boron, rotenone, Neem, Avermectin B, Capsaicin oil and soap. Unfortunately most of those chemicals have unproven efficacy, are inapplicable to broad-scale programs, or have more adverse environmental impacts than malathion. Two chemicals which may serve as alternatives to malathion are SureDye and spinosad. APHIS and ARS have intensified research on the efficacy and effects of these chemicals and, as appropriate, will work with the manufacturers and EPA to expedite their approval for future use patterns.

SureDye is a mixture of fluorescein dyes that are U.S. Food and Drug Administration (FDA) approved for use in cosmetics and drug products. SureDye bait applications have been proposed as a replacement technology for malathion bait. The dye appears effective against the Medfly and several other fruit flies, but it has not been proven to be as effective as malathion. SureDye is not currently proposed for use by APHIS; however, researchers continue to develop bait formulations and application methodology to improve its effectiveness. The environmental effects of SureDye were analyzed in two APHIS studies, "Risk Assessment: SureDye Insecticide Trials, January 1995" and "SureDye Insecticide Applications Human Health Risk Assessment—May 1995." In general, SureDye appears to have minimal risk to human health, nontarget species (other than insects), and the physical environment. One constraint to the use of SureDye is its property to stain fabrics and other surfaces.

Spinosad is a metabolite that results from the fermentation of a bacterium; it is in a new class of pesticides, called naturalytes. It is being studied by APHIS and ARS for use against fruit flies, and by other organizations for use against other plant pests, including some lepidoptera. Spinosad has been used by APHIS and its cooperators in some fruit fly control programs. Field studies of spinosad and SureDye's ingredient, phloxine B, have been conducted in California, Florida, Hawaii, Texas, and Guatemala. APHIS has completed a human health risk assessment of spinosad (APHIS, 1999a) and a nontarget species risk assessment of spinosad (APHIS, 1999b). Like SureDye, spinosad appears to have minimal risk to human health, nontarget species, and the physical environment.

One of the limiting factors in the use of pesticide-baits is the relative strength of the attractant. Not all fruit fly species are strongly attracted to the baits that have been developed, therefore pesticide baits may not be the control method of preference for some species. ARS is looking for more effective and specific fruit fly attractants. Of particular interest is the development of attractants for use in bait stations, to enable use of minimum concentrations of pesticides under conditions which represent minimal exposure to humans, livestock, pets, or the rest of the environment.

Activities

- Support and secure pesticide registrations for effective alternatives against fruit flies.
- Develop alternative bait formulations and evaluate their use as substitutes for malathion bait.

4. Communication Strategy

A communication strategy is a vital part of any emergency action, such as a fruit fly eradication program. Such a strategy is used to inform the public of program actions, communicate information about environmental risk, and inform the public of ways to reduce risk. The communication strategy for the 1997 Florida Medfly Cooperative Eradication Program was relatively effective in that it provided public announcements of program decisions and actions, provided personal notification of pesticide applications to people on the State's list of chemically sensitive people (and anyone else who wanted to be notified about applications), and provided recommendations for protection measures.

In spite of media announcements, emergency phone banks, and a variety of other public information mechanisms, many of the public commented that they did not know where to go to get information. APHIS program managers responded to those comments by improving on that communication strategy and packaging it in a format that communicates its content more efficiently to the public. The "Emergency Response Communication Plan—Fruit Flies" (appendix C) contains APHIS' most recent emergency response communication strategy for fruit fly programs. Review of that document indicates that the following risk-reducing activities for communications strategy have already been met.

Activities

- Provide a complete, comprehensive package detailing communications policies to the public.
- Describe how members of the public may obtain information pertaining to program risks.
- Describe actions that will take place upon the implementation of an eradication program and the implementation of pesticide applications.
- Describe notification procedures and explain how chemically sensitive members of the public may avail themselves of direct notification.
- Describe established procedures for receiving and resolving complaints.

VII. Monitoring

A. Introduction

The Animal and Plant Health Inspection Service (APHIS) and its cooperators will monitor fruit fly program areas in order to determine the environmental consequences and efficacy of program treatments. Environmental monitoring is done in accordance with responsibilities under certain environmental statutes. Efficacy monitoring (also called quality control monitoring) is done to confirm the efficacy of the treatments. Monitoring is a cooperative effort involving Federal, State, and county personnel.

B. Environmental Monitoring

Environmental monitoring is done in compliance with the following statutes or their implementing regulations: the National Environmental Policy Act (NEPA); the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA); and the Endangered Species Act (ESA). NEPA monitoring is designed to assess the effectiveness and validity of mitigative measures, such as buffers around sensitive sites, outlined in environmental assessments (EAs) and this environmental impact statement (EIS). Environmental monitoring compares residue levels found in the environment with expected residue levels used in the risk analyses used by the EIS. Monitoring under FIFRA is sometimes required as a condition of special use permits for pesticide applications, issued by the U.S. Environmental Protection Agency.

Monitoring under ESA is designed to assess the effectiveness of program protection measures for endangered and threatened species or their habitats. Those protection measures ordinarily are developed by APHIS and its cooperators, or through consultations with the Fish and Wildlife Service (FWS). Often, because of the emergency nature of fruit fly control programs, program managers need to consult by phone with the FWS and with local fish and game offices to confirm the presence or absence of endangered or threatened species, identify sensitive sites, and confirm the use of protection measures.

APHIS recognizes that it cannot predict the exact locations, characteristics, or severity of future infestations, and cannot, therefore, be very specific in this discussion about the kinds or levels of monitoring that must be done for each program. A specific monitoring plan will be developed for each individual program, based on the site-specific characteristics of that program. The monitoring plan will describe the purpose of the monitoring and the nature of the samples to be collected.

In fruit fly programs (which usually occur in suburban areas), the emphasis of the environmental monitoring will be on the protection of human health. Monitoring (with dye cards, water, and vegetation samples) may be used to ensure that spray buffers adequately protect sensitive sites from spray drift or misapplications. Specific environmental components may be sampled in response to complaints about perceived impacts of treatments or lack of effectiveness of mitigative measures.

Figure 7–1. Monitoring samples are tagged and sent for laboratory analysis. (Photo credit USDA, APHIS)

An APHIS environmental monitoring coordinator oversees the collection, packaging, and shipment of samples to the National Monitoring and Residue Analysis Laboratory (NMRAL) in Gulfport, Mississippi (or to another private, accredited laboratory, if the workload exceeds NMRAL's capacity). The results of the laboratory's residue analyses are associated with environmental data recorded at the time of the treatment and sampling, and are interpreted by APHIS' environmental monitoring staff. The data are reported at the end of the program, or intermittently during the program, as required.

C. Efficacy Monitoring (Quality Control Monitoring)

For chemical treatments (malathion, spinosad, SureDye, diazinon, chlorpyrifos, fenthion, and methyl bromide), the purity of the chemical and the precision of the formulation will be determined. Program pesticide applicators will follow standard operating procedures described in this EIS and in the guidelines, policies, and manuals of APHIS and program cooperators.

Figure 7–2. Quantitative analysis of residue samples at the laboratory. (Photo credit USDA, APHIS)

Efficacy monitoring will be done also to confirm accurate placement and delivery of pesticides. The spray equipment on individual aircraft is calibrated to ensure precise metering of pesticide quantities and droplet size. Dye cards are used on the ground to verify the size and distribution of pesticide droplets at the target. Dye cards are also used to verify the placement of pesticide in proximity to boundaries of the treated areas, identify areas that were skipped, and estimate the amount of drift.

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VIII. Environmental Laws, the Program, and the EIS

A. Introduction

In the planning and implementation of its programs and actions, the Animal and Plant Health Inspection Service (APHIS) complies with a variety of environmental statutes and regulations. Most of those statutes and regulations have the underlying objective of forcing Federal managers to consider comprehensively the environmental consequences of their actions before making any firm decisions. In addition, the statutes and regulations provide guidance in the procedures that must be followed, the analytical process itself, and the ways of obtaining public involvement. This environmental impact statement is prepared specifically to meet the needs of the National Environmental Policy Act of 1969 (NEPA), 42 U.S.C. 4321, *et seq*.

B. APHIS Environmental Policy

APHIS strives to comply with environmental regulations and statutes as an integral part of the decisionmaking process to identify and consider available alternatives that lead to more successful programs. NEPA is the origin of current APHIS environmental policy. It requires each Federal agency to publish regulations implementing its procedural requirements. APHIS originally published the "APHIS Guidelines Concerning Implementation of NEPA Procedures" (44 FR 50381–50384, August 28, 1979). Subsequently, it published the APHIS "National Environmental Policy Act Implementing Procedures" (7 CFR. 372), which superseded its earlier guidelines. APHIS bases its current procedures on: NEPA itself; the Council on Environmental Quality's "Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act," 40 CFR 1500, *et seq.*; the U.S. Department of Agriculture's "NEPA Regulations," 7 CFR 1b, 3100; and the APHIS "National Environmental Policy Act Implementing Procedures."

C. National Environmental Policy Act

NEPA requires Federal agencies to consider environmental consequences in their planning and decisionmaking processes. It requires them to prepare detailed statements (environmental impact statements) for major Federal actions which significantly affect the quality of the human environment. These statements must consider the environmental impact of the proposed action, adverse effects which cannot be avoided should the proposal be implemented, alternatives to the proposed action, the relationship between local and short-term uses of the human environment, and the maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitments of resources necessary to implement the action. NEPA provided the basis for many other statutes and environmental regulations within the United States.

NEPA established the President's Council on Environmental Quality, which published regulations for the implementation of NEPA that became effective in 1979. Those regulations were designed to standardize the process that Federal agencies must use to analyze their proposed actions. Those regulations have been the models for the NEPA implementing regulations that have been promulgated by Federal agencies.

D. Endangered Species Act

The Endangered Species Act of 1973 (ESA), 16 U.S.C. 4332, *et seq.*, was passed to provide for a Federal mechanism to protect endangered and threatened species. This act provides for an analysis of the impact of Federal programs upon listed species. Under ESA, animal and plant species must be specifically listed in order to gain protection. Federal agencies proposing programs which could have an effect on listed or proposed endangered and threatened species prepare biological assessments for those species. Those biological assessments analyze potential effects and describe any protective measures the agencies will employ to protect the species. A consultation process, section 7 consultation (after that section of the Act), is employed as needed. Such consultation is important to APHIS' environmental process and then becomes an integral part of the proposed program.

E. Executive Order 12898—Environmental Justice

Executive Order (E.O.) 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," focuses Federal attention on the environmental and human health conditions of minority and low-income communities, and promotes community access to public information and public participation in matters relating to human health or the environment. The executive order requires Federal agencies to conduct their programs, policies, and activities that substantially affect human health or the environment in a manner so as not to exclude persons and populations from participation in or benefitting from such programs. It also enforces existing statutes to prevent minority and low-income communities from being subjected to disproportionately high and adverse human health or environmental effects.

F. Executive Order 13045—Protection of Children from Environmental Health Risks and Safety Risks

E.O. 13045, "Protection of Children from Environmental Health Risks and Safety Risks," acknowledges that children may suffer disproportionately from environmental health and safety risks because of their developmental stage, greater metabolic activity levels, and behavior patterns, as compared to adults. This E.O. (to the extent permitted by law and appropriate, and consistent with the agency's mission) requires each Federal agency to identify, assess, and address environmental health risks and safety risks that may disproportionately affect children. It also established a task force, requires the coordination of research and integration of collected data, gives guidelines for the analysis of effects, and directed the establishment of an "Interagency Forum on Child and Family Statistics."

G. Executive Order 13112—Invasive Species

E.O. 13112, "Invasive Species," directs Federal agencies to use their programs and authorities to prevent the spread or to control populations of alien species that cause economic or environmental harm, or harm to human health. Alien species are, with respect to a particular ecosystem, any species, including its seeds, eggs, spores, or other biological material capable of propagating that species that is not native to that ecosystem. The fruit flies considered for regulation in this cooperative programmatic environmental impact statement (EIS) are all classified as invasive, alien species. Identification of these species and the proposed alternatives to control and prevent the spread of these invasive species in the EIS serves to fulfill obligations under NEPA as well as this.

H. Miscellaneous Federal Environmental Statutes

APHIS complies with a number of other environmental acts, statutes, and regulations. Examples of these include the Migratory Bird Treaty Act; Bald and Golden Eagle Act; Federal Insecticide, Fungicide, and Rodenticide Act; Toxic Substances Control Act; Resource Conservation and Recovery Act; Comprehensive Environmental Response, Compensation, and Liability Act of 1980; Clean Air Act; Clean Water Act; and the Food Quality Protection Act.

I. State Environmental Statutes

The potential program States all have various environmental statutes and regulations. Many of the regulations and regulatory organizations that enforce them are direct parallels of the Federal regulations and regulatory organizations. California, for example, has the California Environmental Quality Act and has formed the California Environmental Protection Agency.

For the proposed Fruit Fly Cooperative Control Program, APHIS will work with State and/or other Federal agencies to implement eradication programs within various States. APHIS will rely on its State cooperators to identify applicable State environmental regulations, take the lead for their procedures, and ensure full compliance with State laws.

Appendix A. Public Comment on the Draft Environmental Impact Statement

I. Introduction

The Animal and Plant Health Inspection Service (APHIS) wishes to thank all who reviewed the "Fruit Fly Cooperative Control Program Draft Environmental Impact Statement–1999" (draft EIS) and provided their comments, via the mail or orally at meetings. APHIS welcomes public involvement and considers public perspectives in its decision processes. During the scoping period, APHIS requested and received oral and written comments which were considered fully in the planning for the draft EIS. Those comments are available for public review at the U.S. Department of Agriculture, Animal and Plant Health Inspection Service Reading Room, 14th Street and Independence Avenue, SW, Room 1141, South Building, Washington, DC, 20250.

The U.S. Environmental Protection Agency (EPA) published the notice of availability for the draft EIS in the *Federal Register* on July 30, 1999. In addition, APHIS published its own *Federal Register* notice of availability on August 12, 1999, which (1) provided background information about the draft EIS, (2) identified major issues, (3) invited public comment, (4) provided notice of public meetings, and (5) provided guidance on commenting. The official comment period ran until October 12, 1999. Public meetings were held in Washington, DC, on August 16, 1999; Tampa, Florida, on August 18, 1999; Miami, Florida, on August 20, 1999; and Los Angeles, California, on August 25, 1999. A meeting scheduled for Brownsville, Texas, on August 23, 1999, was canceled because of a hurricane and was not rescheduled because of the lack of interest shown for a previous meeting in that city for the the previous Medfly EIS.

Despite the national scope of the draft EIS, there was not a large response to our request for comments. There was minimal attendance at meetings and only 83 pieces of mail (65 postcards and 18 letters) were received. The postcards were all alike and served no helpful review purpose, only conveying the following message, "Use Sterile Medflies and spinosad. No Malathion." The 18 letters, however, ranged from brief to extraordinarily comprehensive (incorporating other reports and even Internet literature reviews), and were considered extremely helpful. All are available for review at the APHIS Reading Room.

Because the information was voluminous and it would have been impractical to try to respond on a point-by-point basis to each of the letters, APHIS has summarized the respondents' comments, as provided by 40 CFR 1503.4. This appendix concisely summarizes the public comments and provides APHIS' responses to the major issues contained within those comments. The major issues fell within two categories–human health risks and the EIS process. All who sent letter responses during the comment period are listed at the end of this appendix, along with their State and organization, as shown on their correspondence. Respondents' complete addresses have been added to our Distribution List, appendix G.

II. Summarization of Comments and Responses to Comments

The majority of concerns raised by the public are associated with the program use of pesticides and the estimation of human health risks from that use. The comments also identified issues relating to the EIS process. Specific concerns are summarized and addressed in this section.

A. Human Health Risk

Issue 1: Some commenters share a concern that malathion, a widely-used program insecticide, its metabolic byproducts, or its degradation products, may be carcinogens (agents that cause cancer). They have identified studies and researchers which seem to corroborate their perspective, and noted that EPA has recharacterized malathion's carcinogenic risk.

Response: APHIS shares the public's concern over the effects of the materials used in its cooperative programs for control of fruit flies, and for this reason delayed the preparation of this EIS, pending the results of an ongoing carcinogenicity study of malathion by EPA.

Malathion's potential for carcinogenicity has been studied thoroughly by a Cancer Assessment Review Committee (CARC) of the EPA's Health Effects Division. The independent FIFRA/FQPA Scientific Advisory Panel (SAP) is considering the CARC's findings and preparing recommendations to EPA regarding management of the potential risk. EPA has indicated that it will consider the recommendations of the SAP in its final risk management decision. The narrative descriptors that EPA uses to define the carcinogenic risk of pesticides were revised according to guidelines proposed in 1999. CARC, based upon those 1999 guidelines, has classified malathion as having "suggestive evidence of carcinogenicity, but not sufficient to assess human carcinogenic potential." That classification was based on: (1) occurrence of liver tumors in rats only at excessive doses; (2) the occurrence of other tumors in rats, also at excessive doses and/or considered unrelated to treatment; and (3) rare tumors in oral palate mucosa and nasal respiratory epithelium of rats which could not be distinguished as either treatment related or due to random occurrence. This classification indicates that EPA considers any potential carcinogenic risk of malathion to be too low to quantify based upon their weight of evidence determination. Similarly, CARC studied the potential carcinogenicity of malaoxon, a primary degradation and metabolic byproduct. CARC indicated that malaoxon is "not likely to be carcinogenic to humans" based upon its review of chronic rodent assays and other research studies.

EPA's classification of malathion's carcinogenic risk potential suggests that any carcinogenic response from exposure to program malathion applications would be indistinguishable from the background frequency of carcinogenic response. In APHIS' perspective, based on a thorough review of EPA's new classification of malathion, there is virtually no change in the carcinogenic risk associated with proposed program use of malathion that was reported in the draft EIS. Notwithstanding its perspective on malathion, APHIS continues to seek new and safer pesticide alternatives for use in cooperative fruit fly programs.

Issue 2. Potential health risks (especially for people with unusual immunological responses such as allergy, hypersensitivity, or multiple chemical sensitivity) are highly variable. The risks to such persons are so great that they outweigh the potential benefits of the program.

Response: Potential health effects, especially the immunological responses noted, are subject to considerable variability within a human population. Such immunological responses may occur at low exposures, may vary considerably in intensity, and may be nonspecific. They also may arise from chemicals in the environment that are not pesticides (e.g., perfumes, inks, plastics, and solvents). Because of the individual variation, the effects on hypersensitive individuals from program pesticide applications can not be assessed quantitatively with any degree of precision. Such variability in response to exposures has also made it difficult for the medical community to provide a clear definition of what constitutes a hypersensitive response or what diagnostic features are needed to identify multiple chemical sensitivity.

APHIS reviewed reports that examined the linkage between the programs' use of chemical pesticides and adverse health effects in chemically sensitive individuals. That information, in the current literature and in the reports of health practitioners, was found to be equivocal (with both support for, and opposition to, a causal relationship). An individual diagnosed with multiple chemical sensitivity (incurred from nonprogram exposures to chemicals in a laboratory) studied this issue, for the preparation of the Medfly EIS (USDA, APHIS, 1993). Based upon his recommendations and APHIS' experience in previous programs, APHIS has concentrated its efforts on providing timely and adequate notification of program activities to those individuals.

There are some State and private medical registries of individuals diagnosed with chemical hypersensitivity. Such individuals and any other individuals reporting a chemical hypersensitivity condition are notified in advance of application methods and times of application to provide them the opportunity to take whatever measures they deem appropriate to protect themselves against any potential personal health effects from exposure. Program managers are capable of providing information about ways of avoiding exposure, but individuals should use their own judgment (based on their own conditions) in choosing the most appropriate measures for protecting themselves from exposure and potential adverse effects.

Issue 3. Commenters have questioned the risk assessment methods used in the assessments that were incorporated by reference in the draft EIS. Some believe the risk assessments were not conservative enough and others believe that they were too conservative. Some believe that when the data is equivocal or when uncertainty is involved, we must be conservative.

Response: EPA, as part of its pesticide registration process, has primary responsibility for assessing the risk associated with pesticide use. Following EPA's leadership in risk assessment technology, APHIS employed comparable approaches to toxicologic analyses for its fruit fly programs. Impacts were assessed in the EIS according to the relative risks of specific health outcomes from program methodology. The EIS employs realistic exposure scenarios that would be expected to result from program actions. Those scenarios were developed to accurately reflect routine, extreme, and accidental circumstances. The extreme and accidental scenarios assume a level of human negligence that is expected to occur infrequently. These scenarios are described in detail in the human health risk assessments. Although control methods have been proposed for use based primarily on their demonstrated effectiveness, the EIS estimates risks based on projected program use patterns, so that decisionmakers will be able to weigh the environmental factors in developing control strategies for site-specific conditions.

Selection of acceptable toxicological endpoints and application of uncertainty factors in the assessment of potential adverse human health effects is a technical decision. Potential adverse toxicological effects from the use of program chemicals were considered for parent compounds, degradation products, metabolites, inert ingredients, and various contaminants. Quantitative assessments are possible when there is sufficient data. Quantitative risk assessment requires an accurate assessment of potential exposure and a clear understanding of the relationship between dose and response. A quantitative assessment of risk for the parent compounds is usually straightforward. Exposure to degradation products or metabolic byproducts is relatively lower, and the relationships between dose and response for these compounds usually are not as well defined as for the parent compound. Although some of the compounds present in the formulated pesticide may be more toxic than the parent compound, their contribution to overall toxicity is often less due to lower concentrations and the resulting lower exposure.

When there was uncertainty, the quantitative risk assessments were conservatively designed to err on the side of safety. APHIS generally accepts those studies that meet criteria set by EPA and uses reference dose values when appropriate. The continuing development of applications of new pesticides to fruit fly control has required APHIS to calculate regulatory reference values (RRVs) for some compounds not yet analyzed by EPA for reference dose calculation. It has been APHIS' practice to select the RRV for the adverse health endpoint at the lowest exposure as the basis for quantification of hazard quotients for given exposure scenarios when EPA reviews have not been conducted. The RRV values may be modified after EPA reviews are completed. The selection of RRVs may be based upon the most sensitive indicator of exposure rather than the most sensitive indicator of adverse effect. For example, the RRV selected for malathion is based upon a human study that determined the minimal exposure that resulted in inhibition of plasma cholinesterase or butyrylcholinesterase (an indicator of exposure but not adverse effect). The exposure from this study was considerably less than would be required for detection of any adverse effects which require moderate inhibition of red blood cell cholinesterase or acetylcholinesterase. APHIS continues to review studies to ensure that the most appropriate RRVs are selected for given pesticide exposure.

Comments on the draft EIS have expressed widely diverging views about the human health risk assessments prepared for this document. Some respondents stated that the risk assessments were not conservative enough and that actual risks from certain health outcomes were understated. Others stated that the risk assessments were overly conservative and that actual risks from health outcomes were overstated. Issues of disagreement among respondents included what constitutes an appropriate exposure scenario, how likely a given exposure is, when quantitative analysis is appropriate, what human health outcomes should be considered, what the likelihood of a given health outcome is, what constitutes an acceptable laboratory outcome for risk assessment, whether hypersensitivity is a valid health effect, how environmental justice issues should be analyzed, and how meaningful the risk scores are. Although each of these subjects was covered in the revision of the EIS, it is clear that APHIS can not resolve these areas of disagreement to the mutual satisfaction of all.

Issue 4. New compounds have been identified for fruit fly control. It isn't clear why older, more harmful chemical insecticides (with known risks) are being used instead of these new compounds.

Response: APHIS and its cooperators in fruit fly programs continually search for effective and less harmful methods (chemical and nonchemical) for controlling fruit flies. As they are discovered, new compounds are tested for use and developed further when field and laboratory tests show promise. Chemicals, such as spinosad, are integrated into programs when they become available, and as research on their efficacy and potential environmental effects is completed. Although the development of spinosad was recent and the analysis was presented in an appendix in the draft EIS, spinosad received consideration that was comparable to that of the other bait spray applications–malathion and SureDye. Any new pesticides or other treatments that show promise as effective substitutes for bait spray applications, soil treatments, or commodity treatments will be analyzed thoroughly when their availability, efficacy, and effects have been determined for APHIS programs.

Completion of an EIS does not end the environmental process, but facilitates further action. Following completion of this EIS, there will be monitoring (a NEPA requirement) to determine whether the program effects on the environment were consistent with the analyses. This monitoring data will be used to either reinforce current understanding or to justify changes in future program actions. New data about the pesticides, new methods of risk analysis, and new control techniques are continually being researched and developed. As relevant information applicable to fruit fly programs becomes available, future site-specific environmental assessments will apply this information to new programs and associated risk assessments. It is noteworthy that several major developments have occurred since the beginning of preparations for this EIS. One development that has directly affected this EIS is the use of the insecticide, spinosad, which had not been developed for fruit fly control. Other major developments relate to the review of EPA risk assessments to comply with the Food Quality Protection Act. The revised risk assessments have altered classification of some pesticides. The results of these risk assessments have affected the approval for some applications and have placed restrictions on some use patterns. Completion of this EIS without the results of some EPA risk assessments would have been inappropriate. It should also be recognized that any future revisions of EPA risk assessments for the pesticides used in fruit fly programs will be considered as part of the preparation of APHIS risk assessments for site-specific programs. The likelihood of regulatory and technological changes requires that the risk assessments for an EIS be revisited as pertinent new information becomes available.

Issue 5. A uniform treatment strategy is not available for all of the species. This makes it difficult to comprehend the cumulative risk for all fruit fly control, as well as the risk for individual programs.

Response: Each of the individual control methods described in this EIS is not applicable for the control of all 80 species of fruit flies and to all site-specific conditions. For example, the fruit fly male annihilation technique is quite effective against the Oriental fruit fly, but the efficacy of this methodology has not been developed for some other species. Although methods have been developed for some fruit fly species, the most efficacious methods for control of many of the fruit flies species have not yet been ascertained. For example, methods for control of the olive fruit fly were perfected only after the first infestation in the United States was detected. The control methods adopted for the olive fruit fly control program are similar to those applied for other *tephritid* species. It is not possible to identify precisely all the methods for each fruit fly species at all locations in the United States, or the potential distribution of many of the species if their introduction were to occur. Therefore, this EIS concentrates on the most likely locations of introduction, those fruit fly species most likely to be introduced, and those methods proven to be effective against those species at those locations.

B. The EIS Process

Issue 1. Some commenters have registered concern that the EIS is not complete, it doesn't answer all the human health questions, or it doesn't take into account new data.

Response: APHIS does review all environmental and human health reports related to fruit fly programs that are received. The draft and final Florida Department of Health monitoring report for the Medfly Eradication Program in 1998 has been reviewed. APHIS has accepted the findings of the final monitoring report as an indicative assessment of the reported potential cases of adverse health effects for the program in 1998. The report acknowledged the difficulties of epidemiological analysis in ascertaining whether reported individual health outcomes are the result of exposure to program pesticides or the result of other unrelated causation. The lack of any clinically verified cases of poisoning attributed to the program pesticide applications illustrates the limitations of these studies to demonstrate meaningful evidence of any cause-effect relationships. The limitations of the findings are acknowledged and recommendations for improvements to health monitoring are being taken under advisement.

Issue 2. The EIS is too broad and lacks critical site-specific information that managers need to make informed decisions.

Response: This EIS is programmatic and not site-specific; its discussions and analysis must be broad enough to accommodate all fruit fly program areas nationwide. Individual programs and associated local conditions are considered within the context of additional, individual site-specific environmental assessments that are prepared for those individual programs. Some site-specific examples may be provided in this EIS to help clarify certain issues or provide a perspective of the relative impacts, but this EIS is neither intended, nor required, to provide encyclopedic data about all possible sites and all possible effects at those sites.

III. Commenters

	Name	Organization	State
1.	Elaine Holmes		FL
2.	Joel Nelson		CA
3.	[Handwritten name illegible]		FL
4.	Sandra Ross, Ph.D.	Health & Habitat	CA
5.	Dr. Omar Shafey	FL Department of Health	FL
6.	Kenneth W. Holt	Centers for Disease Control & Prevention	GA
7.	Betty Greenwood		FL
8.	Robert Fawley		FL
9.	Julie Sternfels		FL
10.	Richard & Lora Ann Sigler		CA
11.	Juanita Fawley		FL
12.	Marc Lappé, Ph.D.		CA
13.	[Handwritten name illegible]		FL
14.	Willie R. Taylor		DC
15.	Bob Crawford		FL
16.	Cheryl A. Gross	Sarasota County Health Department	FL
17.	Eric Waldo		FL
18.	April Post		CA
19.	Cheriel Jensen		CA
20.	Richard E. Sanderson		DC
21.	Pat Minyard		CA
22.	Alice Suncloud		HI
23.	Richard G. Hunter		FL
24.	Michael J. DiBartolomeis, Ph.D.	State of CA Environmental Health & Hazard	CA
25.	Edgar Hirshberg		FL
26.	Vernetta Ross		FL
27.	Marie R. Breakey		FL
28.	Mary Ann Walters		FL
29.	Frank Ferlita		FL
30.	J.C. Roberts		FL
31.	David B. Smith		FL
32.	Bettye Honeywell		FL
33.	Terrie Smith		FL
34.	James J. Clinton		FL
35.	Dorothy Frazer		FL
36.	Terry Giff		FL
37.	William C. Quenan, Jr.		FL
38.	Callie Manning		FL
39.	[Handwritten name illegible]		FL

Name	Organization	State
40. Leri Johnson		FL
41. Cynthia P. Glee		FL
42. Patricia Turner		FL
43. Brenda Baltbo		FL
44. Arte J. Franz		FL
45. Rev. Federick J. Bushby		FL
46. K. Kampfe		FL
47. Marjorie Hodgen		FL
48. A. Izquierdo		FL
49. Patricia H. Latshaw		FL
50. Terry Jaffe		FL
51. George Latshaw		FL
52. JoAnn Wren		FL
53. Gladys M. Gerlik		FL
54. Marion Everson		FL
55. James M. Vardar		FL
56. Drexel Jackson		FL
57. Ronald Brown		FL
58. Jamie Starr		FL
59. Ben Faulkner		FL
60. Glenda Faulkner		FL
61. Dana G. Leavengood		FL
62. Minnie Wiggins		FL
63. Astmea Brooks		FL
64. Hannah Nelson		FL
65. Barry Smits		FL
66. Edward Ferguson		FL
67. [Handwritten name illegible]		FL
68. June K. Arnhym		FL
69. Ray Pineda		FL
70. [Handwritten name illegible]		FL
71. Lillion Ferlita		FL
72. Tammy L. Mee		FL
73. Virginia Casey		FL
74. H.W. Melton		FL
75. R. Gonzalez, Jr.		FL
76. Fran Darley		FL
77. Shelia Hogan		FL
78. Bruce V. Sewell		FL
79. [Handwritten name illegible]		FL
80. Shirley Gregoire		FL

Name	Organization	State
81. Cynthia Laurence		FL
82. Marsha J. Weaver		FL
83. [Handwritten name illegible]		FL
84. Del A. Fernandez		FL
85. Joan Strauman		FL
86. Oliver Stewart		FL
87. Benjamin Colvino		FL
88. Hally Rubin		FL
89. Brenda Costillo		FL
90. Albert M. Valentine		FL
91. Patricia A. Lawes		FL
92. [Handwritten name illegible]		FL
93. [Handwritten name illegible]		FL
94. John M. Coil		FL
95. Mariette Coulter		FL
96. W.E. Weber		FL
97. Robert D. Berrett		FL
98. Patricia B. Berrett		FL
99. Anne Marie de Moret		FL
100. A. Bowen		FL
101. J.A.W., Jr.		FL
102. Carole Mihlman		FL
103. Emil Assily		FL
104. Richard E. Sanderson		DC

Appendix B. Site-specific Procedures

The Animal and Plant Health Inspection Service (APHIS) and its cooperators would like to implement fruit fly programs in a manner that achieves the exclusion and/or control objectives while preserving the quality and diversity of the human environment. This programmatic environmental impact statement (EIS) estimates in a generic way the range of impacts that might be expected for various program alternatives. It cannot, however, predict the exact locations of future programs or precisely estimate the potential impacts of an individual program. In compliance with the objectives of the National Environmental Policy Act (NEPA), APHIS will conduct a site-specific evaluation and implement site-specific procedures at the local level which are designed to reduce the potential for environmental impact.

A. Site-specific Evaluation

Before a program is implemented, program managers will take an in-depth look at the site-specific characteristics of the program area (local geographic features, human health, and nontarget species), the program's proposed operational procedures, and the proposed control methods. The site-specific evaluation process considers characteristics such as:
(1) unique and sensitive aspects of the proposed program area,
(2) applicable environmental and program documentation, and
(3) applicable new developments in environmental science or control technologies.

In addition to complying with NEPA's objectives, the site-specific evaluation will determine if the general findings of this programmatic EIS remain equally applicable to each individual program's specific situation and whether additional or new concerns exist. In cases where major changes are apparent, a supplement to the EIS or a new EIS may be required.

B. Site-specific Procedures

Prior to and during a fruit fly program, APHIS and/or its cooperators will follow standard procedures for environmental assessment, communication of risk information, and reduction of environmental risks. This EIS is expected to influence those procedures and the timetable, which may vary, depending upon the characteristics of the area, the specific pest, and the availability of vital information. The operational roles of APHIS and its cooperators may vary from State to State, also influencing that timetable.

The site-specific procedures include tasks related to quarantines (detection of infestations, designation of quarantine areas, and notices of quarantine), environmental assessments (review of the EIS, preparation of site-specific assessments, publication of notices, and public review), consultation with other Federal and/or State agencies, risk communication and public notification (the chemically sensitive, hospitals and police, residents, and beekeepers), and program adjustment. Detailed information about the status of programs and these activities is available from program officials or telephone hotlines that are established for individual programs.

Appendix C: Emergency Response Communication Plan—Fruit Flies

Emergency Response Communication Plan—Fruit Flies

As an agency concerned about pest and disease situations that can occur or change rapidly, the Animal and Plant Health Inspection Service (APHIS) has a vital need to effectively communicate program activities to its target audiences using a wide variety of informational materials. During emergency situations, such as fruit fly outbreaks, effective and timely communication becomes even more crucial. APHIS provides onsite support during fruit fly outbreaks, serving along with State officials as primary liaisons with the news media to provide accurate information to stakeholders, industry, and the public.

Audiences:

- Media
- State, city and county governments
- Industry/stakeholders
- Environmental groups
- General public
- Special interest groups
- Trading partners
- Congress
- Other Federal government counterparts
- Agency headquarters personnel

Goals:

1. To provide accurate, timely information to all identified audiences.

2. To proactively inform and involve identified audiences about program activities.

3. To be responsive to inquiries from various audiences about program activities.

4. To create and disseminate informational materials on program activities to increase awareness.

5. To communicate information to all identified audiences about program risks and risk-reducing measures.

Ongoing Communications Actions:

- APHIS conducts an ongoing national educational campaign aimed at increasing awareness about the importance of protecting American agriculture from foreign pests and diseases, such as Medfly. The campaign receives funding annually to support various communications activities, such as developing informational materials, staffing industry shows, and holding press conferences, designed to increase awareness and ultimately prevent agriculture pest and disease outbreaks.

- APHIS will explore forming an information technology response team that will identify personnel and equipment needed to establish effective and timely communication at an emergency project site in the event of an outbreak. The option of using video teleconferencing to better link field program activities to headquarters will be reviewed.

- APHIS continually updates existing informational materials such as fact sheets, photos, pre-written advisory letters, and video footage on potential pests, such as Medfly, so accurate information can be distributed in a timely manner in case an outbreak occurs.

- APHIS continually maintains and updates lists of national and local industry and State representatives, as well as cooperators, so contact can be made quickly to the appropriate people should an outbreak occur.

Actions Occurring Upon Detection of a Fruit Fly Outbreak:

(It should be noted that whether State or federal officials take the primary responsibility for the following actions will depend on circumstances and resources at the time of the outbreak.)

- Establishes immediately an onsite emergency response team with a public affairs contact, who acts as liaison between the program and State information and program officers, industry, the public, media, and other interested parties. Additional project personnel should be identified immediately to assist with public communications efforts.

- Establishes immediately all technology links onsite, including obtaining and setting up equipment, to expedite communication efforts.

- Establishes a phonebank staffed by project personnel to answer inquiries about ongoing program activities and provides general training for those answering phones.

[See the attached appendix for more in-depth information on the subject.]

- Provides local city and government officials and Congressional representatives with pertinent program information and continual updates.

- Issues a joint press release that has been approved by the project leader announcing the area of the outbreak, any actions taken, and the potential impact.

- Updates and distributes informational materials such as fact sheets, radio and television public service announcements, photographs, exhibits, brochures, and feature articles to appropriate audiences in appropriate languages, if needed, to inform them of program activities.

- Sets up an Internet Web page with continually updated information on the progress of the program and any new information or press releases.

- Holds a meeting with major industry/stakeholder groups, including public interest groups and members of the public health community, to inform them of current and planned program activities and potential impacts.

- Establishes immediate, regular briefings (daily at first, then on an as needed basis) where interested stakeholders and the media can obtain current program information.

- Establishes contact with federal and State airport authorities and their public affairs personnel to increase outreach efforts, such as a press conference and amnesty bins, that are aimed at advising those traveling outside the quarantine area not to take agricultural products with them.

- Compiles daily reports on all aspects of program activities that are circulated to internal audiences and used to update media.

- Maintains chronology of program events, documenting all-important activities.

Actions Occurring with the Commencement of Fruit Fly Chemical Treatments:
(These actions will be in addition to the above actions, which will continue to occur.)

- Ensures that notices announcing the publishing of environmental documents, such as an environmental assessment and environmental impact statement, are published prior to any treatment procedures.

- Coordinates with State officials to identify appropriate spokespersons to respond to inquiries about the program from target audiences and reviews handouts for accuracy.

- Obtains a list of chemically sensitive individuals from the appropriate State Health Agency and ensures these individuals are personally notified of program treatment activities a minimum of 24 hours in advance. APHIS maintains this list of individuals and adds any individuals that indicate they should be included.

- Ensures all identified audiences are notified at least 24 hours in advance via various informational tools, such as local access cable channels, normal media outlets, phone calls, or door-to-door visits, of the program's intent to treat a specific area. Specific audiences, such as chemically sensitive individuals, are also given additional information, such as medical information describing expected health effects of the treatment, means to mitigate impact of the treatment, the program hotline number, questions and answers about the program, and information listing risk involved in the treatment.

- Holds a public meeting/gathering for all audiences to proactively explain program activities and give those impacted an opportunity to express concerns or opinions.

- Notifies all local hospitals, public health centers, local veterinarians, schools, day care centers, police, fire agencies, physicians, and other special needs audiences of pesticide treatment schedules and the type of pesticides being used in treatments.

- Provides target audiences with a hotline number or an entity, such as a poison control center, where they can express their health and environmental concerns about the program. These concerns are gathered and provided to identified entities for evaluation of adverse impacts of program activities. Provides assistance to these entities in setting up data-gathering instruments, such as a questionnaire. Solicits weekly evaluations from these entities and uses them to appropriately mitigate potential problems.

- Establishes a network with appropriate local entities to address local health and environmental issues. Provides assistance to these entities in setting up data-gathering instruments, such as a questionnaire.

- If aerial applications are necessary, the project will allow time (minimally 48 hours, optimally up to 10 days) to make necessary public announcements, conduct press conferences, and hold public meetings. The project will work with local public health agencies to establish data-gathering capabilities on possible public health effects within the same time period. Operationally, this time period should allow the project to have the public notices printed and distributed door-to-door, transport the chemical to the operations base, locate an airport that has the necessary facilities and security, and work with the contractor to install the specialized guidance and spray equipment.

Appendix

I. Phone Banks

In a effort to answer basic questions about program activities, a prerecorded message will run on all phone bank "hotline" lines, with callers having the immediate option to speak with a person about various concerns, such as environmental, health, or property damage, or select other options from a system menu. The general message will be time dated so callers will know that the information is current. The "hotline" is staffed by personnel trained to answer questions from the public about treatment schedules and pesticide usage. Written material is provided that anticipates common questions and details the history and protocol of the project as well as the biology of the pest. Specialists, such as a toxicologist/epidemiologist, are identified at the outset and are available during treatment to answer questions throughout the business day and at least

1 hour before treatment begins and several hours after treatment ends. Standardized forms and routing are used to document complaints and threats. The recorded message will take calls after office hours that will be returned the next day. The phone bank will remain operational during the entire period that pesticides are being applied.

Callers are provided with appropriate phone numbers or an entity, such as a poison control center, where they can express their health and environmental concerns about the program. These concerns are gathered and provided to identified entities for evaluation of adverse impacts of program activities. The project solicits weekly evaluations from these entities and uses them to appropriately mitigate potential problems

II. Press Releases

Both national and local project joint press releases will be issued in the event of a fruit fly outbreak. Those to be issued at the national level include the initial detection of a fruit fly outbreak, the declaration of an emergency situation, the initial decision to conduct aerial treatment to combat the outbreak, and the eradication of the outbreak. All other program developments will be publicized in joint press releases distributed locally.

The overall procedure for press releases will be as follows:

1. The project federal or State information officer prepares a daily release detailing the impact of the pest, the mode of treatment, treatment area boundaries, scheduling and duration of treatment, and appropriate referral phone numbers. Information will be verified by the treatment management staff and approved by the project leader.

2. Releases will be distributed to local media, particularly those that cover the treatment area. Foreign language releases will be prepared if a significant portion of the resident population in the treatment area does not speak English.

3. In each release, a media contact is named with a phone number. This person supplies the press with regular progress reports or information on significant developments.

4. Daily press briefings will be held and local interviews, stock footage, photos, graphics, and other special requests generated by the press release will be filled by the information officer.

III. Media Contact

Creating a rapport with local media results in accurate coverage of a program. To avoid conflicting and confusing statements, all outgoing information should be processed through a central clearinghouse or designated spokespersons from either the county, federal, or State government. The spokesperson’s job is to be thoroughly briefed and current on particular aspects of the program, such as treatment, regulatory activities, or public health issues. Specialists, such as a toxicologist/epidemiologist, are identified at the outset and are available to answer questions throughout the program. All program personnel should refer questions to these spokespersons.

IV. Information Collection and Reporting

Project leaders will initiate timely daily staff meetings in order to provide accurate and current information for daily project reports that are disseminated throughout internal audiences and are used to brief the media. An administrative officer is identified at the outset to gather and coordinate program information into the daily report of activities by 9:00 a.m. each day and write/update the project chronology. These reports summarize the previous day's activities as well as progress made in various program areas. Topics include: trapping, regulatory activities, entomology, treatment, environmental monitoring, public health issues, and media. Information gleaned from reports is used to keep impacted trading partners and other stakeholders apprised of program activities.

V. Notification

The purpose of notification is to comply with federal and/or State law and present accurate information in an understandable and nonthreatening format to all concerned groups. Local and State elected representatives of the residents in the treatment area will be notified and apprised of major developments before and during treatment. Any resident whose property will be treated with foliar sprays or soil drenches will be notified 24 hours in advance.

Treatment notices include the name of the pest to be eradicated, the material to be used, the boundaries and a phone number to call in case of additional questions on project operations, and the numbers of local health/environmental entities. Following treatment, a completion notice is left detailing any precautions the homeowner should take, including harvest intervals on treated fruit. Treatment without prior notification may be necessary on a small number of properties if active larvae are detected. However, reasonable efforts will be made to contact the homeowner.

Notification of aerial treatment will be given in compliance with State law or at least 24 hours before the first pesticide application begins, whichever is greater. Notification can occur by various information tools, such as mass mailing or door-to-door contact.

VI. Public Meetings/Gatherings

Public meetings/gatherings need to be scheduled prior to the target date for treatment. Door-to-door or direct mail notification of affected residences prior to the meeting is preferable to notices published in local papers. Prior to a meeting, any special political, social, economic, and environmental concerns of the community should be identified in order to select a suitable panel. A suggested formula for a panel is:

1. A moderator who can ensure orderly conduct of the meeting and direct questions to appropriate persons for answers.

2. Representatives from the local government office who are familiar with local concerns.

3. A representative from the project who can answer specific questions about the biology of the pest, the detection history, quarantine restrictions, proposed treatment, and its impact.

4. Specific area experts, especially from public health, toxicology, environmental hazards assessment, fish and game, water resources, and private industry.

Issues that usually surface at meetings are pesticide usage (toxicity, drift, and persistence); alternatives to pesticides; human health and environmental concerns; public water supply contamination; hazards to bees and wildlife; damage to homes, cars, and crops; hazards to pets and livestock; and organic farming concerns. The panel should be prepared to effectively address these concerns.

Meeting sites should be centrally located and have accommodations for physically challenged, translations, adequate parking, seating, electrical outlets, lighting, ventilation, and audio equipment. A suggested procedural format begins with the moderator's statement of purpose and announcement of the time allotment (2 to 3 hours) followed by short presentations by each panel member addressing obvious questions. Members of the public are then allotted 5 minutes to express their concerns or ask questions. The ability of the moderator to restrict outbursts is critical.

All concerns expressed at the meeting will be thoroughly evaluated and the project will respond appropriately, such as by publishing an editorial in local papers, airing a commentary piece on local television, or issuing a press release. Another possible follow-through to a public meeting is to have spokespersons from small groups with specific concerns meet again with the project management to discuss those concerns. Meetings with community leaders may also foster cooperation with the project.

Another option to holding a public meeting is to hold more of an informal gathering where the Federal and State officials proactively inform audiences about program activities, such as treatment, trapping, regulatory, environmental monitoring, animal health, and human health. The gathering should also have a place where audiences can express and register their complaints and concerns, whether verbally or in writing, about all aspects of the program.

VII. Complaints & Concerns

The project should immediately identify appropriate county and State agencies and entities that will address complaints with regard to the project, such as environmental and health concerns and property damage. All identified audiences will be provided with phone numbers of these agencies and entities so they can express their concerns appropriately. The project is responsible for obtaining weekly reports from these entities, evaluating the data, and taking appropriate action to mitigate program activities, if necessary. They will also provide these entities with any needed tool for gathering information that will be useful for evaluating program effects.

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Appendix D. Endangered and Threatened Species

(Listed Species As of September 1, 2000)
(Proposed Species As of September 1, 2000)

APHIS is consulting in advance with the U.S. Fish and Wildlife Service (FWS) on endangered and threatened species (E&T species) and their habitats that may be present in the four States which are considered to be most at risk of fruit fly invasion: California, Florida, Texas, and Washington. This appendix provides the current list of E&T species (and proposed E&T species in those States). APHIS will consult with FWS should an outbreak occur in any of the low risk States, before any program is implemented.

State	Common Name	Scientific Name	Federal Status
California	Albatross, short-tailed	*Phoebastria albatrus*	Endangered
	Beetle, Delta green ground	*Elaphrus viridis*	Threatened
	Beetle, Mount Hermon June	*Polyphylla barbata*	Endangered
	Beetle, Ohlone tiger	*Cicindela ohlone*	Proposed Endangered
	Beetle, valley elderberry longhorn	*Desmocerus californicus dimorphus*	Threatened
	Butterfly, bay checkerspot	*Euphydryas editha bayensis*	Threatened
	Butterfly, Behren's silverspot	*Speyeria zerene behrensii*	Endangered
	Butterfly, callippe silverspot	*Speyeria callippe callippe*	Endangered
	Butterfly, El Segundo blue	*Euphilotes battoides allyni*	Endangered
	Butterfly, Lange's metalmark	*Apodemia mormo langei*	Endangered
	Butterfly, lotis blue	*Lycaeides argyrognomon lotis*	Endangered
	Butterfly, mission blue	*Icaricia icarioides missionensis*	Endangered
	Butterfly, Myrtle's silverspot	*Speyeria zerene myrtleae*	Endangered
	Butterfly, Oregon silverspot	*Speyeria zerene hippolyta*	Threatened
	Butterfly, Palos Verdes blue	*Glaucopsyche lygdamus palosverdesensis*	Endangered
	Butterfly, Quino checkerspot	*Euphydryas editha quino*	Endangered
	Butterfly, San Bruno elfin	*Callophrys mossii bayensis*	Endangered
	Butterfly, Smith's blue	*Euphilotes enoptes smithi*	Endangered
	Chub, bonytail	*Gila elegans*	Endangered
	Chub, Cowhead Lake tui	*Gila bicolor vaccaceps*	Proposed Endangered
	Chub, Mohave tui	*Gila bicolor mohavensis*	Endangered
	Chub, Owens tui	*Gila bicolor snyderi*	Endangered
	Condor, California	*Gymnogyps californianus*	Endangered
	Crayfish, Shasta (=placid)	*Pacifastacus fortis*	Endangered
	Eagle, bald	*Haliaeetus leucocephalus*	Threatened

Appendix D, continued.

State	Common Name	Scientific Name	Federal Status
	Fairy shrimp, Conservancy	*Branchinecta conservatio*	Endangered
	Fairy shrimp, longhorn	*Branchinecta longiantenna*	Endangered
	Fairy shrimp, Riverside	*Streptocephalus woottoni*	Endangered
	Fairy shrimp, vernal pool	*Branchinecta lynchi*	Threatened
	Fairy shrimp, San Diego	*Branchinecta sandiegonensis*	Endangered
	Fly, Delhi Sands flower-loving	*Rhaphiomidas terminatus abdominalis*	Endangered
	Flycatcher, Southwestern willow	*Empidonax traillii extimus*	Endangered
	Fox, San Joaquin kit	*Vulpes macrotis mutica*	Endangered
	Frog , California red-legged	*Rana aurora draytonii*	Threatened
	Frog, mountain yellow-legged	*Rana muscosa*	Proposed Endangered
	Gnatcatcher, coastal California	*Polioptila californica californica*	Threatened
	Goby, tidewater	*Eucyclogobius newberryi*	Endangered
	Goose, Aleutian Canada	*Branta canadensis leucopareia*	Threatened
	Grasshopper, Zayante band-winged	*Trimerotropis infantilis*	Endangered
	Jaguar	*Panthera onca*	Endangered
	Kangaroo rat, Fresno	*Dipodomys nitratoides exilis*	Endangered
	Kangaroo rat, giant	*Dipodomys ingens*	Endangered
	Kangaroo rat, Morro Bay	*Dipodomys heermanni morroensis*	Endangered
	Kangaroo rat, San Bernardino	*Dipodomys merriami parvus*	Endangered
	Kangaroo rat, Stephens'	*Dipodomys stephensi* (incl. *D. cascus*)	Endangered
	Kangaroo rat, Tipton	*Dipodomys nitratoides nitratoides*	Endangered
	Lizard, blunt-nosed leopard	*Gambelia silus*	Endangered
	Lizard, Coachella Valley fringe-toed	*Uma inornata*	Threatened
	Lizard, Island night	*Xantusia riversiana*	Threatened
	Moth, Kern primrose sphinx	*Euproserpinus euterpe*	Threatened
	Mountain beaver, Point Arena	*Aplodontia rufa nigra*	Endangered
	Mouse, Pacific pocket	*Perognathus longimembris pacificus*	Endangered
	Mouse, salt marsh harvest	*Reithrodontomys raviventris*	Endangered
	Murrelet, marbled	*Brachyramphus marmoratus marmoratus*	Threatened
	Otter, southern sea	*Enhydra lutris nereis*	Threatened
	Owl, northern spotted	*Strix occidentalis caurina*	Threatened
	Pelican, brown	*Pelecanus occidentalis*	Endangered

Appendix D, continued.

State	Common Name	Scientific Name	Federal Status
	Plover, mountain	*Charadrius montanus*	Proposed Threatened
	Plover, western snowy	*Charadrius alexandrinus nivosus*	Threatened
	Pupfish, desert	*Cyprinodon macularius*	Endangered
	Pupfish, Owens	*Cyprinodon radiosus*	Endangered
	Rabbit, riparian brush	*Sylvilagus bachmani riparius*	Endangered
	Rail, California clapper	*Rallus longirostris obsoletus*	Endangered
	Rail, light-footed clapper	*Rallus longirostris levipes*	Endangered
	Rail, Yuma clapper	*Rallus longirostris yumanensis*	Endangered
	Salamander, California tiger	*Ambystoma californiense*	Endangered
	Salamander, desert slender	*Batrachoseps aridus*	Endangered
	Salamander, Santa Cruz long-toed	*Ambystoma macrodactylum croceum*	Endangered
	Salmon, chinook	*Oncorhynchus (=Salmo) tshawytscha*	Endangered
	Salmon, coho	*Oncorhynchus (=Salmo) kisutch*	Threatened
	Seal, Guadalupe fur	*Arctocephalus townsendi*	Threatened
	Sea-lion, Steller (=northern)	*Eumetopias jubatus*	Endangered
	Sheep, bighorn (Peninsular Ranges pop.)	*Ovis canadensis*	Endangered
	Shrew, Buena Vista Lake ornate	*Sorex ornatus relictus*	Proposed Endangered
	Shrike, San Clemente loggerhead	*Lanius ludovicianus mearnsi*	Endangered
	Shrimp, California freshwater	*Syncaris pacifica*	Endangered
	Skipper, Laguna Mountains	*Pyrgus ruralis lagunae*	Endangered
	Smelt, delta	*Hypomesus transpacificus*	Threatened
	Snail, Morro shoulderband (=banded dune)	*Helminthoglypta walkeriana*	Endangered
	Snake, giant garter	*Thamnophis gigas*	Threatened
	Snake, San Francisco garter	*Thamnophis sirtalis tetrataenia*	Endangered
	Sparrow, San Clemente sage	*Amphispiza belli clementeae*	Threatened
	Splittail, Sacramento	*Pogonichthys macrolepidotus*	Threatened
	Squawfish, Colorado	*Ptychocheilus lucius*	Endangered
	Steelhead	*Oncorhynchus mykiss*	Endangered & Threatened
	Stickleback, unarmored threespine	*Gasterosteus aculeatus williamsoni*	Endangered
	Sucker, Lost River	*Deltistes luxatus*	Endangered
	Sucker, Modoc	*Catostomus microps*	Endangered
	Sucker, razorback	*Xyrauchen texanus*	Endangered

Appendix D, continued.

State	Common Name	Scientific Name	Federal Status
	Sucker, Santa Ana	*Catostomaus, santaanoe*	Threatened
	Sucker, shortnose	*Chasmistes brevirostris*	Endangered
	Tadpole shrimp, vernal pool	*Lepidurus packardi*	Endangered
	Tern, California least	*Sterna antillarum browni*	Endangered
	Toad, arroyo	*Bufo microscaphus californicus*	Endangered
	Tortoise, desert	*Gopherus agassizii*	Threatened
	Towhee, Inyo California (=brown)	*Pipilo crissalis eremophilus*	Threatened
	Trout, bull (Columbia R. pop.)	*Salvelinus confluentus*	Proposed Threatened
	Trout, bull (Klamath R. pop.)	*Salvelinus confluentus*	Proposed Endangered
	Trout, Lahontan cutthroat	*Oncorhynchus (=Salmo) clarki henshawi*	Threatened
	Trout, Little Kern golden	*Oncorhynchus (=Salmo) aguabonita whitei*	Threatened
	Trout, Paiute cutthroat	*Oncorhynchus (=Salmo) clarki seleniris*	Threatened
	Vireo, least Bell's	*Vireo bellii pusillus*	Endangered
	Vole, Amargosa	*Microtus californicus scirpensis*	Endangered
	Whipsnake (=striped racer), Alameda	*Masticophis lateralis euryxanthus*	Threatened
	Woodrat, riparian (= San Joaquin Valley)	*Neotoma fuscipes riparia*	Endangered
	San Diego thornmint	*Acanthomintha ilicifolia*	Threatened
	San Mateo thornmint	*Acanthomintha obovata* ssp. *duttonii*	Endangered
	Munz's onion	*Allium munzii*	Endangered
	Sonoma alopecurus	*Alopecurus aequalis* var. *sonomensis*	Endangered
	Ambrosia, San Diego	*Ambrosia pumila*	Proposed Endangered
	Large-flowered fiddleneck	*Amsinckia grandiflora*	Endangered
	Hoffmann's rock-cress	*Arabis hoffmannii*	Endangered
	McDonald's rock-cress	*Arabis mcdonaldiana*	Endangered
	Bear Valley sandwort	*Arenaria ursina*	Proposed Threatened
	Santa Rosa Island manzanita	*Arctostaphylos confertiflora*	Endangered
	Ione manzanita	*Arctostaphylos myrtifolia*	Threatened
	Presidio (=Raven's) manzanita	*Arctostaphylos hookeri* (=pungens) var. *ravenii*	Endangered
	Morro manzanita	*Arctostaphylos morroensis*	Threatened
	Pallid manzanita	*Arctostaphylos pallida*	Threatened

Appendix D, continued.

State	Common Name	Scientific Name	Federal Status
	Marsh sandwort	*Arenaria paludicola*	Endangered
	Bear Valley sandwort	*Arenaria ursina*	Threatened
	Cushenbury milk-vetch	*Astragalus albens*	Endangered
	Braunton's milk-vetch	*Astragalus brauntonii*	Endangered
	Clara Hunt's milk-vetch	*Astragalus clarianus*	Endangered
	Lane Mountain (=Coolgardie) milk-vetch	*Astragalus jaegerianus*	Endangered
	Coachella Valley milk-vetch	*Astragalus lentiginosus* var. *coachellae*	Endangered
	Shining (=shiny) milk-vetch	*Astragalus lentiginosus* var. *micans*	Proposed Threatened
	Fish Slough milk-vetch	*Astragalus lentiginosus* var. *piscinensis*	Threatened
	Sodaville milk-vetch	*Astragalus lentiginosus* var. *sesquimetralis*	Proposed Threatened
	Peirson's milk-vetch	*Astragalus magdalenae* var. *peirsonii*	Threatened
	Mlk-vetch, Ventura Marsh	*Astragalus pycnostachyus lanosissimus*	Proposed Endangered
	Coastal dunes milk-vetch	*Astragalus tener* var. *titi*	Endangered
	Triple-ribbed milk-vetch	*Astragalus tricarinatus*	Endangered
	San Jacinto Valley crownscale (=saltbush)	*Atriplex coronata* var. *notatior*	Endangered
	Encinitis baccharis (=Coyote bush)	*Baccharis vanessae*	Threatened
	Nevin's barberry	*Berberis nevinii*	Endangered
	Island barberry	*Berberis pinnata* ssp. *insularis*	Endangered
	Truckee barberry	*Berberis sonnei*	Endangered
	Sonoma sunshine (=Baker's stickyseed)	*Blennosperma bakeri*	Endangered
	Thread-leaved brodiaea	*Brodiaea filifolia*	Threatened
	Chinese Camp brodiaea	*Brodiaea pallida*	Threatened
	Tiburon mariposa lily	*Calochortus tiburonensis*	Threatened
	Mariposa pussypaws	*Calyptridium pulchellum*	Threatened
	Stebbins' morning-glory	*Calystegia stebbinsii*	Endangered
	San Benito evening-primrose	*Camissonia benitensis*	Threatened
	White sedge	*Carex albida*	Endangered
	Tiburon paintbrush	*Castilleja affinis* ssp. *neglecta*	Endangered
	Fleshy owl's-clover	*Castilleja campestris* ssp. *succulenta*	Threatened
	Ash-gray Indian paintbrush	*Castilleja cinerea*	Threatened

Appendix D, continued.

State	Common Name	Scientific Name	Federal Status
	San Clemente Island Indian paintbrush	*Castilleja grisea*	Endangered
	Soft-leaved paintbrush	*Castilleja mollis*	Endangered
	California jewelflower	*Caulanthus californicus*	Endangered
	Coyote ceanothus (=Coyote Valley California-lilac)	*Ceanothus ferrisae*	Endangered
	Vail Lake ceanothus	*Ceanothus ophiochilus*	Threatened
	Pine Hill ceanothus	*Ceanothus roderickii*	Endangered
	Spring-loving centaury	*Centaurium namophilum*	Threatened
	Catalina Island mountain-mahogany	*Cercocarpus traskiae*	Endangered
	Hoover's spurge	*Chamaesyce hooveri*	Threatened
	Purple amole	*Chlorogalum purpureum* var. *purpureum*	Threatened
	Howell's spineflower	*Chorizanthe howellii*	Endangered
	Orcutt's spineflower	*Chorizanthe orcuttiana*	Endangered
	Ben Lomond spineflower	*Chorizanthe pungens* var. *hartwegiana*	Endangered
	Monterey spineflower	*Chorizanthe pungens* var. *pungens*	Threatened
	Robust spineflower (includes Scotts Valley spineflower)	*Chorizanthe robusta*	Endangered
	Sonoma spineflower	*Chorizanthe valida*	Endangered
	Chorro Creek bog thistle	*Cirsium fontinale obispoense*	Endangered
	Fountain thistle	*Cirsium fontinale* var. *fontinale*	Endangered
	Suisun thistle	*Cirsium hydrophilum* var. *hydrophilum*	Endangered
	La Graciosa thistle	*Cirsium loncholepis*	Endangered
	Presidio clarkia	*Clarkia franciscana*	Endangered
	Vine Hill clarkia	*Clarkia imbricata*	Endangered
	Pismo clarkia	*Clarkia speciosa* ssp. *immaculata*	Endangered
	Springville clarkia	*Clarkia springvillensis*	Threatened
	Salt marsh bird's-beak	*Cordylanthus maritimus* ssp. *maritimus*	Endangered
	Palmate-bracted bird's-beak	*Cordylanthus palmatus*	Endangered
	Pennell's bird's-beak	*Cordylanthus tenuis* ssp. *capillaris*	Endangered
	Soft bird's-beak	*Cordylanthus mollis* ssp. *mollis*	Endangered
	Santa Cruz cypress	*Cupressus abramsiana*	Endangered
	Gowen cypress	*Cupressus goveniana* ssp. *goveniana*	Threatened
	Baker's larkspur	*Delphinium bakeri*	Endangered
	Yellow larkspur	*Delphinium luteum*	Endangered

Appendix D, continued.

State	Common Name	Scientific Name	Federal Status
	San Clemente Island larkspur	*Delphinium variegatum* ssp. *kinkiense*	Endangered
	Slender-horned spineflower	*Dodecahema leptoceras*	Endangered
	Conejo dudleya	*Dudleya abramsii* ssp. *parva*	Threatened
	Marcescent dudleya	*Dudleya cymosa* ssp. *marcescens*	Threatened
	Santa Monica Mountains dudleya	*Dudleya cymosa* ssp. *ovatifolia*	Threatened
	Santa Cruz Island dudleya	*Dudleya nesiotica*	Threatened
	Santa Clara Valley dudleya	*Dudleya setchellii*	Endangered
	Laguna Beach liveforever	*Dudleya stolonifera*	Threatened
	Santa Barbara Island liveforever	*Dudleya traskiae*	Endangered
	Verity's dudleya	*Dudleya verityi*	Threatened
	Kern mallow	*Eremalche kernensis*	Endangered
	Santa Ana River woolly-star	*Eriastrum densifolium* ssp. *sanctorum*	Endangered
	Hoover's woolly-star	*Eriastrum hooveri*	Threatened
	Parish's daisy	*Erigeron parishii*	Threatened
	Indian Knob mountain balm	*Eriodictyon altissimum*	Endangered
	Ione (=Irish Hill) buckwheat	*Eriogonum apricum* (incl. vars. *apricum, prostratum)*	Endangered
	Lompoc yerba santa	*Eriodictyon capitatum*	Endangered
	Southern mountain wild buckwheat	*Eriogonum kennedyi* var. *austromontanum*	Threatened
	Cushenbury buckwheat	*Eriogonum ovalifolium* var. *vineum*	Endangered
	San Mateo woolly sunflower	*Eriophyllum latilobum*	Endangered
	San Diego button-celery	*Eryngium aristulatum* var. *parishii*	Endangered
	Loch Lomond coyote-thistle	*Eryngium constancei*	Endangered
	Contra Costa wallflower	*Erysimum capitatum* var. *angustatum*	Endangered
	Menzies' wallflower	*Erysimum menziesii*	Endangered
	Ben Lomond wallflower	*Erysimum teretifolium*	Endangered
	Pine Hill flannelbush	*Fremontodendron californicum* ssp. *decumbens*	Endangered
	Mexican flannelbush	*Fremontodendron mexicanum*	Endangered
	Island bedstraw	*Galium buxifolium*	Endangered
	El Dorado bedstraw	*Galium californicum* ssp. *sierrae*	Endangered
	Monterey gilia	*Gilia tenuiflora* ssp. *arenaria*	Endangered
	Hoffmann's slender-flowered gilia	*Gilia tenuiflora* ssp. *hoffmannii*	Endangered

Appendix D, continued.

State	Common Name	Scientific Name	Federal Status
	Ash Meadows gumplant	*Grindelia fraxino-pratensis*	Threatened
	Island rush-rose	*Helianthemum greenei*	Threatened
	Otay tarplant	*Hemizonia conjugens*	Threatened
	Gaviota tarplant	*Hemizonia increscens* ssp. *villosa*	Endangered
	Marin dwarf-flax	*Hesperolinon congestum*	Threatened
	Santa Cruz tarplant	*Holocarpha macradenia*	Threatened
	Water howellia	*Howellia aquatilis*	Threatened
	Burke's goldfields	*Lasthenia burkei*	Endangered
	Contra Costa goldfields	*Lasthenia conjugens*	Endangered
	Beach layia	*Layia carnosa*	Endangered
	San Joaquin wooly-threads	*Lembertia congdonii*	Endangered
	San Bernardino Mountains bladderpod	*Lesquerella kingii* ssp. *bernardina*	Endangered
	San Francisco lessingia	*Lessingia germanorum (=L. g.* var. *germanorum*)	Endangered
	Western lily	*Lilium occidental*	Endangered
	Pitkin Marsh lily	*Lilium pardalinum* ssp. *pitkinense*	Endangered
	Butte County meadowfoam	*Limnanthes floccosa* ssp. *californica*	Endangered
	Sebastopol meadowfoam	*Limnanthes vinculans*	Endangered
	San Clemente Island woodland-star	*Lithophragma maximum*	Endangered
	San Clemente Island broom	*Lotus dendroideus* ssp. *traskiae*	Endangered
	Nipomo Mesa lupine	*Lupinus nipomensis*	Endangered
	Clover lupine	*Lupinus tidestromii*	Endangered
	San Clemente Island bush-mallow	*Malacothamnus clementinus*	Endangered
	Santa Cruz Island bush-mallow	*Malacothamnus fasciculatus* var. *nesioticus*	Endangered
	Santa Cruz Island malocothrix	*Malacothrix indecora*	Endangered
	Island malacothrix	*Malacothrix squalida*	Endangered
	Willowy monardella	*Monardella linoides* ssp. *viminea*	Endangered
	Navarretia, spreading (=prostrate)	*Navarretia fossalis*	Threatened
	Navarretia, few-flowered	*Navarretia leucocephala* ssp. *pauciflora (=N. pauciflora)*	Endangered
	Navarretia, many-flowered	*Navarretia leucocephala* ssp. *plieantha*	Endangered
	Colusa grass	*Neostapfia colusana*	Threatened
	Amargosa niterwort	*Nitrophila mohavensis*	Endangered

Appendix D, continued.

State	Common Name	Scientific Name	Federal Status
	Dehesa bear-grass	*Nolina interrata*	Proposed Threatened
	Eureka Valley evening-primrose	*Oenothera avita* ssp. *eurekensis*	Endangered
	Antioch Dunes evening-primrose	*Oenothera deltoides* ssp. *howellii*	Endangered
	Bakersfield cactus	*Opuntia treleasei*	Endangered
	California Orcutt grass	*Orcuttia californica*	Endangered
	San Joaquin Valley orcutt grass	*Orcuttia inaequalis*	Threatened
	Hairy orcutt grass	*Orcuttia pilosa*	Endangered
	Slender orcutt grass	*Orcuttia tenuis*	Threatened
	Sacramento orcutt grass	*Orcuttia viscida*	Endangered
	Cushenbury oxytheca	*Oxytheca parishii* var. *goodmaniana*	Endangered
	Lake County stonecrop	*Parvisedum leiocarpum*	Endangered
	White-rayed pentachaeta	*Pentachaeta bellidiflora*	Endangered
	Lyon's pentachaeta	*Pentachaeta lyonii*	Endangered
	Island phacelia	*Phacelia insularis* ssp. *insularis*	Endangered
	Yreka phlox	*Phlox hirsuta*	Endangered
	Yadon's piperia	*Piperia yadonii*	Endangered
	Calistoga allocarya	*Plagiobothrys strictus*	Endangered
	San Bernardino bluegrass	*Poa atropurpurea*	Endangered
	Napa bluegrass	*Poa napensis*	Endangered
	San Diego mesa mint	*Pogogyne abramsii*	Endangered
	Otay mesa mint	*Pogogyne nudiuscula*	Endangered
	Hickman's potentilla	*Potentilla hickmanii*	Endangered
	Hartweg's golden sunburst	*Pseudobahia bahiifolia*	Endangered
	San Joaquin adobe sunburst	*Pseudobahia peirsonii*	Threatened
	Gambel's watercress	*Rorippa gambellii*	Endangered
	Layne's butterweed	*Senecio layneae*	Threatened
	Santa Cruz Island rockcress	*Sibara filifolia*	Endangered
	Keck's checkermallow	*Sidalcea keckii*	Endangered
	Kenwood Marsh checker-mallow	*Sidalcea oregana* ssp. *valida*	Endangered
	Pedate checker-mallow	*Sidalcea pedata*	Endangered
	Metcalf Canyon jewelflower	*Streptanthus albidus* ssp. *albidus*	Endangered
	Tiburon jewelflower	*Streptanthus niger*	Endangered
	California seablite	*Suaeda californica*	Endangered
	Eureka Dune grass	*Swallenia alexandrae*	Endangered
	California taraxacum	*Taraxacum californicum*	Endangered
	Slender-petaled mustard	*Thelypodium stenopetalum*	Endangered

Appendix D, continued.

State	Common Name	Scientific Name	Federal Status
	Kneeland Prairie penny-cress	*Thlaspi californicum*	Endangered
	Santa Cruz Island fringepod (lacepod)	*Thysanocarpus conchuliferus*	Endangered
	Hidden Lake bluecurls	*Trichostema austromontanum* ssp. *compactum*	Threatened
	Showy Indian clover	*Trifolium amoenum*	Endangered
	Monterey clover	*Trifolium trichocalyx*	Endangered
	Greene's tuctoria	*Tuctoria greenei*	Endangered
	Solano grass	*Tuctoria mucronata*	Endangered
	Red Hills vervain	*Verbena californica*	Threatened
	Big-leaved crownbeard	*Verbesina dissita*	Threatened
Florida	Bankclimber (mussel), purple	*Elliptoideus sloatianus*	Threatened
	Bat, gray	*Myotis grisescens*	Endangered
	Butterfly, Schaus swallowtail	*Heraclides (=Papilio) aristodemus ponceanus*	Endangered
	Caracara, Audubon's crested	*Polyborus plancus audubonii*	Threatened
	Crocodile, American	*Crocodylus acutus*	Endangered
	Darter, Okaloosa	*Etheostoma okaloosae*	Endangered
	Deer, key	*Odocoileus virginianus clavium*	Endangered
	Eagle, bald	*Haliaeetus leucocephalus*	Threatened
	Falcon, American peregrine	*Falco peregrinus anatum*	Endangered
	Scrub-jay, Florida	*Aphelocoma coerulescens*	Threatened
	Kite, Everglade snail	*Rostrhamus sociabilis plumbeus*	Endangered
	Manatee, West Indian	*Trichechus manatus*	Endangered
	Moccasinshell, Gulf	*Medionidus penicillatus*	Endangered
	Moccasinshell, Ochlockonee	*Medionidus simpsonianus*	Endangered
	Mouse, Anastasia Island beach	*Peromyscus polionotus phasma*	Endangered
	Mouse, Choctawhatchee beach	*Peromyscus polionotus allophrys*	Endangered
	Mouse, Key Largo cotton	*Peromyscus gossypinus allapaticola*	Endangered
	Mouse, Perdido Key beach	*Peromyscus polionotus trissyllepsis*	Endangered
	Mouse, southeastern beach	*Peromyscus polionotus niveiventris*	Threatened
	Mouse, St. Andrew beach	*Peromyscus polionotus peninsularis*	Endangered
	Panther, Florida	*Felis concolor coryi*	Endangered
	Pigtoe, oval	*Pleurobema pyriforme*	Endangered
	Pocketbook, shinyrayed	*Lampsilis subangulata*	Endangered
	Plover, piping	*Charadrius melodus*	Threatened
	Rabbit, Lower Keys	*Sylvilagus palustris hefneri*	Endangered

Appendix D, continued.

State	Common Name	Scientific Name	Federal Status
	Rice rat, silver	*Oryzomys palustris natator*	Endangered
	Salamander, flatwoods	*Ambystoma cingulatum*	Threatened
	Shrimp, Squirrel Chimney Cave (=Florida cave)	*Palaemonetes cummingi*	Threatened
	Skink, bluetail mole	*Eumeces egregius lividus*	Threatened
	Skink, sand	*Neoseps reynoldsi*	Threatened
	Slabshell, Chipola	*Elliptio chipolaensis*	Threatened
	Snail, Stock Island tree	*Orthalicus reses* (not incl. *nesodryas*)	Threatened
	Snake, Atlantic salt marsh	*Nerodia clarkii taeniata*	Threatened
	Snake, eastern indigo	*Drymarchon corais couperi*	Threatened
	Sparrow, Cape Sable seaside	*Ammodramus maritimus mirabilis*	Endangered
	Sparrow, Florida grasshopper	*Ammodramus savannarum floridanus*	Endangered
	Stork, wood	*Mycteria americana*	Endangered
	Sturgeon, Gulf	*Acipenser oxyrinchus desotoi*	Threatened
	Tern, roseate	*Sterna dougallii dougallii*	Threatened
	Threeridge, fat	*Amblema neislerii*	Endangered
	Turtle, green sea	*Chelonia mydas*	Endangered & Threatened
	Turtle, hawksbill sea	*Eretmochelys imbricata*	Endangered
	Turtle, leatherback sea	*Dermochelys coriacea*	Endangered
	Turtle, loggerhead sea	*Caretta caretta*	Threatened
	Vole, Florida salt marsh	*Microtus pennsylvanicus dukecampbelli*	Endangered
	Woodpecker, red-cockaded	*Picoides (=Dendrocopos) borealis*	Endangered
	Woodrat, Key Largo	*Neotoma floridana smalli*	Endangered
	Crenulate lead-plant	*Amorpha crenulata*	Endangered
	Four-petal pawpaw	*Asimina tetramera*	Endangered
	Florida bonamia	*Bonamia grandiflora*	Threatened
	Brooksville (=Robins') bellflower	*Campanula robinsiae*	Endangered
	Fragrant prickly-apple	*Cereus eriophorus* var. *fragrans*	Endangered
	Deltoid spurge	*Chamaesyce deltoidea* ssp. *deltoidea*	Endangered
	Garber's spurge	*Chamaesyce garberi*	Threatened
	Pygmy fringe-tree	*Chionanthus pygmaeus*	Endangered
	Florida golden aster	*Chrysopsis floridana*	Endangered
	Florida perforate cladonia	*Cladonia perforata*	Threatened
	Pigeon wings	*Clitoria fragrans*	Threatened

Appendix D, continued.

State	Common Name	Scientific Name	Federal Status
	Short-leaved rosemary	*Conradina brevifolia*	Endangered
	Etonia rosemary	*Conradina etonia*	Endangered
	Apalachicola rosemary	*Conradina glabra*	Endangered
	Avon Park harebells	*Crotalaria avonensis*	Endangered
	Okeechobee gourd	*Cucurbita okeechobeensis* ssp. *okeechobeensis*	Endangered
	Beautiful pawpaw	*Deeringothamnus pulchellus*	Endangered
	Rugel's pawpaw	*Deeringothamnus rugelii*	Endangered
	Garrett's mint	*Dicerandra christmanii*	Endangered
	Longspurred mint	*Dicerandra cornutissima*	Endangered
	Scrub mint	*Dicerandra frutescens*	Endangered
	Lakela's mint	*Dicerandra immaculata*	Endangered
	Scrub buckwheat	*Eriogonum longifolium* var. *gnaphalifolium*	Threatened
	Snakeroot	*Eryngium cuneifolium*	Endangered
	Telephus spurge	*Euphorbia telephioides*	Threatened
	Small's milkpea	*Galactia smallii*	Endangered
	Johnson’s seagrass	*Halophila johnsonii*	Threatened
	Harper's beauty	*Harperocallis flava*	Endangered
	Highlands scrub hypericum	*Hypericum cumulicola*	Endangered
	Beach jacquemontia	*Jacquemontia reclinata*	Endangered
	Cooley's water-willow	*Justicia cooleyi*	Endangered
	Scrub blazingstar	*Liatris ohlingerae*	Endangered
	Pondberry	*Lindera melissifolia*	Endangered
	Scrub lupine	*Lupinus aridorum*	Endangered
	White birds-in-a-nest	*Macbridea alba*	Threatened
	Britton's beargrass	*Nolina brittoniana*	Endangered
	Papery whitlow-wort	*Paronychia chartacea*	Threatened
	Key tree-cactus	*Pilosocereus robinii (=Cereus r.)*	Endangered
	Godfrey's butterwort	*Pinguicula ionantha*	Threatened
	Lewton's polygala	*Polygala lewtonii*	Endangered
	Tiny polygala	*Polygala smallii*	Endangered
	Wireweed	*Polygonella basiramia*	Endangered
	Sandlace	*Polygonella myriophylla*	Endangered
	Scrub plum	*Prunus geniculata*	Endangered
	Chapman rhododendron	*Rhododendron chapmanii*	Endangered

Appendix D, continued.

State	Common Name	Scientific Name	Federal Status
	Miccosukee gooseberry	*Ribes echinellum*	Threatened
	American chaffseed	*Schwalbea americana*	Endangered
	Florida skullcap	*Scutellaria floridana*	Threatened
	Fringed campion	*Silene polypetala*	Endangered
	Gentian pinkroot	*Spigelia gentianoides*	Endangered
	Cooley's meadowrue	*Thalictrum cooleyi*	Endangered
	Florida torreya	*Torreya taxifolia*	Endangered
	Wide-leaf warea	*Warea amplexifolia*	Endangered
	Carter's mustard	*Warea carteri*	Endangered
	Florida ziziphus	*Ziziphus celata*	Endangered
Texas	Amphipod, Peck's cave	*Stygobromus (=Stygonectes) pecki*	Endangered
	Bat, Mexican long-nosed	*Leptonycteris nivalis*	Endangered
	Bear, Louisiana black	*Ursus americanus luteolus*	Threatened
	Beetle, Coffin Cave mold	*Batrisodes texanus*	Endangered
	Beetle, Comal Springs riffle	*Heterelmis comalensis*	Endangered
	Beetle, Comal Springs dryopid	*Stygoparnus comalensis*	Endangered
	Beetle, ground (unnamed)	*Rhadine exilis*	Endangered
	Beetle, ground (unnamed)	*Rhadine infernalis*	Endangered
	Beetle, Helotes mold	*Batrisodes venyivi*	Endangered
	Beetle, Kretschmarr Cave mold	*Texamaurops reddelli*	Endangered
	Beetle, Tooth Cave ground	*Rhadine persephone*	Endangered
	Crane, whooping	*Grus americana*	Endangered
	Curlew, Eskimo	*Numenius borealis*	Endangered
	Darter, fountain	*Etheostoma fonticola*	Endangered
	Eagle, bald	*Haliaeetus leucocephalus*	Threatened
	Falcon, American peregrine	*Falco peregrinus anatum*	Endangered
	Falcon, northern aplomado	*Falco femoralis septentrionalis*	Endangered
	Flycatcher, Southwestern willow	*Empidonax traillii extimus*	Endangered
	Gambusia, Big Bend	*Gambusia gaigei*	Endangered
	Gambusia, Clear Creek	*Gambusia heterochir*	Endangered
	Gambusia, Pecos	*Gambusia nobilis*	Endangered
	Gambusia, San Marcos	*Gambusia georgei*	Endangered
	Harvestman, Bee Creek Cave	*Texella reddelli*	Endangered
	Harvestman, Bone Cave	*Texella reyesi*	Endangered
	Jaguar	*Panthera onca*	Endangered

Appendix D, continued.

State	Common Name	Scientific Name	Federal Status
	Jaguarundi	*Felis yagouaroundi cacomitli*	Endangered
	Manatee, West Indian	*Trichechus manatus*	Endangered
	Minnow, Devils River	*Dionda diaboli*	Threatened
	Minnow, Rio Grande silvery	*Hybognathus amarus*	Threatened
	Ocelot	*Felis pardalis*	Endangered
	Owl, Mexican spotted	*Strix occidentalis lucida*	Threatened
	Pelican, brown	*Pelecanus occidentalis*	Endangered
	Plover, mountain	*Charadrius montanus*	Proposed Threatened
	Plover, piping	*Charadrius melodus*	Threatened
	Prairie-chicken, Attwater's greater	*Tympanuchus cupido attwateri*	Endangered
	Pseudoscorpion, Tooth Cave	*Tartarocreagris (=Microcreagris) texana*	Endangered
	Pupfish, Comanche Springs	*Cyprinodon elegans*	Endangered
	Pupfish, Leon Springs	*Cyprinodon bovinus*	Endangered
	Pupfish, Pecos	*Cyprinodon pecosensis*	Proposed Endangered
	Salamander, Barton Springs	*Eurycea sosorum*	Endangered
	Salamander, San Marcos	*Eurycea nana*	Threatened
	Salamander, Texas blind	*Typhlomolge rathbuni*	Endangered
	Shiner, Arkansas River	*Notropis girardi*	Threatened
	Snake, Concho water	*Nerodia paucimaculata*	Threatened
	Spider, Government Canyon cave	*Neoleptoneta microps*	Endangered
	Spider, robber baron cave	*Cicurina baronia*	Endangered
	Spider, Tooth Cave	*Neoleptoneta (=Leptoneta) myopica*	Endangered
	Spider, vesper cave	*Circurina vespera*	Endangered
	Spider (unnamed)	*Circurina venti*	Endangered
	Tern, least	*Sterna antillarum*	Endangered
	Toad, Houston	*Bufo houstonensis*	Endangered
	Turtle, Kemp's (=Atlantic) ridley sea	*Lepidochelys kempii*	Endangered
	Turtle, loggerhead sea	*Caretta caretta*	Threatened
	Vireo, black-capped	*Vireo atricapillus*	Endangered
	Warbler, golden-cheeked	*Dendroica chrysoparia*	Endangered
	Woodpecker, red-cockaded	*Picoides (=Dendrocopos) borealis*	Endangered
	Large-fruited sand-verbena	*Abronia macrocarpa*	Endangered
	South Texas ambrosia	*Ambrosia cheiranthifolia*	Endangered

Appendix D, continued.

State	Common Name	Scientific Name	Federal Status
	Tobusch fishhook cactus	*Ancistrocactus tobuschii*	Endangered
	Star cactus	*Astrophytum asterias*	Endangered
	Texas ayenia	*Ayenia limitaris*	Endangered
	Texas poppy-mallow	*Callirhoe scabriuscula*	Endangered
	Nellie cory cactus	*Coryphantha (=Escobaria) minima*	Endangered
	Bunched cory cactus	*Coryphantha ramillosa*	Threatened
	Sneed pincushion cactus	*Coryphantha sneedii* var. *sneedii*	Endangered
	Terlingua Creek cats-eye	*Cryptantha crassipes*	Endangered
	Chisos Mountain hedgehog cactus	*Echinocereus chisoensis* var. *chisoensis*	Threatened
	Lloyd's hedgehog cactus	*Echinocereus lloydii*	Endangered
	Black lace cactus	*Echinocereus reichenbachii (=melanocentrus)* var. *albertii*	Endangered
	Davis' green pitaya	*Echinocereus viridiflorus* var. *davisii*	Endangered
	Lloyd's Mariposa cactus	*Echinomastus (=Sclerocactus) mariposensis*	Threatened
	Johnston's frankenia	*Frankenia johnstonii*	Endangered
	Pecos (=puzzle) sunflower	*Helianthus paradoxus*	Threatened
	Slender rush-pea	*Hoffmannseggia tenella*	Endangered
	Texas prairie dawn-flower (=Texas bitterweed)	*Hymenoxys texana*	Endangered
	White bladderpod	*Lesquerella pallida*	Endangered
	Zapata bladderpod	*Lesquerella thamnophila*	Endangered
	Walker's manioc	*Manihot walkerae*	Endangered
	Texas trailing phlox	*Phlox nivalis* ssp. *texensis*	Endangered
	Little Aguja pondweed	*Potamogeton clystocarpus*	Endangered
	Hinckley's oak	*Quercus hinckleyi*	Threatened
	Navasota ladies'-tresses	*Spiranthes parksii*	Endangered
	Texas snowbells	*Styrax texanus*	Endangered
	Ashy dogweed	*Thymophylla tephroleuca*	Endangered
	Texas wild-rice	*Zizania texana*	Endangered
Washington	Albatross, short-tailed	*Phoebastria albatrus*	Endangered
	Bear, grizzly	*Ursus arctos*	Threatened
	Butterfly, Oregon silverspot	*Speyeria zerene hippolyta*	Threatened
	Caribou, woodland	*Rangifer tarandus caribou*	Endangered
	Catchfly, Spalding’s	*Silene spaldingii*	Proposed Threatened

Appendix D, continued.

State	Common Name	Scientific Name	Federal Status
	Deer, Columbian white-tailed	*Odocoileus virginianus leucurus*	Endangered
	Eagle, bald	*Haliaeetus leucocephalus*	Threatened
	Falcon, American peregrine	*Falco peregrinus anatum*	Endangered
	Goose, Aleutian Canada	*Branta canadensis leucopareia*	Threatened
	Lynx, Canada	*Lynx canadensis*	Threatened
	Murrelet, marbled	*Brachyramphus marmoratus marmoratus*	Threatened
	Owl, northern spotted	*Strix occidentalis caurina*	Threatened
	Pelican, brown	*Pelecanus occidentalis*	Endangered
	Plover, western snowy	*Charadrius alexandrinus nivosus*	Threatened
	Salmon, chinook	*Oncorhynchus (=Salmo) tshawytscha*	Endangered
	Salmon, chum	*Oncorhynchus keta*	Threatened
	Salmon, sockeye	*Oncorhynchus nerka*	Endangered
	Sea-lion, Steller (=northern)	*Eumetopias jubatus*	Endangered
	Steelhead	*Oncorhynchus mykiss*	Endangered & Threatened
	Trout, bull (Coastal - Puget Sound pop.)	*Salvelinus confluentus*	Threatened
	Trout, bull (Columbia R. pop.)	*Salvelinus confluentus*	Threatened
	Trout, coastal cutthroat	*Oncorhynchus clarki clarki*	Proposed Threatened
	Wolf, gray	*Canis lupus*	Endangered
	Marsh sandwort	*Arenaria paludicola*	Endangered
	Golden paintbrush	*Castilleja levisecta*	Threatened
	Stickseed, showy	*Hackelia venusta*	Proposed Endangered
	Water howellia	*Howellia aquatilis*	Threatened
	Bradshaw's desert-parsley (=lomatium)	*Lomatium bradshawii*	Endangered
	Kincaid's lupine	*Lupinus sulphureus* var. *kincaidii*	Threatened
	Polygonum, Scotts Valley	*Polygonum hickmanii*	Proposed Endangered
	Nelson's checker-mallow	*Sidalcea nelsoniana*	Threatened
	Wenatchee Mountains (=Oregon), checkermallow	*Sidalcea oregana* var. *calva*	Endangered

Does not include all marine mammals
Does not include sea turtles unless nesting in State coastal areas

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Animal and Plant Health Inspection Service
4700 River Road
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Principal EIS Preparers

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Environmental Protection Officer
B.S. Microbiology
M.A. Biology

Background: Senior Project Leader in Environmental Services (ES). Twenty-seven years service with the Animal and Plant Health Inspection Service (APHIS) in positions involving pest exclusion, pest control, regulatory activities, and environmental protection. Experience coordinating and preparing environmental documents for other major APHIS programs.

EIS Responsibility: Project Manager - overall responsibility for the EIS, coordination of supportive analysis efforts, and management of the interdisciplinary team. Wrote chapters 1, 2, and 8; wrote sections of chapters 3, 6, and 7.

David Bergsten
Toxicologist
B.S. Environmental Science
M.S. Entomology
M.P.H. Disease Control
Ph.D. Toxicology

Background: Toxicologist in ES. Expertise in pesticide research and environmental toxicology. More than 10 years experience with APHIS; experience in preparing environmental documents for other major APHIS programs.

EIS Responsibility: Assistant Project Manager/Toxicologist. Managed and wrote majority of chapters 4 and 5; wrote sections of chapters 3 and 6; wrote and/or contributed to risk assessments incorporated by reference in the EIS; contributed to some of the appendices.

Nancy E. Sweeney
Environmental Protection Officer
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Background: Experience as a wildlife biologist with the Bureau of Land Management, U.S. Fish and Wildlife Service (FWS), and APHIS. A principal author of the regulations for implementation of section 7 (Consultation) of the Endangered Species Act of 1973 (ESA). Has coordinated section 7 consultation activities for a variety of major APHIS programs.

EIS Responsibility: Fruit Fly Program ESA Coordinator; contributed to chapter 5 and prepared appendix D.

Mike Stefan
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B.S. Agriculture
M.S. Botany/Plant Ecology

Background: Operations Officer in Plant Protection and Quarantine (PPQ). Expertise in pest management programs. Formerly National Coordinator for Fruit Fly Programs.

EIS Responsibility: Provided fruit fly program information and data; assisted in planning, coordination, and review of EIS.

Betsey Garver
Writer/Editor
B.A. Sociology

Background: Over 10 years service with APHIS, with administrative and clerical experience with PPQ, and Policy and Program Development. Currently serving as writer/editor with ES.

EIS Responsibility: Desktop publishing of the EIS (including editing, format, and document security); and supportive coordination and planning.

Judy Lee
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Background: Manager of APHIS Reading Room. Expertise in administration and data base development and implementation.

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Mary Biddlecome
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EIS Responsibility: Clerical duties, as needed, in connection with the preparation and distribution of the EIS.

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Retired: Formerly Special Assistant to the Deputy Administrator, PPQ. Expertise in pesticide and chemical research. Has done *in vivo* and *in vitro* work on pesticides' mode of action for the Center for Disease Control.

EIS Responsibility: EIS Project Liaison with the Deputy Administrator's Office, PPQ. Assisted in developing the EIS' focus and communicating program objectives; reviewed EIS.

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EIS Responsibility: Leader, Pesticide Registration Team. Acted as liaison to U.S. Environmental Protection Agency in registration processes; contributed to chapter 3; reviewed EIS.

Appendix F. Cooperation, Review, and Consultation

The following individuals have cooperated in the development of this environmental impact statement (EIS), were consulted on critical issues that have been addressed in this EIS, or reviewed draft sections of the EIS. The expertise and concerns of these individuals were considered during the development of this EIS. There may be some aspects of the EIS or its incorporated analyses which are not endorsed by all of the cooperators and consultants.

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EPA/OHEA—See U.S. Environmental Protection Agency/Office of Health and Environmental Assessment.

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USDA, SCS—See U.S. Department of Agriculture, Soil Conservation Service

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Appendix I. Acronyms and Glossary

A

Absorption The taking up of liquids by solids, or the passage of a substance into the tissues of an organism as the result of several processes (diffusion, filtration, or osmosis); the passage of one substance into or through another (e.g., an operation in which one or more soluble components of a gas mixture are dissolved in a liquid).

Acceptable Daily Intake (ADI) The maximum dose of a substance that is anticipated to be without lifetime risk to humans when taken daily.

Acetylcholinesterase (AChE) An enzyme produced at junctions between nerve cells that hydrolyzes acetylcholine, thereby ending transmission of a nerve impulse.

Acidic Soil Soil having a pH value lower than 7.

Active Ingredient (a.i.) In any pesticide product, the component which kills, or otherwise controls, target pests; pesticides are regulated primarily on the basis of active ingredient.

Acute Exposure A single exposure to a toxic substance that results in severe biological harm or death; acute exposures are usually characterized as lasting no longer than 1 day.

Acute Toxicity The potential of a substance to cause injury or illness when given in a single dose or in multiple doses over a period of 24 hours or less.

Acute Toxicity Study A study with single (or multiple administration for no more than 24 hours) dose exposure with short-term monitoring for effects (up to 14 days); may include median lethality and effective does (LD_{50}, LC_{50}, ED_{50}, EC_{50}), eye toxicity, dermal toxicity (excluding skin sensitization tests), and inhalation toxicity studies. See Acceptable Daily Intake.

ADI See Acceptable Daily Intake.

Adsorption Attraction or bonding of ions or compounds, usually temporarily to the surface of a solid (compare with Absorption).

Aerobic Occurring or growing in the presence of oxygen; life or processes that require, or are not destroyed by, oxygen.

a.i. See Active Ingredient.

Alkaline Soil Soil having a pH value greater than 7.

Ambient Air Open air; an unconfined portion of the atmosphere.

Annual A plant that completes its entire life cycle from seed germination to seed production and death within a single season.

APHIS Animal and Plant Health Inspection Service; an agency within the United States Department of Agriculture.

Application Rate The amount of pesticide product applied per unit area.

Aquatic Life Organisms inhabiting water for all or part of their life cycle.

Aquifer An underground geological formation, or group of formations, containing usable amounts of groundwater that can supply wells and springs; an underground water resource.

Arachnid A member of the class Arachnida, a group of invertebrates characterized by four pairs of jointed appendages; spiders, mites, and scorpions are arachnids.

Assay A test or measurement used to evaluate a characteristic of a chemical; see Bioassay, Mutagenicity Assay.

Atmosphere The mass of air surrounding the earth, composed largely of oxygen and nitrogen; a standard unit of pressure representing the pressure exerted by a 29.92 inch column of mercury at sea level at 45^0 latitude and equal to 1,000 grams per square centimeter.

Attractant, Insect A natural or synthesized substance that lures insects by stimulating their sense of smell; sex, food, or oviposition attractants are used in traps or bait formulations.

B

Bacteria A group (division) of microscopic organisms; bacteria consume or break down organic matter and other chemicals, thereby reducing potential for pollution; bacteria in soil, water or air can also cause human, animal, and plant health problems.

Bioaccumulation — Uptake and temporary storage of a chemical in or on an organism; over a period of time a higher concentration of chemical may be found in the organism than in the environment.

Bioassay — A method for quantitatively determining the concentration of a substance or its effect on a living animal, plant, or microorganism under controlled conditions.

Bioconcentration — The property of some chemicals to collect in tissues of certain species at concentrations higher than the surrounding environment; term is used primarily for aquatic species; see Bioaccumulation.

Biodegradation — The processes by which living systems, particularly microorganisms, break down chemical compounds; the products of biodegradation may be more or less toxic than their precursors.

Biodiversity — The relative abundance and frequency of biological organisms within ecosystems.

Biological Control — The reduction of pest populations by means of living organisms encouraged by humans; utilizes parasites, predators, or competitors to reduce pest populations (also called biocontrol).

Biotechnological Control — Use of genetic engineering to control a pest; may involve genetic engineering of host plants, biocontrol agents, or the pest itself to achieve control.

Buffer Zone — An area where control treatments are foregone or are modified to protect an adjacent environmentally sensitive area.

By-product — Material, other than the principal product, that is generated as a consequence of an industrial process.

C

Cancellation — Cancellation of a pesticide registration under section 6(b) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) is required if unreasonable adverse effects to the environment and public health develop when a product is used according to widespread and commonly recognized practice, or if its labeling or other material required to be submitted does not comply with FIFRA provisions.

Carcinogen — A cancer-producing substance.

Certified Applicator — Commercial or private applicator certified as competent to apply pesticides.

CFCs — See Chlorofluorocarbons.

CFR — Code of Federal Regulations (U.S.).

Chemical Sensitivity — An adverse reaction(s) to ambient levels of toxic chemical(s) contained in air, food, and water.

Chlorofluorocarbons (CFCs) — A family of inert, nontoxic, and easily liquified chemicals used in refrigeration, air conditioning, packaging, insulation, or as solvents and aerosol propellants; because these compounds are not destroyed in the lower atmosphere, they drift into the upper atmosphere where their chlorine components destroy ozone.

Chlorpyrifos — An organophosphate insecticide, analyzed for use in this program as a soil drench.

Chronic Toxicity — An adverse biologic response, such as mortality or an effect on growth or reproductive success, resulting from repeated or long-term (equal to or greater than 3 months) doses (exposures) of a compound usually at low concentrations; see Acute Toxicity, Subchronic Toxicity.

Clastogenic — Any adverse effect to an organism, for example from a chemical, that results in structural changes in chromosomes (primarily breaks in chromosomes).

Clay — Soil particles less than 0.0002 mm in diameter; the soil textural class characterized by a predominance of clay particles.

Community — An assemblage of populations of plants, animals, bacteria, and fungi that live in an environment and interact with one another, forming a distinctive living system with its own composition, structure, environmental relations, development, and function; an association of interacting populations, usually defined by the nature of their interaction or the place in which they live.

Concentration — The ratio of the mass or volume of a solute to the mass or volume of the solution or solvent; the amount of active ingredient or herbicide equivalent in a quantity of diluent (e.g., expressed as lb/gal, ml/liter, etc.), or an amount of a substance in a specified amount of medium (e.g., air and water).

Conservation Avoiding waste of, and renewing when possible, human and natural resources; the protection, improvement, and use of natural resources according to principles that will assure their highest economic or social benefits.

Contaminant An undesired physical, chemical, biological, or radiological substance that can have an adverse affect on air, water, soil, etc.

Control Action or treatment to reduce a pest population; also, an untreated test group.

Control Treatment A treatment (application) used within an insect control program; or in an analytical context, the absence of an application, as in the control for a test of an insecticide application.

Cover Vegetation or other material providing protection as ground cover.

Criteria Descriptive factors taken into account by EPA in setting standards to various pollutants; these are used to determine limits on allowed concentration levels and to limit the number of violations per year.

Criteria Pollutants The 1970 amendments to the Clean Air Act required EPA to set National Ambient Air Quality Standards for certain pollutants known to be hazardous to human health; EPA has identified and set standards to protect human health and welfare effects of these pollutants.

Critical Habitat Habitat designated as critical to the survival of an endangered or threatened species, and listed in 50 CFR 17 or 226.

Cultural Control Reduction of insect populations by utilization of agricultural practices such as crop rotation, clean culture, or tillage.

Cumulative Chemical Risk The sum of all potential adverse effects from all exposures to a specific chemical.

Cumulative Effects or Impacts Those effects or impacts that result from incremental impact of a proogram action when added to other past, present, and reasonably foreseeable future actions.

Cytogenetic Pertaining to the formation or production of cells.

D

Decomposition The breakdown of materials by bacteria and fungi; the chemical makeup and physical appearance of materials are changed.

Degradation Breakdown of a compound by physicochemical or biochemical processes into basic components with properties different from those of the original compound; see Biodegradation.

Delayed Neurotoxicity Transformation of a compound by physicochemical degeneration of the axons of peripheral motor nerves that commences 7 to 10 days after exposure to a causative agent such as an organophosphate insecticide.

Deoxyribonucleic Acid (DNA) The molecule in which the genetic information for most living cells is encoded; viruses also contain DNA.

Deposit A quantity of a pesticide deposited on a unit area.

Dermal Exposure The portion of a toxic substance that an organism receives as a result of the substance coming into contact with the organism's body surface.

Dermal Sensitization Dermal exposure to an allergen that results in the development of hypersensitivity.

Developmental Toxicity The adverse effects on a developing organism that may result from its exposure to a substance prior to conception (either parent), during prenatal development, or postnatally to the time of sexual maturation; adverse developmental effects may include lethality in the developing organisms, structural abnormalities, altered growth, and functional deficiency.

Diazinon An organophosphate insecticide, analyzed for use in this program as a soil drench.

Diversity The distribution and abundance of different plant and animal communities and species within an area; the number of species in a community or region; see Biodiversity.

DNA See Deoxyribonucleic Acid

Dose A given quantity of material that is taken into the body; dosage is usually expressed in amount of substance per unit of animal body weight often in milligrams of substance per kilogram (mg/kg) of animal body weight, or other appropriate units; to radiology, the quantity of energy or radiation absorbed; see Concentration.

Drench Saturation of a soil with pesticide, usually to control root diseases.

Drift The airborne movement of a pesticide away from the targeted site of an application.

E

EC_{50} See Median Effective Concentration.

Eclosion The emergence of an adult insect from a pupal case, or the emergence of an insect larva from an egg.

Economic Threshold A pest population level at which economic damage begins to occur; this level may vary depending upon crop and locality.

Ecoregion A geographic area that is relatively homogeneous with respect to ecological systems.

EIS See Environmental Impact Statement.

Endangered Species A plant or animal species identified by the Secretary of the Interior in accordance with the 1973 Endangered Species Act, as amended, that is in danger of extinction throughout all or a significant portion of its range.

Environment The sum of all external conditions affecting the life, development, and survival of an organism; all the organic and inorganic features that surround and affect a particular organism or group of organisms.

Environmental Assessment (EA) A concise public document which provides sufficient evidence and analysis for determining whether to prepare an Environmental Impact Statement or Finding of No Significant Impact. It aids in compliance with the National Environmental Policy Act (NEPA) when no Environmental Impact Statement is needed.

Environmental Fate	The result of natural processes acting upon a substance; including transport (e.g., on suspended sediment), physical transformation (e.g., volatilization, precipitation), chemical transformation (e.g., photolysis), and distribution among various media (e.g., living tissues); the transport, accumulation, an disappearance of a chemical in the environment.
Environmental Impact Statement (EIS)	A document prepared by a Federal agency in which anticipated environmental effects of alternative planned courses of action are evaluated; a detailed written statement as required by section 102(2)(C) of the National Environmental Policy Act (NEPA).
EPA	U.S. Environmental Protection Agency
Eradication	The complete elimination of a pest species; for some agricultural pests, this may mean the reduction of the pest populations to nondetectable levels.
Erosion	The wearing away of land surface by wind or water. Erosion occurs naturally from weather or runoff, but can be intensified by land cleaning practices related to farming, residential or industrial development, road building, or timber cutting.
Estimated Environmental Concentration (EEC)	Concentration of a substance in a particular media (soil, air, water, or vegetation), estimated from its chemical properties (e.g., volatility, half-life), considering media characteristics.
Estuary	Regions of interaction between rivers and near shore ocean waters where tidal action and river flow.
Exposure	The condition of being subjected to a substance that may have a harmful effect.
Exposure Analysis	The estimation of the amount of chemicals to which organisms are subjected during the application of pesticides.
Exposure Scenario	Overall description of the potential contact of an organism or population under specified conditions (i.e. routes of contact, exposure duration) used to estimate possible exposure during pesticide application.

F

Fenthion An organophosphate insecticide, analyzed for use in this program as a soil drench.

Feral Wild; applies to fruit fly pest populations rather than fruit fly sterile releases.

Fertilizer Any organic or inorganic substance, either of natural or synthetic origin, which is added to the soil to provide elements essential to or enhancing plant growth.

Fetotoxic Capable of causing adverse effects to the fetal stage of development.

FIFRA Federal Insecticide, Fungicide, and Rodenticide Act; the Act establishes procedures for the registration, classification, and regulation of pesticides.

Finding of No Significant Impact A document prepared by a Federal agency that presents the reasons why a proposed action would not have a significant impact on the environment and thus would not require preparation of an Environmental Impact Statement. A FONSI is based on the results of an Environmental Assessment.

FONSI See Finding of No Significant Impact

Food Web An abstract representation of the various food pathways (energy flow) through populations in the community.

Formulation The way in which a basic pesticide is prepared for practical use; includes preparation as wettable powder, granular, or emulsifiable concentrate; a pesticide preparation supplied by a manufacturer for practical use; a pesticide product ready for application; also, refers to the process of manufacturing or mixing a pesticide product in accordance with the EPA-approved formula.

Full Foliar Coverage Applied thoroughly over the crop or plant to a point of runoff or drip.

Fumigant Pesticide applied as liquid or powder which volatilizes to gas; usually applied beneath a tarp, sheet, or other enclosure.

Fumigation Use of chemicals in gaseous form to destroy pests, usually applied under a cover or shelter.

Fungi (Singular, Fungus) A group of organisms that lack chlorophyll (i.e., are not photosynthetic) and which are usually multicellular, filamentous, and nonmotile; they include the molds, mildews, yeasts, mushrooms, and puffballs; some decompose organic matter, some cause disease, others stabilize sewage and break down solid wastes in composting.

FWS Fish and Wildlife Service; an agency of the U.S. Department of the Interior.

G

Gene A short length of a chromosome that influences a set of characters; a length of DNA that directs the synthesis of a protein.

Genotoxicity A specific adverse effect on the genome (the complement of genes contained in the haploid set of chromosomes) of living cells, that upon the duplication of the affected cells, can be expressed as a mutagenic or a carcinogenic event because of specific alteration of the molecular structure of the genome.

Geochemical Cycles Changes in chemical and geological properties of a substance over time.

Gravid Bearing eggs.

Ground Cover Plants grown to keep soil from eroding.

Groundwater The supply of freshwater found beneath the Earth's surface (usually in aquifers), which is often used for supplying wells and springs. Because groundwater is a major source of drinking water, there is growing concern over areas where leaching agricultural or industrial pollutants or substances from leaking underground storage tanks are contaminating groundwater.

H

Habitat The place occupied by wildlife or plant species; includes the total environment occupied.

Half-life	The time necessary for the concentration of a chemical to decrease by 50%; a measure of the persistence of a chemical in a given medium (the greater the half-life, the more persistent a chemical is likely to be).
Hazard	The potential that the use of a pesticide would result in an adverse effect on man or the environment; the intrinsic ability of a stressor to cause adverse effects under a particular set of circumstances.
Hazard Assessment	A component of risk assessment that consists of the review and evaluation of toxicological data to identify the nature of the hazards associated with a chemical, and to quantify the relationship between dose and response.
Herbicide	Chemical designed to kill or inhibit unwanted plants or weeds.
Herbivore	An animal that feeds on plants.
Host	Any plant or animal attacked by a pest or a parasite.
Human Health Risk Assessment	Quantitative appraisal of the actual or potential effects of a pollutant on humans, such as workers or residents.
Hydrolysis	The decomposition of chemical compounds through a reaction with water.
Hypersensitivity	Abnormal or excessive reactivity to any substance.

I

Immunopathologic	Of a disease or abnormality of the immune system.
Immunosuppressive	Having the quality or capability to impair the function of the immune system.
In Vitro	In glass; a test-tube culture; any laboratory test using living cells taken from an organism.
In Vivo	In the living body of a plant or animal; in vivo tests are those laboratory experiments carried out on whole animals or human volunteers.

Inhalation Exposure of test animals through breathing, either to vapor or dust, for a predetermined time.

Inhalation Toxicity The quality of being poisonous to man or animals when breathed into the lungs.

Insect Growth Regulators Substances (often hormones) which exert an effect on insect growth; they may be used to prevent growth or metamorphosis of pests, thereby exerting control over pest populations.

Insecticide A pesticide compound specifically designed to kill or control the growth of insects.

Integrated Pest Management (IPM) The selection, integration, and implementation of pest control actions on the basis of predicted economic, ecological, and sociological consequences; the process of integrating and applying practical methods of prevention and control to keep pest situations from reaching damaging levels while minimizing potentially harmful effects of pest control measures on humans, nontarget species, and the environment.

Irrigation Technique for applying water or waste water to land areas to supply the water and nutrient needs of plants.

L

Label All printed material attached to or part of the pesticide container.

LC See Lethal Concentration.

LC_1 A concentration of a substance in water or air, expressed in milligrams per liter (mg/L) or milligrams per cubic meter (mg/m^3) that is lethal to 1% of test animals.

LC_{50} Median lethal concentration; the concentration of a toxicant necessary to kill 50% of the organisms, in a population being tested; usually expressed in parts per million (ppm), milligrams per liter (mg/L) or milligrams per cubic meter (mg/m^3).

LD See Lethal Dose.

LD_1 The dose of a toxic substance at which 1% of the test organisms die.

LD_{50}	Median lethal dose; the dose necessary to kill 50% of the test organisms; usually expressed in milligrams of chemical per kilogram of body weight (mg/kg).
Leaching	Downward movement of materials in the soil through water or other aqueous media. Soluble nutrients, such as nitrate, are often leached out of the seedling root zone.
LEL	See Lowest Effect Level.
Lethal Concentration (LC)	A concentration of a substance in water or air that is lethal to a test organism.
Lethal Dose (LD)	A dose of a substance that is lethal to a test organism.
Lipophilicity	Relative tendency of a chemical substance to bind to fat tissues in an organism (as opposed to binding to water).
LOAEL	See Lowest Observed Adverse Effect Level.
LOEC	See Lowest Observed Effect Concentration
LOEL	See Lowest Observed Effect Level.
Lowest Effect Level (LEL)	In a series of dose levels tested, the lowest level at which there is an effect on the species tested.
Lowest Observed Adverse Effect Level (LOAEL)	The lowest exposure level at which there are statistically significant increases in frequency or severity of specific adverse effects among individuals of the tested population when compared to the control population.
Lowest Observed Effect Concentration (LOEC)	The lowest exposure level (concentration) at which there are any observable differences between the test and control populations.
Lowest Observed Effect Level (LOEL)	The lowest exposure level at which there are observable differences between the test and control populations.

M

Macroinvertebrates Invertebrate species that are sufficiently large to be handled without the aid of a microscope.

Malathion Bait An insecticide formulation consisting of the active ingredient malathion mixed with a protein hydrolysate bait; may be applied aerially or from the ground.

Male Annihilation A control method that reduces fruit fly populations by employing mass trapping to lure and kill male fruit fly before they have a chance to mate.

Margin of Safety (MOS) An arbitrary separation between the highest no effect level of a chemical found by animal experimentation and the level of exposure estimated to be safe for humans.

Media Specific environments (e.g., air, water, soil) that are the subject of regulatory concern and activities.

mg/kg Milligrams per kilogram; used to designate the amount of toxicant required per kilogram of body weight of test organisms to produce a designated effect; usually the amount necessary to kill 50% of the test animals.

mg/kg/day Milligrams per kilogram of body weight per day.

Microbial Degradation The breakdown of a chemical substance into simpler components by bacteria.

Microorganism Living organisms, usually so small that individually they only can be seen through a microscope; see Microbes.

Mist Liquid particles measuring 40 to 500 microns, that are formed by condensation of vapor; by comparison, “fog” particles are smaller than 40 microns.

Mist Blower A mechanical pesticide application device that can be used to apply ultra low volume (ulv) pesticides; usually truck mounted.

Mitigate To lessen the effect; to make less harsh or harmful.

Model A description, analogy, or abstraction used to help visualize or conceptualize something that cannot be directly observed or measured; a system of postulates, data, and inferences presented as a mathematical description of an entity or a state of affairs.

Modeling An investigative technique using a mathematical or physical representation of a system or theory that accounts for all or some of its known properties; models are often used to test the effect of changes of system components on the overall performance of the system.

Monitoring The act of measuring environmental conditions through time periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements and/or pollutant levels in various media, humans, animals, or other living things; also the act of measuring operational components or results to verify the efficacy of treatments.

Monotypic Including a single representative species.

Morphological Pertaining to the shape or structure of an organism or object.

Morphology The branch of biology that deals with the forms and structures of animals and plants.

MOS See Margin of Safety.

Mutagen A substance that tends to increase the frequency or extent of genetic mutations (changes in hereditary material); any substance that can cause a change in genetic material.

Mutagenicity Capacity of a chemical to cause a permanent genetic change in a cell other than that which occurs during normal genetic recombination.

Mutation A change in the genetic material of a cell.

N

Neoplasm An altered, relatively autonomous growth of tissue composed of abnormal cells, the growth of which is more rapid than that of other tissues and is not coordinated with the growth of other tissues.

NEPA The National Environmental Policy Act of 1969 and subsequent amendments.

Neurotoxic Toxic to nerves or nervous tissue.

Neurotoxicity The quality of exerting a destructive or poisonous effect upon nerve tissue.

No Observed Adverse Effect Level (NOAEL) The highest dose level at which there are no observable differences between the test and control populations.

No Observed Effect Level (NOEL) The highest dose level at which there are no observable differences between the test and control populations.

Nontarget Organisms Those organisms (species) that are not the focus of control efforts.

O

Oncogenic Capable of producing or inducing tumors in animals; the tumors may be either malignant (cancerous) or benign (noncancerous).

Oral Toxicity Toxicity of a compound when given or taken by mouth, usually expressed as number of milligrams of chemical per kilogram of body weight of animal.

Organic Matter Material composed of living and/or once-living organisms (plant, animal, and microbial); organic matter increases the buffer capacity, cation exchange capacity, and water retention of the soil and provides a substrate for microbial activity.

Organic Soil Soil usually containing 20% or more organic matter; may also refer to carbonaceous waste contained in plant or animal matter and originating from domestic or industrial sources.

Organism Any living thing.

Organophosphate Insecticide Class of insecticides (also one or two herbicides and fungicides) derived from phosphoric acid esters, e.g., as malathion and diazinon.

Oxidation The addition of oxygen which breaks down organic waste or chemicals such as cyanides, phenols, and organic sulfur compounds in sewage by bacterial and chemical means; the combination of oxygen with other elements; the process in chemistry whereby electrons are removed from a molecule.

Ozone A structural form of oxygen, found in the earth's upper atmosphere; ozone provides a protective layer shielding the earth from the harmful health effects of ultraviolet radiations on humans and the environment; lower in the atmosphere, ozone is a chemical oxidant and pollutant emitted by combustion sources; ozone can seriously affect the human respiratory system and is one of the most prevalent and widespread of all the criteria pollutants for which the Clean Air required EPA to set standards.

Ozone Depletion Destruction of the stratospheric ozone layer which shields the earth from ultraviolet radiation harmful to life; caused by certain chlorine- and/or bromine-containing compounds (chlorofluorocarbons or halons) which break down when they reach the stratosphere and catalytically destroy ozone molecules.

P

Parameter An attribute or characteristic that can be measured (a measuring tool); in statistics, refers to attributes of models or populations; in chemistry, often refers to the attributes of samples (for example, a water sample); may refer to variables in some contexts.

Parasite An organism which lives in or on another organism from which it derives its nourishment.

Parasitoid A parasite which lives within its host only during its larval development, eventually killing the host.

Pathogen A disease-causing organism.

Perennial A plant that continues growing from year to year; tops may die back in winter, but roots or rhizomes persist (compare with Annual).

Persistence The quality of an insecticide or a compound to persist as an effective residue; persistence is related to volatility, chemical stability, and biodegredation.

Pest An insect, rodent, nematode, fungus, weed, or other form of terrestrial or aquatic plant or animal life, or virus, bacterial, or microorganism that is injurious to health or the environment.

Pesticide Any substance or mixture of substances designed to kill insects, rodents, fungi, weeds, or other forms of plant or animal life that are considered to be pests; see Herbicide, Insecticide.

Pesticide Tolerance The amount of pesticide residue allowed by law to remain in or on a harvested crop; by using various safety factors, EPA sets these levels well below the point where the chemicals might be harmful to consumers.

pH Numerical measure (negative logarithm of the hydrogen ion activity) of the acidity or alkalinity in a soil or solution; a pH reading of 7 is neutral, less than 7 is acidic, and more than 7 is alkaline (basic).

Physical Control Physical actions (e.g., fruit stripping or host destruction) taken to control a pest.

Photolysis The decomposition or dissociation of a molecule resulting from light (ultraviolet) absorption; thus, the decomposition of molecules by sunlight; see Photodegradation.

Phytotoxic Causing injury or death to plants.

Pica Behavior Pathological behavior characterized by the persistent eating of nonnutritive, generally nonfood, substances.

Plume A visible or measurable discharge of a contaminant from a given point of origin; as for example, a plume of smoke from a factory or, in the context of the Medfly program, the intentional venting of methyl bromide from a terminated fumigation; the area of measurable and potentially harmful radiation leaking from a damaged reactor; the distance from a toxic release considered dangerous for those exposed to the leaking fumes.

Population A potentially interbreeding group of organisms of a single species, occupying a particular space; generically, the number of humans or other living creatures in a designated area.

Potentiation The action of two or more substances from which one or more enhances the toxicity of another. The potentiator generally is not toxic to the same endpoint as the substance being potentiated.

ppm Parts per million; the number of parts of chemical substance per million parts of the substrate in question.

R

Reasonable Alternatives Alternatives to the proposal that are practical or feasible from the technical and economic standpoint and using common sense, rather than simply desirable from the standpoint of the applicant.

Recharge The process by which water is added to a zone of saturation usually by percolation from the soil surface, e.g., the recharge of an aquifer.

Reference Dose (RfD) The term preferred by EPA to express acceptable daily intake for humans; an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population, including sensitive subgroups, that is likely to be without an appreciable risk of deleterious effects during a lifetime.

Region A defined geographic area; regions may be defined administratively (e.g., EPA Region III), politically (e.g., Texas), geographically (e.g., the Southwest), biogeographically (e.g., short-grass prairie), physiographically (e.g., Rocky Mountains), or by other means.

Registration Formal EPA approval and listing of a new pesticide before it can be sold or distributed in intrastate or interstate commerce; registrations are in accordance with FIFRA; EPA is responsible for registration (premarket licensing) of pesticides on the basis of data demonstrating that they will not cause unreasonable adverse effects on human health or the environment when used according to approved label directions.

Registration Standards An individual standard established by EPA for the consideration and approval of a pesticide product.

Regulatory Control A combination of control methods including quarantines and certification treatments; regulatory controls may include chemical and/or nonchemical treatment methods; because of the integrity of the regulatory effort associated with Medfly control programs, regulatory control is discussed within this EIS as a unitized component.

Reregistration The reevaluation and reapproval of existing pesticides originally registered prior to current scientific and regulatory standards; EPA reregisters pesticides through its Registration Standards Program.

Reservoir Any natural or artificial holding area use to store, regulate, or control water.

Residue Quantity of pesticide and its metabolites remaining on and in a crop, soil, or water.

Residual Amount of contaminant remaining in the environment after a natural or technological process has taken place (e.g., the sludge remaining after initial waste water treatment, or particulates remaining in air after the air passes through a scrubbing or other pollutant removal process).

Resistance The ability of a population or system to absorb an impact without significant change from normal fluctuations; for plants and animals, the ability to withstand adverse environmental conditions and/or exposure to toxic chemicals or disease.

Resource A substance or object required by an organism for normal maintenance, growth, and reproduction; if the resource is scarce relative to demand, it is referred to as a limiting resource; nonrenewable resources (such as space) occur in fixed amounts and can be fully utilized; renewable resources (such as food) are produced at a rate that may be partly determined by their utilization.

RfD See Reference Dose

Risk The probability that a substance will produce harm under specified conditions.

Risk Analysis An analytical process to determine the nature and often the magnitude of risk to organisms, including attendant uncertainty; an analytical process based on scientific considerations, but also requiring judgment when the available information is incomplete.

Risk Assessment The qualitative and quantitative evaluation performed in an effort to define the risk posed to human health and/or the environment by the presence or potential presence and/or use of specific pollutants.

Risk Characterization Description of the nature and magnitude of risk; risk characterization uses the information gathered in other stages to represent the overall situation; the toxicity and exposure are considered jointly in the estimation or characterization of risk.

Runoff That part of precipitation, snow melt, or irrigation water that runs off the land into streams or other surface water; it can carry pollutants from the air and land into the receiving waters.

S

Scoping A process for determining the span of issues to be addressed and for identifying the significant issues related to a proposed action.

Secondary Poisoning (Also Secondary Toxicity) Intoxication resulting from feeding on the carcass or gastrointestinal tract contents of a primary victim that died from exposure of toxic materials.

Silt Fine particles of sand or rock that can be picked up by the air or water and deposited as sediment; a soil textural class characterized by a predominance of silt particles.

Socioeconomics Sociological and economic factors considered together.

Solubility The property of being able to dissolve in another substance; the mass of a dissolved substance that will saturate a fixed volume of a solvent under static conditions.

Species A group of closely related, morphologically similar individuals which actually or potentially interbreed; a reproductively isolated aggregate of interbreeding populations of organisms.

Spot Treatment A pesticide application to a small, or otherwise restricted area of a whole unit.

Stratosphere The upper portion of the atmosphere, in which temperature varies very little with changing altitude and clouds are rare.

Subchronic Toxicity Adverse biologic response of an organism, such as mortality or an effect on growth or reproductive success, resulting from repeated or short-term (3 month) doses (exposures) of a compound, usually at low concentrations; see Acute Toxicity, Chronic Toxicity.

Suppression Reduction of a pest population to below some predetermined economic threshold.

SureDye® Bait An insecticide formulation under development consisting of a mixture of two xanthene dyes, phloxine B and uranine, combined with a protein hydrolysate bait; may be applied aerially or from the ground.

Surrogate Species A substitute species that can be compared with a lesser known or more rare species.

Susceptibility Capacity to be adversely affected by pesticide exposure.

Synergism The action of two or more substances to achieve an effect of which each individually incapable; synergistic effects may be greater or less than the sum of effects of the substances in question.

Systemic Entering and then distributing throughout the body of an organism, as in the movement of a toxicant.

T

Target The plants, animals, structures, areas or pests to be treated with a pesticide application.

Teratogen Any substance capable of producing structural abnormalities of prenatal origin, present at birth or manifested shortly thereafter; a substance that causes physical birth defects in the offspring following exposure of the pregnant female.

Teratology The division of toxicology that deals with development and congenital malformations.

Threatened Species Any species listed in the Federal Register that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

Threshold Limit Value-Time Weighted Average (TLV-TWA) The time-weighted average concentration for a normal 8-hour workday and a 40-hour work week to which nearly all workers may be repeatedly exposed without adverse effect.

Tolerance Amount of pesticide residue permitted by Federal regulation to remain on or in a crop, expressed as parts per million (ppm); capacity to withstand pesticide treatment without adverse effects on normal growth and function; the maximum residue concentration legally allowed for a specific pesticide, its metabolites, or breakdown products, in or on a particular raw agricultural product, processed food, or feed item, expressed as parts per million.

Toxic Poisonous to living organisms.

Toxicant A poisonous substance such as the active ingredient in pesticide formulations that can injure or kill plants, animals, or microorganisms.

Toxicity The capacity or property of a substance to cause any adverse effects, based on scientifically verifiable data from animal or human exposure tests; that specific quantity of a substance which may be expected, under specific conditions, to do damage to a specific living organism; capacity of a chemical to induce an adverse effect.

Toxicity Categories EPA definitions: Category I. The words Danger-Poison and the skull and crossbones symbol are required on the labels for all highly toxic compounds. These pesticides all fall within the acute oral LD_{50} range of 2 mg/kg. Category II. The word *Warning* is required on the labels for all moderately toxic compounds. They all fall within the acute oral LD_{50} range of 50 to 500 mg/kg. Category III. The word *Caution* is required on labels for slightly toxic pesticides that fall within the LD_{50} range of 500 to 5,000 mg/kg. Category IV. The word *Caution* is required on labels for compounds having acute LD_{50}s greater than 5,000 mg/kg.

Trophic Level Functional classification of organisms in a community according to feeding (energy) relationships; the first trophic level includes green plants, the second trophic level includes herbivores, and so on.

U

Ultra Low Volume Sprays that are applied at 0.5 gallon or less per acre or sprays applied as the undiluted formulation.

Uncertainty May be due to missing information, or gaps in scientific theory; whenever uncertainty is encountered, a decision, based upon scientific knowledge and policy, must be made; the term “scientific judgment” is used to distinguish this decision from policy decisions made in risk management.

USDA United States Department of Agriculture.

USDI United States Department of Interior.

V

Volatility The tendency of a substance to evaporate at normal temperatures and pressures.

Volatilization The vaporizing or evaporating of a substance chemical; phase conversion of a liquid or solid into vapor.

W

Watershed A terrestrial area that contributes to water flow.

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may not equal the product of the annual number of responses multiplied by the reporting burden per response.)

All responses to this notice will be summarized and included in the request for OMB approval. All comments will also become a matter of public record.

Done in Washington, DC, this 22nd day of February 2002 .

W. Ron DeHaven,

Acting Administrator, Animal and Plant Health Inspection Service.

[FR Doc. 02–4804 Filed 2–27–02; 8:45 am]

BILLING CODE 3410–34–U

DEPARTMENT OF AGRICULTURE

Animal and Plant Health Inspection Service

[Docket No. 02–013–1]

Notice of Request for Extension of Approval of an Information Collection

AGENCY: Animal and Plant Health Inspection Service, USDA.

ACTION: Extension of approval of an information collection; comment request.

SUMMARY: In accordance with the Paperwork Reduction Act of 1995, this notice announces the Animal and Plant Health Inspection Service's intention to request an extension of approval of an information collection in support of the specifications for the humane handling, care, treatment, and transportation of marine mammals under the Animal Welfare Act regulations.

DATES: We will consider all comments we receive that are postmarked, delivered, or e-mailed by April 29, 2002.

ADDRESSES: You may submit comments by postal mail/commercial delivery or by e-mail. If you use postal mail/commercial delivery, please send four copies of your comment (an original and three copies) to: Docket No. 02–013–1, Regulatory Analysis and Development, PPD, APHIS, Station 3C71, 4700 River Road Unit 118, Riverdale, MD 20737–1238. Please state that your comment refers to Docket No. 02–013–1. If you use e-mail, address your comment to *regulations@aphis.usda.gov*. Your comment must be contained in the body of your message; do not send attached files. Please include your name and address in your message and ''Docket No. 02–013–1'' on the subject line.

You may read any comments that we receive on this docket in our reading room. The reading room is located in room 1141 of the USDA South Building, 14th Street and Independence Avenue SW., Washington, DC. Normal reading room hours are 8 a.m. to 4:30 p.m., Monday through Friday, except holidays. To be sure someone is there to help you, please call (202) 690–2817 before coming.

APHIS documents published in the **Federal Register**, and related information, including the names of organizations and individuals who have commented on APHIS dockets, are available on the Internet at *http://www.aphis.usda.gov/ppd/rad/webrepor.html*.

FOR FURTHER INFORMATION CONTACT: For information regarding the Animal Welfare Act regulations and standards for marine mammals, contact Dr. Barbara Kohn, Senior Staff Veterinarian, Animal Care, APHIS, 4700 River Road Unit 84, Riverdale, MD 20737–1234; (301) 734–7833. For copies of more detailed information on the information collection, contact Mrs. Celeste Sickles, APHIS' Information Collection Coordinator, at (301) 734–7477.

SUPPLEMENTARY INFORMATION:

Title: Animal Welfare.

OMB Number: 0579–0115.

Type of Request: Extension of approval of an information collection.

Abstract: The Animal Welfare Act standards and regulations have been promulgated to promote and ensure the humane care and treatment of regulated animals. The regulations in 9 CFR part 3, subpart E, address specifications for the humane handling, care, treatment, and transportation of marine mammals. These specifications require facilities to keep certain records and provide certain information that are needed to enforce the Animal Welfare Act and the regulations.

The regulations (9 CFR part 3, subpart E) require facilities to complete many information collection activities, such as written protocols for cleaning, contingency plans, daily records of animal feeding, water quality records, documentation of facility-based employee training, plans for any animals kept in isolation, medical records, a description of the interactive program, and health certificates. These information collection activities do not mandate the use of any official government form and are necessary to enforce regulations intended to ensure the humane care and treatment of marine mammals.

We are asking the Office of Management and Budget (OMB) to approve our use of these information collection activities for an additional 3 years.

The purpose of this notice is to solicit comments form the public (as well as affected agencies) concerning our information collection. These comments will help us:

(1) Evaluate whether the collection of information is necessary fo the proper performance of the functions of the Agency, including whether the information will have practical utility;

(2) Evaluate the accuracy of our estimate of the burden of the collection of information, including the validity of the methodology and assumptions used;

(3) Enhance the quality, utility, and clarity of the information to be collected; and

(4) Minimize the burden of the collection of information on those who are to respond, through use, as appropriate, of automated, electronic, mechanical, and other collection technologies; e.g., permitting electronic submission of responses.

Estimate of burden: The public reporting burden for this collection of information is estimated to average 0.5952 hours per response.

Respondents: Employees or attendants of USDA licensed/registered marine mammal facilities.

Estimated annual number of respondents: 3,170.

Estimated annual number of responses per respondent: 8.6208.

Estimated annual number of responses: 27,328.

Estimated total annual burden on respondents: 16,265 hours. (Due to averaging, the total annual burden hours may not equal the product of the annual number of responses multiplied by the reporting burden per response.)

All responses to this notice will be summarized and included in the request for OMB approval. All comments will also become a matter of public record.

Done in Washington, DC, this 22nd day of February 2002.

W. Ron DeHaven,

Acting Administrator, Animal and Plant Health Inspection Service.

[FR Doc. 02–4807 Filed 2–27–02; 8:45 am]

BILLING CODE 3410–34–P

DEPARTMENT OF AGRICULTURE

Animal and Plant Health Inspection Service

[Docket No. 02–009–1]

Fruit Fly Cooperative Control Program; Record of Decision Based on Final Environmental Impact Statement—2001

AGENCY: Animal and Plant Health Inspection Service, USDA.

ACTION: Notice.

SUMMARY: This notice advises the public of the Animal and Plant Health Inspection Service's record of decision for the Fruit Fly Cooperative Control Program final environmental impact statement.

ADDRESSES: Copies of the record of decision and the final environmental impact statement on which the record of decision is based are available for public inspection at USDA, room 1141, South Building, 14th Street and Independence Avenue SW., Washington, DC, between 8 a.m. and 4:30 p.m., Monday through Friday, except holidays. To be sure someone is there to help you, please call (202) 690–2817 before coming. The documents may also be viewed on the Internet at *http://www.aphis.usda.gov/ppd/es/ppq/fffeis.pdf.*

Copies of the record of decision and the final environmental impact statement may be obtained from:

Environmental Services, PPD, APHIS, USDA, 4700 River Road Unit 149, Riverdale, MD 20737–1237; (301) 734–6742; Western Regional Office, PPQ, APHIS, USDA, 1629 Blue Spruce, Suite 204, Ft. Collins, CO 80524; or

Eastern Regional Office, PPQ, APHIS, USDA, 920 Main Campus, Suite 200, Raleigh, NC 27606–5202.

FOR FURTHER INFORMATION CONTACT: Mr. Harold Smith, Environmental ProtectionOfficer, Environmental Services, PPD, APHIS, 4700 River Road Unit 149, Riverdale, MD 20737–1237; (301) 734–6742.

SUPPLEMENTARY INFORMATION: This notice advises the public that the Animal and Plant Health Inspection Service (APHIS) has prepared a record of decision based on the Fruit Fly Cooperative Control Program final environmental impact statement. This record of decision has been prepared in accordance with: (1) The National Environmental Policy Act of 1969 (NEPA), as amended (42 U.S.C. 4321 *et seq.*), (2) regulations of the Council on Environmental Quality for implementing the procedural provisions of NEPA (40 CFR parts 1500–1508), (3) USDA regulations implementing NEPA (7 CFR part 1), and (4) APHIS' NEPA Implementing Procedures (7 CFR part 372).

The Agency record of decision is set forth below.

Record of Decision; Fruit Fly Cooperative Control Program; Final Environmental Impact Statement—2001

Decision

The U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) has prepared a final environmental impact statement (EIS) for its Fruit Fly Cooperative Control Program. The EIS analyzed alternatives for control of various exotic fruit fly pests that threaten United States agricultural and environmental resources. After considering fully the analysis presented in the EIS (including supportive documents cited or incorporated by reference), I have accepted the findings of the EIS.

The selection of alternatives for individual future fruit fly programs will be on an individual basis, made only after site-specific assessment of the individual program areas. The selection of an alternative (and its associated control methods) will consider the findings of the EIS, the site-specific assessment, the public response, and any other relevant information available to APHIS at the time. APHIS will conduct environmental monitoring, and prepare environmental monitoring plans that are specific to each program, which will describe the purpose of the monitoring and the nature of the samples to be collected and analyzed. Also, APHIS will implement an emergency response communication plan for each future program that has been designed to reduce risk to the public. I have determined that this course of action includes all practicable means to avoid or minimize environmental harm from fruit fly control measures that may be employed by APHIS in future fruit fly control programs.

Alternatives Considered

The alternatives considered within the EIS include: No action, a nonchemical program, and an integrated program (the preferred alternative). The integrated program alternative includes both nonchemical and chemical component methods. The alternatives are broad in scope and reflect the major choices that must be made for future programs. In addition to control methods, the action alternatives include exclusion (quarantines and inspections) and detection and prevention (including sterile insect technique) methods. The EIS considered and compared the potential impacts of the alternatives as well as their component control methods.

Decisional Background

In arriving at this decision, I have considered pertinent risk analyses, chemical background statements, information on endangered and threatened species, and other technical documents whose analyses and conclusions were integrated into and summarized within the EIS. I have also considered APHIS' responsibilities under various statutes or regulations, the technological feasibilities of the alternatives and control methods, and public perspectives relative to environmental issues. Although scientific controversy may exist relative to the severity of potential impacts, especially with regard to pesticide impacts, I am satisfied that APHIS has estimated correctly the impacts of alternatives for fruit fly control.

APHIS understands the potential consequences of control methods (especially chemical control methods) used for fruit fly control. Chemical control methods have greater potential for direct adverse environmental consequences than nonchemical control methods. Chemical pesticides have the potential to adversely affect human health, nontarget species, and physical components of the environment. APHIS fully appreciates the dangers pesticides may pose, especially to sensitive members of communities, and consequently has made a significant effort to research and develop the use of newer, less harmful pesticides. One such pesticide, the microbially produced biological insecticide spinosad, shows great promise and will be used as a direct replacement for malathion where possible in future fruit fly programs.

APHIS is committed to the rational use of chemical pesticides and strives to reduce their use wherever possible. However, APHIS has statutory obligations that require it to act decisively to eliminate foreign fruit fly pests that invade our country. Given the current state of control technology, we believe that nonchemical control methods (used exclusively) are not capable of eradicating most fruit fly species. We know too that the net result of a decision not to use chemicals would be that other government entities or commercial growers would be likely to use even more chemicals over a wider area, with correspondingly greater environmental impact. APHIS is convinced that coordinated and well-run government programs that limit the use of pesticides to the minimum necessary to do the job are in the best interests of the public and the environment. APHIS continues to support and favor the use of integrated pest management strategies for control of fruit fly pests.

Final Implementation

In all cases, a site-specific assessment will be made prior to the time a decision is made on the control methods that will be used on a particular program. That assessment will consider characteristics such as unique and sensitive aspects of the program area, applicable environmental and program documentation, and applicable new developments in environmental science or control technologies. The site-specific assessment will also confirm the adequacy or need for additional program mitigative measures. Site-specific assessments will be made available to the public, and APHIS will consider the public's perspective relative to individual programs.

To avoid or minimize environmental harm, APHIS will implement appropriate risk reduction strategies, as described in chapter VI of the EIS. These strategies are fully described in the EIS and include but are not limited to the following: Pesticide applicat or certification, training and applicator orientation, special pesticide handling, precautions for pesticide application, identification of sensitive sites, public notification procedures, and interagency coordination and consultation.

(The record of decision was signed by Richard L. Dunkle, Deputy Administrator, Plant Protection and Quarantine, APHIS, on February 5, 2002.)

Done in Washington, DC, this 22nd day of February 2002.

W. Ron DeHaven,

Acting Administrator, Animal and Plant Health Inspection Service.

[FR Doc. 02–4806 Filed 2–27–02; 8:45 am]

BILLING CODE 3410–34–P

DEPARTMENT OF AGRICULTURE

Animal and Plant Health Inspection Service

[Docket No. 02–006–1]

Monsanto Co.; Availability of Environmental Assessment for Extension of Determination of Nonregulated Status for Canola Genetically Engineered for Glyphosate Herbicide Tolerance

AGENCY: Animal and Plant Health Inspection Service, USDA.

ACTION: Notice.

SUMMARY: We are advising the public that an environmental assessment has been prepared for a proposed decision to extend to one additional canola event our determination that a canola line developed by Monsanto Company, which has been genetically engineered for tolerance to the herbicide glyphosate, is no longer considered a regulated article under our regulations governing the introduction of certain genetically engineered organisms. We are making this environmental assessment available to the public for review and comment.

DATES: We will consider all comments we receive that are postmarked, delivered, or e-mailed by April 1, 2002.

ADDRESSES: You may submit comments by postal mail/commercial delivery or by e-mail. If you use postal mail/commercial delivery, please send four copies of your comment (an original and three copies) to: Docket No. 02–006–1, Regulatory Analysis and Development, PPD, APHIS, Station 3C71, 4700 River Road Unit 118, Riverdale, MD 20737–1238. Please state that your comment refers to Docket No. 02–006–1. If you use e-mail, address your comment to *regulations@aphis.usda.gov.* Your comment must be contained in the body of your message; do not send attached files. Please include your name and address in your message and ''Docket No. 02–006–1'' on the subject line.

You may read the extension request, the environmental assessment, and any comments we receive on this docket in our reading room. The reading room is located in room 1141 of the USDA South Building, 14th Street and Independence Avenue SW., Washington, DC. Normal reading room hours are 8 a.m. to 4:30 p.m., Monday through Friday, except holidays. To be sure someone is there to help you, please call (202) 690–2817 before coming.

APHIS documents published in the **Federal Register**, and related information, including the names of organizations and individuals who have commented on APHIS dockets, are available on the Internet at *http://www.aphis.usda.gov/ppd/rad/webrepor.html.*

FOR FURTHER INFORMATION CONTACT: Dr. James White, Plant Protection and Quarantine, APHIS, Suite 5B05, 4700 River Road Unit 147, Riverdale, MD 20737–1236; (301) 734–5940. To obtain a copy of the extension request or the environmental assessment, contact Ms. Kay Peterson at (301) 734–4885; e-mail: *Kay.Peterson@aphis.usda.gov.*

SUPPLEMENTARY INFORMATION: The regulations in 7 CFR part 340, ''Introduction of Organisms and Products Altered or Produced Through Genetic Engineering Which Are Plant Pests or Which There is Reason to Believe Are Plant Pests,'' regulate, among other things, the introduction (importation, interstate movement, or release into the environment) of organisms and products altered or produced through genetic engineering that are plant pests or that there is reason to believe are plant pests. Such genetically engineered organisms and products are considered ''regulated articles.''

The regulations in § 340.6(a) provide that any person may submit a petition to the Animal and Plant Health Inspection Service (APHIS) seeking a determination that an article should not be regulated under 7 CFR part 340. Further, the regulations in § 340.6(e)(2) provide that a person may request that APHIS extend a determination of nonregulated status to other organisms. Such a request must include information to establish the similarity of the antecedent organism and the regulated article in question.

Background

On November 20, 2001, APHIS received a request for an extension of a determination of nonregulated status (APHIS No. 01–324–01p) from Monsanto Company (Monsanto) of St. Louis, MO, for a canola (*Brassica napus* L.) transformation event designated as glyphosate-tolerant canola event GT200 (GT200), which has been genetically engineered for tolerance to the herbicide glyphosate. The Monsanto request seeks an extension of a determination of nonregulated status that was issued for Roundup Ready® canola line RT73, the antecedent organism, in response to APHIS petition number 98–216–01p (see 64 FR 5628–5629, Docket No. 98–089–2, published February 4, 1999). Based on the similarity of GT200 to the antecedent organism RT73, Monsanto requests a determination that glyphosate-tolerant canola event GT200 does not present a plant pest risk and, therefore, is not a regulated article under APHIS' regulations in 7 CFR part 340.

Analysis

Like the antecedent organism, canola event GT200 has been genetically engineered to express an enzyme, 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS), from *Agrobacterium* sp. strain CP4, and the glyphosate oxidoreductase (GOX) gene/protein from *Ochrobactrum anthropi* strain LBAA, both of which impart tolerance to the herbicide glyphosate. The subject canola and the antecedent organism were produced through use of the *Agrobacterium tumefaciens* method to transform the parental canola variety Westar. Expression of the added genes in GT200 and the antecedent organism is controlled in part by gene sequences derived from the plant pathogen figwort mosaic virus.

Canola event GT200 and the antecedent organism were genetically