Bureau of Land Management

Reno, Nevada



Diquat
Ecological Risk Assessment

Final Report

November 2005

Bureau of Land Management Contract No. NAD010156
ENSR Document Number 09090-020-650

Executive Summary

The United States Department of the Interior (USDI) Bureau of Land Management (BLM) is proposing a program to treat vegetation on up to six million acres of public lands annually in 17 western states in the continental United States (US) and Alaska. As part of this program, the BLM is proposing the use of ten herbicide active ingredients (a.i.) to control invasive plants and noxious weeds on approximately one million of the 6 million acres proposed for treatment. The BLM and its contractor, ENSR, are preparing a Vegetation Treatments Programmatic Environmental Impact Statement (EIS) to evaluate this and other proposed vegetation treatment methods and alternatives on lands managed by the BLM in the western continental US and Alaska. In support of the EIS, this Ecological Risk Assessment (ERA) evaluates the potential risks to the environment that would result from the use of the herbicide diquat, including risks to Rare, Threatened, and Endangered (RTE) plant and animal species.

One of the BLM's highest priorities is to promote ecosystem health, and one of the greatest obstacles to achieving this goal is the rapid expansion of invasive plants (including noxious weeds and other plants not native to the region) across public lands. These invasive plants can dominate and often cause permanent damage to natural plant communities. If not eradicated or controlled, invasive plants will jeopardize the health of public lands and the activities that occur on them. Herbicides are one method employed by the BLM to control these plants.

Herbicide Description

Diquat is a nonselective contact herbicide for the control of broad-leaf aquatic weeds post-emergence. This herbicide is a cell membrane disrupter that is activated by exposure to sunlight to form oxygen compounds that damage cell membranes.

Diquat is used by the BLM for vegetation control in their Aquatics program. Application (to ponds but not streams) is carried out through both aerial and ground dispersal. Aerial dispersal is executed through the use of a plane or helicopter. Ground applications are executed on foot or horseback with backpack sprayers and from all terrain vehicles or trucks equipped with spot or boom/broadcast sprayers. The BLM typically applies diquat at a rate of 1.0 pounds (lbs) a.i. per acre (a.i./ac). The maximum application rate is 4.0 lbs a.i./ac.

Ecological Risk Assessment Guidelines

The main objectives of this ERA were to evaluate the potential ecological risks from diquat to the health and welfare of plants and animals and their habitats and to provide risk managers with a range of generic risk estimates that vary as a function of site conditions. The categories and guidelines listed below were designed to help the BLM determine which of the proposed alternatives evaluated in the EIS should be used on BLM-managed lands.

- Exposure pathway evaluation – The effects of diquat on several ecological receptor groups (i.e., terrestrial animals, non-target terrestrial plants, fish and aquatic invertebrates, and non-target aquatic plants) via particular exposure pathways were evaluated. The resulting exposure scenarios included the following:
    - direct contact with the herbicide or a contaminated waterbody;
    - indirect contact with contaminated foliage;
    - ingestion of contaminated food items;
    - off-site drift of spray to terrestrial areas; and
    - accidental spills to waterbodies.
- Definition of data evaluated in the ERA – Herbicide concentrations used in the ERA were based on typical and maximum application rates provided by the BLM. These application rates were used to predict herbicide concentrations in various environmental media (e.g., soils, water). Some of these calculations required the

computer model AgDRIFT®, which was used to estimate off-site herbicide transport due to spray drift, and an additional sensitivity model designed to determine how pond and stream volumes affect exposure concentrations.

- Identification of risk characterization endpoints – Endpoints used in the ERA included acute mortality; adverse direct effects on growth, reproduction, or other ecologically important sublethal processes; and adverse indirect effects on the survival, growth, or reproduction of salmonid fish. Each of these endpoints was associated with measures of effect such as the No Observed Adverse Effect Level (NOAEL) and the median lethal effect dose and median lethal concentration (LD_{50} and LC_{50}).

- Development of a conceptual model – The purpose of the conceptual model is to display working hypotheses about how diquat might pose hazards to ecosystems and ecological receptors. This is shown via a diagram of the possible exposure pathways and the receptors evaluated for each exposure pathway.

In the analysis phase of the ERA, Estimated Exposure Concentrations (EECs) were identified for the various receptor groups in each of the applicable exposure scenarios via exposure modeling. Risk Quotients (RQs) were then calculated by dividing the EECs by herbicide- and receptor-specific or exposure media-specific Toxicity Reference Values (TRVs) selected from the available literature. These RQs were compared to Levels of Concern (LOCs) established by the US Environmental Protection Agency (USEPA) Office of Pesticide Programs (OPP) for specific risk presumption categories (i.e., acute high risk, acute high risk potentially mitigated through restricted use, acute high risk to endangered species, and chronic high risk).

Uncertainty

Uncertainty is introduced into the herbicide ERA through the selection of surrogates to represent a broad range of species on BLM-managed lands, the use of mixtures of diquat with other potentially toxic ingredients (i.e., degradates, inert ingredients, and adjuvants), and the estimation of effects via exposure concentration models. The uncertainty inherent in screening level ERAs is especially problematic for the evaluation of risks to RTE species, which are afforded higher levels of protection through government regulations and policies. To attempt to minimize the chances of underestimating risk to RTE and other species, the lowest toxicity levels found in the literature were selected as TRVs; uncertainty factors were incorporated into these TRVs; allometric scaling was used to develop dose values; model assumptions were designed to conservatively estimate herbicide exposure; and indirect as well as direct effects on species of concern were evaluated.

Herbicide Effects

Literature Review

According to the Ecological Incident Information System (EIIS) database run by the USEPA OPP, diquat has been associated with ten reported "ecological incidents" involving damage or mortality to non-target flora or fauna. It was listed as probable (seven incidents) or possible (three incidents) that registered use of diquat was responsible.

A review of the available ecotoxicological literature was conducted in order to evaluate the potential for diquat to negatively directly or indirectly affect non-target taxa. This review was also used to identify or derive TRVs for use in the ERA. The sources identified in this review indicate that diquat is moderately toxic to mammals, particularly via dermal exposure. Diquat is also moderately toxic to birds and honeybees (*Apis* spp.). In addition, adverse effects to non-target terrestrial plant species occurred with exposure to low concentrations of diquat (0.0047 lbs a.i./ac). Diquat has relatively low toxicity to fish and moderate toxicity to aquatic invertebrates. Diquat does not appear to appreciably bioconcentrate in fish tissue. Aquatic macrophytes were adversely affected by diquat concentrations as low as 0.00075 milligrams (mg) /liter (L) (typical herbicide application rates in this ERA resulted in pond concentrations of 0.11 mg a.i./L and stream concentrations of 0.56 mg a.i./L). There did not appear to be appreciable differences in

sensitivities among aquatic macrophytes, diatoms, and algae. No acute toxicity studies conducted on amphibian species were found in the literature reviewed.

Ecological Risk Assessment Results

Based on the ERA conducted for diquat, there is the potential for risk to ecological receptors from exposure to herbicides under specific conditions on BLM-managed lands. The following bullets summarize the risk assessment findings for diquat under each evaluated exposure scenario:

- Direct Spray – Risks were predicted for pollinating insects due to direct spray and indirect contact with contaminated foliage. Acute risks were predicted for 7 of 10 wildlife scenarios, and chronic risks were predicted for 6 of 10 wildlife scenarios (risk is somewhat lower at the typical application rate versus the maximum rate). Risk to terrestrial and aquatic non-target plants, fish, and aquatic invertebrates is likely when waterbodies are accidentally or intentionally (pond applications) sprayed. No risks were predicted for piscivorous wildlife.

- Off-Site Drift to Non-Target Terrestrial Plants – Risks to typical and RTE terrestrial plant species were predicted within 900 feet (ft) of all aerial applications at both the typical and maximum application rates. Risk quotients were also elevated for typical and RTE plant species within 100 ft of ground applications (low and high booms).

- Accidental Spill to Pond – Risk to fish, aquatic invertebrates, and non-target aquatic plants is likely when herbicides are spilled directly into the pond.

In addition, species that depend on non-target species for habitat, cover, and/or food may be indirectly impacted by possible reductions in terrestrial or aquatic vegetation or effects on terrestrial and aquatic wildlife, particularly in accidental direct spray and spill scenarios. For example, RTE salmonids may be indirectly impacted by a reduction in food supply (i.e., fish and aquatic invertebrates) or a reduction in vegetative cover in the relatively unlikely case of an accidental spill to the stream.

Based on the results of the ERA, it is unlikely that RTE species would be harmed by appropriate use (see following section) of the herbicide diquat on BLM-managed lands. Although non-target terrestrial plants have the potential to be adversely affected by off-site drift of diquat, adherence to certain application guidelines (e.g., defined application rates, equipment, herbicide mixture, and downwind distance to potentially sensitive habitat) would minimize the potential effects on non-target plants and associated indirect effects on species that depend on those plants for food, habitat, and cover.

Recommendations

The following recommendations are designed to reduce potential unintended impacts to the environment from the application of diquat:

- Select herbicide products carefully to minimize additional impacts from adjuvants. This is especially important for application scenarios that already predict potential risk from the a.i. itself.

- Review, understand, and conform to "Environmental Hazards" section on herbicide label. This section warns of known pesticide risks to wildlife receptors or to the environment and provides practical ways to avoid harm to organisms or the environment.

- Avoid accidental direct spray and spill conditions to reduce the greatest potential impacts.

- Use the typical application rate, rather than the maximum application rate, to reduce risk to some wildlife receptors (e.g., large carnivore, small bird).

- Use ground application methods at the typical or maximum application rate with buffer zones of more than 100 ft to reduce potential risks to typical terrestrial plants from off-site drift.

- To reduce potential risks to RTE terrestrial plants from off-site drift during ground applications, use buffer zones of more than 100 ft at the typical rate, or buffer zones of at least 1,000 ft when using the maximum application rate (based on basic regression evaluation of RQs and distance).

- Buffer zones of greater than 900 ft may be necessary if aerial application is planned. Regression analysis indicates that a buffer zone of 1,200 ft should be protective of typical and RTE plant species.

- Avoid application to ponds where RTE species have been identified.

The results from this ERA assist the evaluation of proposed alternatives in the EIS and contribute to the development of a Biological Assessment (BA), specifically addressing the potential impacts to proposed and listed RTE species on western BLM treatment lands. Furthermore, this ERA will inform BLM field offices on the proper application of diquat to ensure that impacts to plants and animals and their habitat are minimized to the extent practical.

TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1-1
1.1 Objectives of the Ecological Risk Assessment 1-1

2.0 BLM HERBICIDE PROGRAM DESCRIPTION 2-1
2.1 Problem Description 2-1
2.2 Herbicide Description 2-1
2.3 Herbicide Incident Reports 2-2

3.0 HERBICIDE TOXICOLOGY, PHYSICAL-CHEMICAL PROPERTIES, AND ENVIRONMENTAL FATE 3-1
3.1 Herbicide Toxicology 3-1
3.1.1 Overview 3-1
3.1.2 Toxicity to Terrestrial Organisms 3-2
3.1.2.1 Mammals 3-2
3.1.2.2 Birds 3-2
3.1.2.3 Terrestrial Invertebrates 3-3
3.1.2.4 Terrestrial Plants 3-3
3.1.3 Toxicity to Aquatic Organisms 3-3
3.1.3.1 Fish 3-3
3.1.3.2 Amphibians 3-4
3.1.3.3 Aquatic Invertebrates 3-4
3.1.3.4 Aquatic Plants 3-4
3.2 Herbicide Physical-Chemical Properties 3-5
3.3 Herbicide Environmental Fate 3-6

4.0 ECOLOGICAL RISK ASSESSMENT 4-1
4.1 Problem Formulation 4-1
4.1.1 Definition of Risk Assessment Objectives 4-1
4.1.2 Ecological Characterization 4-1
4.1.3 Exposure Pathway Evaluation 4-1
4.1.4 Definition of Data Evaluated in the ERA 4-2
4.1.5 Identification of Risk Characterization Endpoints 4-2
4.1.6 Development of the Conceptual Model 4-3
4.2 Analysis Phase 4-4
4.2.1 Characterization of Exposure 4-4
4.2.1.1 Direct Spray 4-5
4.2.1.2 Off-site Drift 4-6
4.2.1.3 Accidental Spill to Pond 4-6
4.2.2 Effects Characterization 4-6
4.3 Risk Characterization 4-7
4.3.1 Direct Spray 4-7
4.3.1.1 Terrestrial Wildlife 4-7
4.3.1.2 Non-target Plants – Terrestrial and Aquatic 4-8
4.3.1.3 Fish and Aquatic Invertebrates 4-8
4.3.1.4 Piscivorous Birds 4-8
4.3.2 Off-site Drift to Terrestrial Plants 4-8
4.3.3 Accidental Spill to Pond 4-9
4.3.4 Potential Risk to Salmonids from Indirect Effects 4-9
4.3.4.1 Qualitative Evaluation of Impacts to Prey 4-9

4.3.4.2 Qualitative Evaluation of Impacts to Vegetative Cover 4-10
4.3.4.3 Conclusions 4-10

5.0 SENSITIVITY ANALYSIS 5-1
5.1 Pond Volume and Stream Flow Sensitivity 5-1
5.2 AgDRIFT® Sensitivity 5-1

6.0 RARE, THREATENED, AND ENDANGERED SPECIES 6-1
6.1 Use of LOCs and TRVs to Provide Protection 6-2
6.2 Use of Species Traits to Provide Protection to RTE Species 6-2
6.2.1 Identification of Surrogate Species 6-3
6.2.1.1 Species Selected in Development of TRVs 6-3
6.2.1.2 Species Selected as Surrogates in the ERA 6-4
6.2.2 Surrogates Specific to Taxa of Concern 6-4
6.2.3 Biological Factors Affecting Impact from Herbicide Exposure 6-6
6.3 Review of Extrapolation Methods Used to Calculate Potential Exposure and Risk 6-6
6.3.1 Uncertainty Factors 6-6
6.3.2 Allometric Scaling 6-7
6.3.3 Recommendations 6-7
6.4 Indirect Effects on Salmonids 6-8
6.4.1 Biological Disturbance 6-8
6.4.2 Physical Disturbance 6-9
6.5 Conclusions 6-9

7.0 UNCERTAINTY IN THE ECOLOGICAL RISK ASSESSMENT 7-1
7.1 Toxicity Data Availability 7-1
7.2 Potential Indirect Effects on Salmonids 7-3
7.3 Ecological Risks of Degradates, Inert Ingredients, Adjuvants, and Tank Mixtures 7-3
7.3.1 Degradates 7-3
7.3.2 Inerts 7-3
7.3.3 Adjuvants and Tank Mixtures 7-5
7.3.3.1 Adjuvants 7-5
7.3.3.2 Tank Mixtures 7-6
7.4 Uncertainty Associated with Herbicide Exposure Concentration Models 7-6
7.4.1 AgDRIFT® 7-7
7.5 Summary of Potential Sources of Uncertainty 7-7

8.0 SUMMARY 8-1
8.1 Recommendations 8-1

9.0 REFERENCES 9-1

APPENDIXES

Appendix A – Summary of Available and Relevant Toxicity Data for Diquat/Ecological Risk Assessment Literature Review – Diquat

Appendix A.1 – Bibliography List

Appendix A.2 – Tier II and III Literature Review Forms

Appendix A.3 – Spreadsheet of Toxicity Data for Diquat TRV

Appendix B – Ecological Risk Assessment Worksheets

Appendix C – Species Listed Under the Endangered Species Act for 17 BLM States

Appendix D – Review of Confidential Business Information Memo

LIST OF TABLES

2-1 BLM Diquat Use Statistics 2-3
3-1 Selected Toxicity Reference Values for Diquat 3-7
3-2 Physical-Chemical Properties of Diquat. 3-9
4-1 Levels of Concern 4-11
4-2 Risk Quotients for Direct Spray and Spill Scenarios 4-12
4-3 Risk Quotients for Off-Site Drift Scenarios 4-14
5-1 Relative Effects of Pond Variables on Herbicide Exposure Concentrations using Typical BLM Application Rate 5-4
5-2 Relative Effects of Stream Variables on Herbicide Exposure Concentrations using Typical BLM Application Rate 5-4
5-3 Herbicide Exposure Concentrations used during the Supplemental AgDRIFT® Sensitivity Analysis 5-5
6-1 Surrogate Species Used to Derive Diquat TRVs 6-11
6-2 Surrogate Species Used in Quantitative ERA Evaluation 6-11
6-3 Rare, Threatened, and Endangered Birds and Selected Surrogates 6-12
6-4 Rare, Threatened, and Endangered Mammals and Selected Surrogates 6-13
6-5 Rare, Threatened, and Endangered Reptiles and Selected Surrogates 6-14
6-6 Rare, Threatened, and Endangered Amphibians and Selected Surrogates 6-14
6-7 Species and Organism Traits That May Influence Herbicide Exposure and Response 6-15
6-8 Summary of Findings: Interspecific Extrapolation Variability 6-16
6-9 Summary of Findings: Intraspecific Extrapolation Variability 6-16
6-10 Summary of Findings: Acute-to-Chronic Extrapolation Variability 6-16
6-11 Summary of Findings: LOAEL-to-NOAEL Extrapolation Variability 6-16
6-12 Summary of Findings: Laboratory to Field Extrapolations 6-17
7-1 Potential Sources of Uncertainty in the ERA Process 7-8
8-1 Summary of Risk Categories for Diquat 8-3

LIST OF FIGURES

4-1 Conceptual Model for Aquatic Herbicides 4-15
4-2 Simplified Food Web 4-16
4-3 Direct Spray - Risk Quotients for Terrestrial Animals 4-17
4-4 Direct Spray - Risk Quotients for Non-Target Terrestrial Plants 4-18
4-5 Accidental Direct Spray and Spills - Risk Quotients for Non-Target Aquatic Plants 4-19
4-6 Accidental Direct Spray and Spills - Risk Quotients for Fish 4-20
4-7 Accidental Direct Spray and Spills - Risk Quotients for Aquatic Invertebrates 4-21
4-8 Off-site Drift - Risk Quotients for Non-Target Terrestrial Plants 4-22

LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS

ac	-	acres
a.i.	-	active ingredient
BA	-	Biological Assessment
BCF	-	Bioconcentration Factor
BLM	-	Bureau of Land Management
BO	-	Biological Opinion
BW	-	Body Weight
CALPUFF	-	California Puff
CBI	-	Confidential Business Information
cms	-	Cubic meters per second
CWE	-	Cumulative Watershed Effect
DPR	-	Department of Pesticide Registration
EC_{25}	-	Concentration causing 25% inhibition of a process (Effect Concentration)
EC_{50}	-	Concentration causing 50% inhibition of a process (Median Effective Concentration)
Ed.	-	Edition
EEC	-	Estimated Exposure Concentration
EIS	-	Environmental Impact Statement
EIIS	-	Ecological Incident Information System
EFED	-	Environmental Fate and Effects Division
ERA	-	Ecological Risk Assessment
ESA	-	Endangered Species Act
FIFRA	-	Federal Insecticide, Fungicide, and Rodenticide Act
FOIA	-	Freedom of Information Act
ft	-	feet
g	-	grams
gal	-	gallon
GLEAMS	-	Groundwater Loading Effects of Agricultural Management Systems
HHRA	-	Human Health Risk Assessment
HSDB	-	Hazardous Substances Data Bank
IPM	-	Integrated Pest Management
IRIS	-	Integrated Risk Information System
ISO	-	International Organization for Standardization
Kd	-	Partition coefficient
kg	-	kilogram
K_{oc}	-	Organic carbon-water partition coefficient
K_{ow}	-	Octanol-water partition coefficient
L	-	Liters
lb(s)	-	pound(s)
LC_{50}	-	Concentration causing 50% mortality (Median Lethal Concentration)
LD_{50}	-	Dose causing 50% mortality (Median Lethal Dose)
LOAEL	-	Lowest Observed Adverse Effect Level
LOC(s)	-	Level(s) of Concern
Log	-	Common logarithm (base 10)
m	-	meters
mg	-	milligrams

LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS (Cont.)

mg/kg	-	milligrams per kilogram
mg/L	-	milligrams per liter
mmHg	-	millimeters of mercury
MSDS	-	Material Safety Data Sheet
MRID	-	Master Record Identification Number
MW	-	Molecular Weight
NOAA	-	National Oceanic and Atmospheric Administration
NOAEL	-	No Observed Adverse Effect Level
OPP	-	Office of Pesticide Programs
OPPTS	-	Office of Pollution Prevention and Toxic Substances
ORNL	-	Oak Ridge National Library
ppm	-	parts per million
RQ	-	Risk Quotient
RTE	-	Rare, Threatened, and Endangered
RTEC	-	Registry of Toxic Effects of Chemical Substances
SDTF	-	Spray Drift Task Force
TOXNET	-	National Library of Medicines Toxicology Data Network
TP	-	Transformation Product
TRV	-	Toxicity Reference Value
TSCA	-	Toxic Substances Control Act
US	-	United States
USDA	-	United States Department of Agriculture
USDI	-	United States Department of the Interior
USEPA	-	United States Environmental Protection Agency
USFWS	-	United States Fish and Wildlife Service
µg	-	micrograms
>	-	greater than
<	-	less than
=	-	equal to

1.0 INTRODUCTION

The United States Department of the Interior Bureau of Land Management (USDI BLM) is proposing a program to treat vegetation on up to six million acres of public lands annually in 17 western states in the continental US and Alaska. The primary objectives of the proposed program include fuels management, weed control, and fish and wildlife habitat restoration. Vegetation would be managed using five primary vegetation treatment methods - mechanical, manual, biological, chemical, and prescribed fire.

The BLM is preparing a *Vegetation Treatments Programmatic EIS* to evaluate proposed vegetation treatment methods and alternatives on lands managed by the BLM in the western continental US and Alaska (USDI BLM 2005). As part of the EIS, several ERAs and a *Human Health Risk Assessment* (HHRA; ENSR 2004b) were conducted on several herbicides used, or proposed for use, by the BLM. These risk assessments evaluate potential risks to the environment and human health from exposure to these herbicides both during and after treatment of public lands. For the ERAs, the herbicide active ingredients evaluated were tebuthiuron, diuron, bromacil, chlorsulfuron, sulfometuron-methyl, diflufenzopyr, Overdrive® (a mix of dicamba and diflufenzopyr), imazapic, diquat, and fluridone. The HHRA evaluated the risks to humans from only six active ingredients (sulfometuron-methyl, imazapic, diflufenzopyr, dicamba, diquat, and fluridone) because the other active ingredients were already quantitatively evaluated in previous EISs (e.g., BLM 1991). [Note that in the HHRA, Overdrive® was evaluated as its two separate components, dicamba and diflufenzopyr, as these two active ingredients have different toxicological endpoints, indicating that their effects on human health are not additive.] The purpose of this document is to summarize results of the ERA for the herbicide diquat.

Updated risk assessment methods were developed for both the HHRA and ERA and are described in a separate document, *Vegetation Treatments Programmatic EIS Ecological Risk Assessment Methodology* (hereafter referred to as the "Methods Document;" ENSR 2004c). The methods document provides, in detail, specific information and assumptions used in three models utilized for this ERA (exposure point modeling using Groundwater Loading Effects of Agricultural Management Systems [GLEAMS], AgDRIFT®, and California Puff [CALPUFF]).

1.1 Objectives of the Ecological Risk Assessment

The purpose of the ERA is to evaluate the ecological risks of ten herbicides on the health and welfare of plants and animals and their habitats, including threatened and endangered species. This analysis will be used by the BLM, in conjunction with analyses of other treatment effects on plants and animals, and effects of treatments on other resources, to determine which of the proposed treatment alternatives evaluated in the EIS should be used by the BLM. The BLM Field Offices will also utilize this ERA for guidance on the proper application of herbicides to ensure that impacts to plants and animals are minimized to the extent practical when treating vegetation. The US Fish and Wildlife Service (USFWS) and National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries), in their preparation of a Biological Opinion (BO), will also use the information provided by the ERA to assess the potential impact of vegetation treatment actions on fish and wildlife and their critical habitats.

This ERA, which provides specific information regarding the use of the terrestrial herbicide diquat, contains the following sections:

Section 1: Introduction

Section 2: BLM Herbicide Program Description – This section contains information regarding herbicide formulation, mode of action, and specific BLM herbicide use, which includes application rates and methods of dispersal. This section also contains a summary of incident reports documented with the United States Environmental Protection Agency (USEPA).

Section 3: Herbicide Toxicology, Physical-Chemical Properties, and Environmental Fate – This section contains a summary of scientific literature pertaining to the toxicology and environmental fate of diquat in terrestrial and aquatic environments, and discusses how its physical-chemical properties are used in the risk assessment.

Section 4: Ecological Risk Assessment – This section describes the exposure pathways and scenarios and the assessment endpoints, including potential measured effects. It provides quantitative estimates of risks for several risk pathways and receptors.

Section 5: Sensitivity Analysis – This section describes the sensitivity of each of three models used for the ERA to specific input parameters. The importance of these conditions to exposure concentration estimates is discussed.

Section 6: Rare, Threatened, and Endangered Species (RTE) – This section identifies RTE species potentially directly and/or indirectly affected by the herbicide program. It also describes how the ERA can be used to evaluate potential risks to RTE species.

Section 7: Uncertainty in the Ecological Risk Assessment – This section describes data gaps and assumptions made during the risk assessment process and how uncertainty should be considered in interpreting results.

Section 8: Summary – This section provides a synopsis of the ecological receptor groups, application rates, and modes of exposure. This section also provides a summary of the factors that most influence exposure concentrations with general recommendations for risk reduction.

2.0 BLM HERBICIDE PROGRAM DESCRIPTION

2.1 Problem Description

One of the BLM's highest priorities is to promote ecosystem health, and one of the greatest obstacles to achieving this goal is the rapid expansion of weeds across public lands. These invasive plants can dominate and often cause permanent damage to natural plant communities. If not eradicated or controlled, noxious weeds will jeopardize the health of public lands and the myriad of activities that occur on them. The BLM's ability to respond effectively to the challenge of noxious weeds depends on the adequacy of the agency's resources.

Millions of acres of once healthy, productive rangelands, forestlands and riparian areas have been overrun by noxious or invasive weeds. Noxious weeds are any plant designated by a federal, state, or county government as injurious to public health, agriculture, recreation, wildlife, or property (Sheley et al. 1999). Invasive plants include not only noxious weeds, but also other plants that are not native to the region. The BLM considers plants invasive if they have been introduced into an environment where they did not evolve. Invasive plants usually have no natural enemies to limit their reproduction and spread (Westbrooks 1998). They invade recreation areas, BLM-managed public lands, National Parks, State Parks, roadsides, streambanks, federal, state, and private lands. Invasive weeds can:

- destroy wildlife habitat, reduce opportunities for hunting, fishing, camping and other recreational activities;
- displace RTE species and other species critical to ecosystem functioning (e..g, riparian plants);
- reduce plant and animal diversity;
- invade following wildland and prescribed fire (potentially into previously unaffected areas), limiting regeneration and establishment of native species and rapidly increasing acreage of infested land;
- increase fuel loads and decrease the length of fire cycles and/or increase the intensity of fires;
- disrupt waterfowl and neo-tropical migratory bird flight patterns and nesting habitats; and
- cost millions of dollars in treatment and loss of productivity to private land owners.

The BLM uses an Integrated Pest Management (IPM) approach to manage invasive plants. Management techniques may be biological, mechanical, chemical, or cultural. Many herbicides are currently used by the BLM under their chemical control program. This report considers the impact to ecological receptors (animals and plants) from the use of the herbicide diquat for the management of vegetation on BLM lands.

2.2 Herbicide Description

The herbicide-specific use-criteria discussed in this document were obtained from the product label as registered with the USEPA as it applies to the proposed BLM use. Diquat application rates and methods discussed in this section are based on proposed BLM herbicide use and are in accordance with herbicide labels approved by the USEPA. The BLM should be aware of all state-specific label requirements and restrictions. In addition, new USEPA approved herbicide labels may be issued after publication of this report, and BLM land managers should be aware of all newly approved federal, state, and local restrictions on herbicide use when planning vegetation management programs.

Diquat is a nonselective contact herbicide for the management of aquatic weed species. This herbicide is a cell membrane disrupter that is activated by exposure to sunlight to form oxygen compounds that damage cell membranes.

Diquat is proposed for use by the BLM in their Aquatics vegetation management program. The majority of application occurs in inland freshwater habitats; diquat is rarely used in marine or estuarine habitats. Application is carried out through both aerial and ground dispersal. Aerial dispersal is executed through the use of a plane or helicopter. Ground applications are executed on foot or horseback with backpack sprayers and from all terrain vehicles or trucks equipped with spot or boom/broadcast sprayers. In addition, applications will be made using a boat with either a handgun, which will be used to make spot treatments, or a boom, which will be used to make broadcast applications on top of or under the water surface. The BLM typically applies diquat at a rate of 1.0 lbs a.i./ac. The maximum application rate is 4.0 lbs a.i./ac. Details regarding expected diquat usage by the BLM are provided in Table 2-1 at the end of this section.

2.3 Herbicide Incident Reports

An "ecological incident" occurs when non-target flora or fauna is killed or damaged due to application of a pesticide. When ecological incidents are reported to a state agency or other proper authority, they are investigated and an ecological incident report is generated. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) requires product registrants to report adverse effects of their product to the USEPA.

The USEPA OPP manages a database, the EIIS, which contains much of the information in the ecological incident reports. As part of this risk assessment, USEPA was requested to provide all available incident reports in the EIIS that listed diquat as a potential source of the observed ecological damage.

The USEPA EIIS contained ten incident reports involving diquat. In seven incidents, mortality of fish and other fauna were attributed to diquat; three incidents involved plant damage. Two of the seven incidents had references to additional pesticide use (malathion and copper sulfate). The incident reports listed the likelihood that diquat actually caused the observed damaged as "probable" in seven incidents and "possible" in three incidents. A summary of these incidents is provided in Table 2-2 at the end of this section.

TABLE 2-1

BLM Diquat Use Statistics

Program	Scenario	Vehicle	Method	Used?	Application Rate	
					Typical (lbs a.i./ac)	Maximum (lbs a.i./ac)
Rangeland				No		
Public-Domain Forest Land				No		
Energy & Mineral Sites				No		
Rights-of-way				No		
Recreation				No		
Aquatic	Aerial	Plane	Fixed Wing	Yes	1.0	4.0
		Helicopter	Rotary	Yes	1.0	4.0
	Ground	Human	Backpack	Yes	1.0	4.0
			Horseback	Yes	1.0	4.0
		ATV	Spot	Yes	1.0	4.0
			Boom/Broadcast	Yes	1.0	4.0
		Truck	Spot	Yes	1.0	4.0
			Boom/Broadcast	Yes	1.0	4.0

TABLE 2-2

Diquat Incident Report Summary

Year	Application Area	Incident Type	Diquat Certainty	Other[1]	Dispersal	Organism	Distance[2]	Magnitude of Damage
1982	NA	Undetermined	Probable	Yes	Direct	Spot, Mullet, Trout, Drum,	Vicinity	Mortality
1993	Pond	Registered Use	Possible	No	Direct	Carp, Bream	Adjacent	Mortality - 15 carp, 10 bream
1994	Drain	Intentional Misuse	Probable	No	NA	Fish	Vicinity	Mortality - Unknown
1994	Municipal Operation	Undetermined	Possible	Yes	Direct	Frogs, Wildflowers	Vicinity	Mortality - Unknown
1995	Agricultural	Accident	Probable	No	Drift	Strawberry	Adjacent	Unknown
1998	Pond	Registered Use	Probable	No	Direct	Bass	0	Mortality
1999	Agricultural	Misuse	Probable	No	Drift	Alfalfa	NA	Plant damage
2001	Pond	Accident	Probable	No	Direct	Turtle, Alligator	0	Mortality - 400 turtles, 3 alligator
2002	Lake	Registered Use	Probable	Yes	Direct	Clams	0	Mortality - thousands
2003	NA	Undetermined	Possible	No	Drift	Spinach	NA	Plant damage - unknown

[1] Other = other chemicals used in conjunction with diquat (yes/no).
[2] Distance = estimated distance from application area.
NA = information not available.

3.0 HERBICIDE TOXICOLOGY, PHYSICAL-CHEMICAL PROPERTIES, AND ENVIRONMENTAL FATE

This section summarizes available herbicide toxicology information, describes how this information was obtained, and provides a basis for the level of concern values selected for this risk assessment. Diquat's physical-chemical properties and environmental fate are also discussed.

3.1 Herbicide Toxicology

A review of the available ecotoxicological literature was conducted in order to evaluate the potential for diquat to negatively effect the environment and to derive TRVs for use in the ERA (provided in italics in sections 3.1.2 and 3.1.3). The process for the literature review and the TRV derivation is provided in the Methods Document (ENSR 2004c). This review generally included a review of published manuscripts and registration documents, information obtained through a Freedom of Information Act (FOIA) request to EPA, electronic databases (e.g., EPA pesticide ecotoxicology database, EPA's on-line ECOTOX database), and other internet sources. This review included both freshwater and marine/estuarine data, although the focus of the review was on the freshwater habitats more likely to occur on BLM lands.

Endpoints for aquatic receptors and terrestrial plants were reported based on exposure concentrations (mg/L and lbs/ac, respectively). Dose-based endpoints (e.g., LD_{50}s) were used for birds and mammals. When possible, dose-based endpoints were obtained directly from the literature. When dosages were not reported, dietary concentration data were converted to dose-based values (e.g., LC_{50} to LD_{50}) following the methodology recommended in USEPA risk assessment guidelines (Sample et al. 1996). Acute TRVs were derived first to provide an upper boundary for the remaining TRVs; chronic TRVs were always equivalent to, or less than, the acute TRV. The chronic TRV was established as the highest NOAEL value that was less than both the chronic Lowest Observed Adverse Effect Level (LOAEL) and the acute TRV. When acute or chronic toxicity data was unavailable, TRVs were extrapolated from other relevant data using an uncertainty factor of 3, as described in the Methods Document (ENSR 2004c).

This section reviews the available information identified for diquat and presents the TRVs selected for this risk assessment (Table 3-1). Appendix A presents a summary of the diquat data identified during the literature review. Toxicity data are presented in the units used in the reviewed study. In most cases this applies to the a.i. itself (e.g., diquat); however, some data correspond to a specific product or applied mixture (e.g., Reward®) containing the a.i. under consideration, and potentially other ingredients (e.g., other active ingredients or inert ingredients). This topic, and others related to the availability of toxicity data, is discussed in Section 7.1 of the Uncertainty section. The review of the toxicity data did not focus on the potential toxic effects of inert ingredients (inerts), adjuvants, surfactants, and degradates. Section 7.3 of the Uncertainty section discusses the potential impacts of these constituents in a qualitative manner.

3.1.1 Overview

Test materials for diquat dibromide (technical product) frequently contain 40% or less of diquat cation, and this is the highest purity produced (USEPA 1995a). Accordingly, most TRVs were based on products containing less than 100% a.i.. However, this toxicity data represents the potential impacts due to the types of formulations that BLM would likely use. End-use products (commercial herbicide products) contain only 2 percent more water than technical diquat. Consequently, the toxicity of diquat does not appreciably differ among various formulations (USEPA 1995a). Diquat is moderately toxic to mammals, particularly via dermal exposure. Diquat is also moderately toxic to birds and

honeybees. In addition, adverse effects to non-target terrestrial plant species occurred with exposure to low concentrations of diquat (0.0046 lbs a.i./ac – 0.5% of the typical application rate).

According to USEPA ecotoxicity classifications presented in registration materials[1], diquat has relatively low toxicity to fish and moderate toxicity to aquatic invertebrates. Diquat does not appear to appreciably bioconcentrate in fish tissue. No acute toxicity studies conducted on amphibian species were found in the literature reviewed. Aquatic macrophytes were adversely affected by diquat concentrations as low as 0.00075 mg/L. There did not appear to be appreciable differences in sensitivities among aquatic macrophytes, diatoms, and algae.

3.1.2 Toxicity to Terrestrial Organisms

Although diquat is an aquatic herbicide, it is important to discuss the herbicide's potential impacts on terrestrial organisms, as terrestrial exposure to diquat could occur as a result of off-site drift or an accidental application.

3.1.2.1 Mammals

According to USEPA reregistration eligibility documents (USEPA 1995a), diquat is considered to be moderately toxic to mammals. Acute dermal exposure to concentrations of 262 mg a.i./kilogram (kg) BW caused 50 percent mortality in rabbits (*Leporidae* sp.; the LD_{50}) (USEPA 1995a, Master Record Identification Number [MRID] 001000614). In subchronic dermal exposures lasting 21 to 28 days, the LOAEL was 5 mg a.i./kg BW for rats (*Rattus norvegicus* spp.; USEPA 2002, MRID 40308101). Diquat also caused mortality when administered via oral dosing or the diet. In studies where rats were given a single oral gavage, the reported LD_{50} value was 121 mg/kg BW using technical grade diquat (no % a.i. listed; Gaines and Linder 1986). In a 2-year feeding study, rats exhibited adverse effects when fed dietary concentrations of 75 parts per million (ppm; equivalent to 2.9 mg a.i./kg BW-day), while no adverse effects were observed in rats fed 15 ppm (equivalent to 0.58 mg a.i./kg BW-day) (USEPA 2002, MRID 00145855 and MRID 41085601). No adverse effects to reproduction were reported in a chronic feeding study where rodents were exposed to 16 ppm diquat (0.8 mg a.i./kg BW-day) (USEPA 2002, MRID 41531301).

Based on these findings, the oral LD_{50} (121 mg/kg BW) and chronic dietary NOAEL (0.8 mg a.i./kg BW-day) were selected as the dietary small mammal TRVs. The dermal small mammal TRV was established at 262 mg a.i./kg BW.

Toxicity data for large mammals was limited to a single long-term dietary study. In this one-year feeding study, beagle dogs (*Canis familiaris*) exhibited adverse effects (changes in body and epididymides weight, cataracts in the eye) when fed dietary concentrations of 105 ppm (equivalent to 2.5 mg a.i./kg BW-day). No adverse effects occurred at 21 ppm (equivalent to 0.5 mg a.i./kg BW-day) (USEPA 2002, MRID 41730301).

Since no large mammal LD_{50}s were identified in the available literature, the small mammal dermal LD_{50} was used as a surrogate value. The large mammal dietary NOAEL TRV was established at 0.5 mg a.i./kg BW-day.

3.1.2.2 Birds

Data from available literature indicate that diquat has moderate toxicity to birds. In acute oral exposures, 50 percent of mallards (*Anas platyrhynchos*) died when exposed to a single oral dose of 60.6 mg/kg BW of a 45% diquat product (USEPA 2003, MRID 00106559). Acute dietary tests reported 50 percent mortality in ring-necked pheasant (*Coturnix coturnix*) and Japanese quail (*Coturnix coturnix*) fed concentrations as low as 734 and 264 ppm (equivalent to 43 and 30 mg a.i./kg BW-day, respectively) (USEPA 1995a, MRID 00034769 and MRID 00116565). In these dietary tests, the test organism was presented with the dosed food for 5 days, with 3 days of additional observations after the dosed food was removed. The endpoint reported for this assay is generally an LC_{50} representing mg a.i./ kg food. This concentration-based value was converted to a dose-based value following the methodology presented in the Methods Document (ENSR 2004c). Then the dose-based value was multiplied by the number of days of exposure (generally 5)

[1] Available at http://www.epa.gov/oppefed1/ecorisk_ders/toera_analysis_eco.htm#Ecotox

to result in an LD_{50} value representing the full herbicide exposure over the course of the test. This resulted in LD_{50} values of 150 mg a.i./kg BW and 215 mg a.i./kg BW for the Japanese quail and pheasant, respectively.

Long-term dietary exposure to diquat also elicited adverse effects in birds. Mallards exposed to diquat for an entire generation showed adverse effects when fed 25 ppm, equivalent to a dose of 2.5 mg a.i./kg BW-day (USEPA 2003, MRID 00114230). No adverse effects were noted at dietary concentrations of 5 ppm, equivalent to 0.6 mg a.i./kg BW-day. In bobwhite quail (*Colinus virginianus*), chronic dietary exposure failed to cause adverse effects at concentrations of 20 ppm, equivalent to a dose level of 12 mg a.i./kg BW-day (USEPA 2003, MRID 00119988).

Based on these findings, the Japanese quail dietary LD_{50} (150 mg a.i./kg BW) and the bobwhite quail chronic NOAEL (12 mg a.i./kg BW-day) were selected as the small bird dietary TRVs. The pheasant dietary LD_{50} (215 mg a.i./kg BW) and the mallard dietary chronic NOAEL (0.6 mg a.i./kg BW-day) were selected as the large bird dietary TRVs.

3.1.2.3 Terrestrial Invertebrates

A standard acute contact toxicity bioassay in honeybees is required for the USEPA pesticide registration process. In this study, technical diquat was directly applied to the bee's thorax and mortality was assessed during a 48-hr period. The USEPA reports a LD_{50} value of 100 micrograms (µg)/bee using a 99.6% diquat product (USEPA 2003, MRID 00072012). A similar study conducted for 5 days reported an LD_{50} of 47 µg/bee and a no effect level of 16 µg/bee using technical grade diquat (no % a.i. listed) (USEPA 2003, MRID 40208001).

The honeybee dermal TRV was set at 47 µg/bee, the 5 day LD_{50} value. Based on a honeybee weight of 0.093 g, this TRV was expressed as 505 mg/kg BW.

3.1.2.4 Terrestrial Plants

Toxicity tests were conducted on numerous, non-target plant species (plants tested were vegetable crop species and not western rangeland or forest species). Endpoints in the terrestrial plant toxicity tests were generally related to seed germination, seed emergence, and sub-lethal (i.e. growth) impacts observed during vegetative vigor assays. One study evaluated seed germination and emergence, and the remaining studies assessed vegetative vigor. Seed germination and emergence were evaluated by applying the herbicide to soil containing newly sown seed of 10 crop species. In this study, no effect to plants was observed at 7.49 lb a.i./ac (USEPA 1995a, MRID 40165101). However, a separate study indicated that vegetative vigor was a more sensitive endpoint. Vigor was adversely affected (25 percent of the plants affected; i.e., Effect Concentration [EC_{25}]) in plants exposed to concentrations as low as 0.0047 lb a.i./ac (USEPA 1995a, MRID 41883001).

Two endpoints were used to evaluate terrestrial plant scenarios for aquatic herbicides. These included an EC_{25} and a NOAEL. Since the lowest EC_{25} identified in the database was lower than the lowest reported NOAEL, the terrestrial plant NOAEL was calculated by dividing the EC_{25} value by an uncertainty factor of 3. This uncertainty factor was selected based on a review of the application of uncertainty factors (Chapman et al. 1998) and the use of uncertainty factors for this assessment is described in the Methods Document (ENSR 2004c). The resulting NOAEL TRV was 0.0016 lb a.i./ac derived from the EC_{25} of 0.0047 lb a.i./ac.

3.1.3 Toxicity to Aquatic Organisms

3.1.3.1 Fish

The toxicity of diquat to freshwater fish was evaluated by testing both cold- and warmwater fish species. The acute toxic effects of diquat were evaluated for rainbow trout (*Oncorhynchus mykiss*), coho salmon (*Oncorhynchus kisutch*), and brown trout (*Salmo trutta*; coldwater fish species). These studies found 50% mortality occurred after 96 hours of exposure to concentrations (i.e., the LC_{50}) of 14.83 mg/L using a 19.8% diquat product (USEPA 2003, MRID 00138961). Acute toxicity tests were also conducted on 12 warmwater fish species. In these studies, the 96-hr LC_{50} was found to be as low as 0.75 mg a.i./L (Paul et al. 1994).

In chronic studies, the LOAEL in coldwater fish was 0.5 mg a.i./L based on reduced swimming performance in rainbow trout (Dodson and Mayfield 1979). In this study, the NOAEL was less than 0.5 mg a.i./L, the lowest concentration tested. For warmwater fish, chronic studies found adverse effects in concentrations as low as 1.5 mg/L, while no effects were reported at 0.58 mg/L using a 41% diquat product (USEPA 2003, MRID 40380703). Results from coldwater and warmwater fish species suggest that diquat has relatively low toxicity to fish, but may be toxic to some species.

The lower of the cold- and warmwater fish endpoints were selected as the TRVs for fish. Therefore the warmwater 96-hour LC_{50} of 0.75 mg a.i./L was selected as the acute TRV. Since the NOAEL in the chronic study on rainbow trout was determined to be <0.5 mg a.i./L, the coldwater fish NOAEL was calculated by dividing this value by an uncertainty factor of 3. The resulting NOAEL TRV for coldwater fish species was 0.17 mg a.i./L . This was selected as the chronic fish TRV.

Bioconcentration factors (BCFs) measured in fish tissue ranged from <0.6 to 1.4, indicating that the bioconcentration potential for diquat is low (HSDB 2003).

3.1.3.2 Amphibians

Toxicity tests were conducted on several amphibian species, including frogs, toads, and newts. In a 16-day exposure, northern leopard frogs *(Rana pipiens)* were adversely affected by diquat concentrations as low as 5 mg/L, while no adverse effects were observed at 2 mg/L (Dial and Bauer-Dial 1987). No information was provided regarding the % a.i. in these tests.

The NOAEL (2 mg/L) was selected as an amphibian chronic TRV.

3.1.3.3 Aquatic Invertebrates

Freshwater invertebrate toxicity tests are required for the USEPA pesticide registration process. Numerous acute and chronic toxicity tests were found in the literature. For acute studies, the statistical endpoint (Median Lethal Concentration [LC_{50}] or Median Effective Concentration [EC_{50}]) is the concentration that kills or immobilizes 50 percent of the test organisms. The lowest EC_{50} or LC_{50} reported from these studies was 0.14 mg/L of diquat tested using *Hyallela* (water scud) (USEPA 2003, MRID 00115862; no % a.i. listed). No observed adverse effect concentrations for aquatic invertebrates ranged from 0.044 to >2 mg/L (USEPA 1995a, MRID 00115862; Moss 1978).

The LC_{50} (0.14 mg/L) was selected as the invertebrate acute TRV and the NOAEL of 0.044 mg/L was selected as the chronic TRV.

3.1.3.4 Aquatic Plants

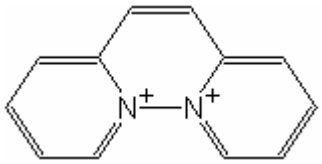
Standard toxicity tests were conducted on aquatic plants, including aquatic macrophytes, freshwater diatoms, and algae. In 14-day studies, 50 percent of the duckweed (*Lemna* sp.) plants were adversely affected by concentrations as low as 0.00075 mg/L of diquat (i.e., the EC_{50}) using a 35.3% diquat product (USEPA 2003, MRID 41883002).

Based on the available literature, there did not appear to be appreciable differences in sensitivities among aquatic macrophytes, diatoms, and algae.

The EC_{50} (0.00075 mg/L) was selected as the aquatic plant acute TRV. Since no NOAEL value in the reviewed literature was lower than the EC_{50}, the EC_{50} was divided by an uncertainty factor of 3 to estimate a NOAEL TRV of 0.0003 mg./L.

3.2 Herbicide Physical-Chemical Properties

The chemical formula for diquat is 6,7-dihydrodipyrido(1,2-a:2',1'-c)pyrazinedi-ium. The chemical structure is shown below:



Diquat Chemical Structure

The diquat molecule exists as a +2 cation when dissolved in water.

The physical-chemical properties and degradation rates critical to diquat's environmental fate are listed in Table 3-2, which presents the range of values encountered in the literature for these parameters. To complete Table 3-2, available USEPA literature on diquat was obtained either from the Internet or through a FOIA request. Herbicide information that had not been cleared of Confidential Business Information (CBI) was not provided by USEPA as part of the FOIA documents. Additional sources, both on-line and in print, were consulted for information about the herbicide:

- The British Crop Protection Council and The Royal Society of Chemistry. 1994. The Pesticide Manual Incorporating the Agrochemicals Handbook. Tenth Edition. Surrey and Cambridge, United Kingdom.
- Compendium of Pesticide Common Names. 2003. A website listing all International Organization for Standardization (ISO)-approved names of chemical pesticides. Available at: http://www.hclrss.demon.co.uk.
- California Department of Pesticide Registration (DPR.). 2003. USEPA/OPP Pesticide Related Database. Updated weekly. Available at: http://www.cdpr.ca.gov/docs/epa/epamenu.htm.
- Hazardous Substances Data Bank (HSDB). 2003. A toxicology data file on the National Library of Medicines Toxicology Data Network (TOXNET). Available at: http://toxnet.nlm.nih.gov.
- Hornsby, A., R. Wauchope, and A. Herner. 1996. Pesticide Properties in the Environment. Springer-Verlag, New York.
- Howard, P (ed.). 1991. Handbook of Physical Properties of Organic Chemicals. CRC Lewis Publishers. Boca Raton. Florida.
- Mackay, D., S. Wan-Ying, and M. Kuo-ching. 1997. Handbook of Environmental Fate and Exposure Data for Organic Chemicals. Volume III. Pesticides Lewis Publishers, Chelsea, Minnesota.
- Montgomery, J.H. (ed.). 1997. Illustrated Handbook of Physical-Chemical Properties and Environmental Fate for Organic Chemicals. Volume V. Pesticide Chemicals. Lewis Publishers, Boca Raton, Florida.
- Tomlin, C (ed.). 1994. The Agrochemicals Desk Reference 2nd Edition. Lewis Publishers, Boca Raton, Florida.

In addition, information was obtained from the product label for the herbicide Reward® (Syngenta 2001) and from the EXTOXNET website (EXTOXNET 1996). Relevant papers from the scientific literature were obtained as part of the

literature review to define ecological toxicity endpoints. The half-life in pond water was estimated using the physical-chemical properties listed in Table 3-2 and the information reviewed concerning the environmental fate of diquat in aquatic systems. Values for foliar half-life and foliar washoff fraction were obtained from a database included in the GLEAMS computer model (U.S. Department of Agriculture; USDA 1999). Residue rates were obtained from the Kenaga nomogram, as updated (Fletcher et al. 1994). Values selected for use in risk assessment calculations are shown in bold in Table 3-2, presented at the end of this section.

3.3 Herbicide Environmental Fate

Diquat's terrestrial fate is dominated by sorption. When sorbed, diquat is immobile and protected from degradation (USEPA 1995a). The K_{oc}, or organic carbon-water partitioning coefficient, measures the affinity of a chemical to organic carbon relative to water. The higher the K_{oc}, the less soluble in water and the higher affinity for organic carbon, an important constituent of soil particles. Therefore, the higher the K_{oc} the less mobile the chemical. Diquat sorbs strongly to soils with reported K_{oc} values ranging from 690 to 7,900,000. Based on this range of K_{oc} values, diquat's mobility in soils will range from low to immobile (Table 3-2; Swann et al. 1983). Diquat exists in soil solution as a cation (Howard 1991). Thus, diquat's sorption mechanism is most accurately viewed as a cation exchange process (Howard 1991). For this reason, clays as well as organic matter can be important diquat sorbents in soil systems. When fixed in the interlayers of montmorrilonite clays, diquat sorption is irreversible (HSDB 2003). Diquat is also stable with respect to hydrolysis (USEPA 1995a). Based upon diquat's vapor pressure and its Henry's Law constant (the ratio of the chemical's distribution between the gas and liquid phases at equilibrium), volatilization from dry or wet soil surfaces should not be an important loss pathway (HSDB 2003). There is some evidence that the more loosely bound diquat fraction in soil may be subject to slow biodegradation (Howard 1991). Field half-lives for diquat ranging from 2.7 years to greater than 3 years have been reported (Table 3-2; HSDB 2003).

In aquatic systems, diquat sorbs to suspended solids, sediments, and also to aquatic vegetation (Simsiman and Chesters 1976; HSDB 2003). Loss of diquat from aquatic systems both through photolysis and biodegradation is possible, but only when the herbicide is not sorbed (HSDB 2003). When sorbed, it is protected from biodegradation and photolysis (Howard 1991). Based upon diquat's Henry's Law constant, volatilization from aquatic systems is not an important loss pathway (HSDB 2003). Although Petit et al. (1995) reports BCFs as high as 62, all other sources reviewed indicate that diquat has little tendency to bioaccumulate in aquatic species (Howard 1991; USEPA 1995a; Mackay et al. 1997; HSDB 2003). Diquat is removed quickly from the water column by sorption, with reported aquatic half-lives of 1-2 days (Table 3-2; HSDB 2003).

TABLE 3-1
Selected Toxicity Reference Values for Diquat

Receptor	Selected TRV	Units	Duration	Endpoint	Species	Notes
RECEPTORS INCLUDED IN FOOD WEB MODEL						
Terrestrial Animals						
Honeybee	47	µg/bee	5 d	LD_{50}		extrapolated from NOAEL; no % a.i. listed
Large Bird	215	mg a.i./kg bw	NR	LD_{50}	ring neck pheasant	
Large Bird	0.6	mg a.i./kg bw-day	1 generation	NOAEL	mallard	
Piscivorous Bird	0.6	mg a.i./kg bw-day	1 generation	NOAEL	mallard	
Small Bird	150	mg a.i./kg bw	NR	LD_{50}	Japanese quail	
Small Bird	> 12	mg a.i./kg bw-day	NR	NOAEL	bobwhite quail	
Small Mammal	0.8	mg a.i./kg bw-day	104 w	NOAEL	rat	
Small Mammal - dermal	262	mg a.i./kg bw	NR	LD_{50}	rabbit	
Small Mammal - ingestion	121	mgkg bw	> 14 d	LD_{50}	rat	water exposure; no diet available; no % a.i. listed
Large Mammal	121	mg/kg bw	> 14 d	LD_{50}	rat	small mammal value; no % a.i. listed
Large Mammal	0.5	mg a.i./kg bw-day	1 y	NOAEL	dog	
Terrestrial Plants						
Typical Species-direct spray, drift	0.0047	lb a.i./ac	NR	EC_{25}	cotton	vigor
RTE Species-direct spray, drift	0.0016	lb a.i./ac	NR	NOAEL	cotton	vigor; extrapolated from EC_{25}
Aquatic Species						
Aquatic Invertebrates	0.14	mg/L	48 h	EC_{50}	amphipod	no % a.i. listed
Fish	0.75	mg a.i./L	96 h	LC_{50}	walleye	
Aquatic Plants & Algae	0.00075	mg a.i./L	14 d	EC_{50}	giant duckweed	35.3% a.i. product
Aquatic Invertebrates	0.044	mg a.i./L	life cycle	NOAEL	water flea	41.4% a.i. product
Fish	0.17	mg a.i./L	NR	NOAEL	rainbow trout	extrapolated from LOAEL /swimming speed
Aquatic Plants & Algae	0.0003	mg a.i./L	14 d	NOAEL	giant duckweed	extrapolated from EC_{50}

TABLE 3-1 (Cont.)
Selected Toxicity Reference Values for Diquat

Receptor	Selected TRV	Units	Duration	Endpoint	Species	Notes
ADDITIONAL ENDPOINTS						
Amphibian	no data					
Amphibian	2	mg/L	16 d	NOAEL	northern leopard frog	no % a.i. listed
Warmwater Fish	0.75	mg a.i./L	96 h	LC_{50}	walleye	
Warmwater Fish	0.58	mg a.i./L	34 d	NOAEL	fathead minnow	41% a.i. product
Coldwater Fish	14.83	mg/L	96 h	LC_{50}	rainbow trout	19.8% a.i. product
Coldwater Fish	0.17	mg a.i./L	NR	NOAEL	rainbow trout	extrapolated from LOAEL /swimming speed

Notes:

Toxicity endpoints for terrestrial animals

LD_{50} - to address acute exposure.

NOAEL - to address chronic exposure

Toxicity endpoints for terrestrial plants

EC_{25} - to address direct spray or drift on typical species.

EC_{05} or NOAEL - to address direct spray or drift on threatened or endangered species

Toxicity endpoints for aquatic receptors

LC_{50} or EC_{50} - to address acute exposure (appropriate toxicity endpoint for non-target aquatic plants will be an EC_{50}).

NOAEL - to address chronic exposure.

Value for fish is the lower of the warmwater and coldwater values.

Units represent those presented in the reviewed study

Piscivorous bird TRV = Large bird chronic TRV.

Fish TRV = lower of coldwater and warm water fish TRVs.

Durations:

h - hours

d - days

w - weeks

m - months

y - years

NR – Not reported

TABLE 3-2
Physical-Chemical Properties of Diquat.

Parameter	Value
Herbicide family	quaternary ammonium herbicide (Compendium of Pesticide Common Names 2003).
Mode of action	Interferes with cell respiration (EXTOXNET 1996).
Chemical Abstract Service number	85-00-7 (dibromide), 2764-72-9 (cation) (Tomlin 1994; Compendium of Pesticide Common Names 2003).
Office of Pesticide Programs chemical code	032201 (USEPA 1995a).
Chemical name	6,7-dihydrodipyrido(1,2-a:2,1-c)pyrazinedi-ium dibromide (dibromide salt) (USEPA 1995a).
Empirical formula	$C_{12}H_{12}Br_2N_2$ (dibromide salt), $C_{12}H_{12}N_2$ (cation) (USEPA 1995a).
Molecular weight (MW)	344.1 (dibromide salt), **184.2** (cation) (Tomlin 1994).
Appearance, ambient	Pure diquat, odorless yellow solid (USEPA 1995a).
Acid / Base properties	Not available.
Vapor pressure (millimeters of mercury [mmHg] at 25ºC)	$< 4 \times 10^{-9}$ (USEPA 1995a); 0 (Hornsby et al. 1996; Mackay et al. 1997); $<9.7 \times 10^{-8}$ (Tomlin 1994; Montgomery 1997).
Water solubility (mg/L at 25ºC)	700,000 (20ºC) (Howard 1991; USEPA 1995a; Montgomery 1997); 570 (Reinert 1989); 718,000 (20ºC, pH 7.2) (Hornsby et al. 1996; Mackay et al. 1997).
Log octanol-water partition coefficient (Log (K_{OW})), unitless	2.78 (Reinert 1989); **-4.6** (Tomlin 1994; Montgomery 1997); -3.05 (Howard 1991).
Henry's Law constant (atm-m^3/mole)	0 (Mackay et al. 1997).
Soil / Organic matter sorption coefficients (Kd / K_{oc})	708 - 2863 (Kd) (Petit et al. 1995); 32,000 - 7,900,000 (K_{oc}) (Ritter et al. 2000); 690 (K_{oc}) (Reinert 1989); Freundlich Kd of 15 in sandy sediment, 36-42 in two sandy soils, and 1882-10740 in sandy loam, sandy clay loam, and loam soils (USEPA 1995a).
Bioconcentration factor (BCF)	<1 – 62 (Petit et al. 1995); **1.03X** for whole fish (bluegill sunfish) exposed to approximately 1030 ppb diquat ion for 14 days (lab study). Depuration from bluegill sunfish was rapid with 50% accumulated ^{14}C residues eliminated from fish after three days. In a field study, diquat did not significantly accumulate in tissues of tilapia and catfish from two Florida fish ponds treated with the equivalent of 0.36 ug diquat ion/ml for four monthly applications (USEPA 1995a).
Field or soil dissipation half-life	No degradation observed after three years in field studies in New York and Idaho (clay loam and loam soils respectively). No evidence of significant leaching during study. (USEPA 1995a); 1,000 days (Hornsby et al. 1996)
Aquatic dissipation half-life	A disappearance time of 30-33 hours was estimated for diquat added to three ponds in North Carolina at 1 ppm (Langeland and Warner 1986); Diquat applied to three test plots in eutrophic FL lake at 4.0 lb a.i. cation/acre with and without polymer. After 25-39 hours, at 61 m from edge of application area only 3 of 53 samples contained between 4 and 10% of application level. Drop in diquat concentration was greater than expected due to dilution (Langeland et al. 1994). Laboratory microcosms were used to study diquat fate in weed and sediment and sediment alone water systems. In systems with weeds, 32% was degraded to water soluble products and 19% sorbed to sediment after 22 days. In systems with only sediment and water, little degradation occurred during the 180 day experiment (Simsiman and Chesters 1976). Dissipation half-lives of 1-2 days were observed for diquat added to Florida pond water (USEPA 1995a).
Hydrolysis half-life	No hydrolysis measured after 30 days at pH 5 or 7; <10% hydrolysis observed after 30 days at pH 9 (Ritter et al. 2000); Stable to hydrolysis at pH 5, 7, 9 (USEPA 1995a).

TABLE 3-2 (Cont.)
Physical-Chemical Properties of Diquat.

Parameter	Value
Photodegradation half-life in water	8 days (half-life, distilled water, 240-260 nm light); < 35 days for 4 µg/ml to degrade in distilled water exposed to sunlight (Mackay et al. 1997). Photodegrades in surface layer of water in 1-3 wks if not adsorbed to particles (Howard 1991). Photolysis: 48 hr to 11 days (Petit et al. 1995); 74 days at pH 7, 25ºC, sterile conditions (Tomlin 1994). Diquat can be considered to be photolytically stable in the environment. Calculated half-life of 74 days for diquat in water with Florida spring sunlight (USEPA 1995a).
Photodegradation half-life in soil	Radiolabeled diquat did not degrade on soils irradiated with a xenon arc lamp for 107.42 hours (equivalent to approximately 32 days of natural sunlight) (USEPA 1995a); 50-75% dry diquat decomposed in 48 - 96 hours in sunlight (Howard 1991).
Soil biodegradation half-life	Diquat at approximately 3 µg/g did not degrade in aerobic sandy loam incubated at 25ºC for 9 months (USEPA 1995a). In four fungi, tolerance to diquat was linked to their ability to degrade the herbicide. *Aspergillus niger* released radiolabeled carbon dioxide from C^{14} diquat while *Penicillium frequentans*, *Mucor hiemalis*, and *Zygorhynchus heterogamous* did not. The later three fungi could not grow at low herbicide concentrations (Smith et al. 1976).
Residue Rate for grass [1]	**197 ppm** (maximum) and **36 ppm** (typical) per lb a.i./ac
Residue Rate for vegetation [2]	**296 ppm** (maximum) and **35 ppm** (typical)
Residue Rate for insects [3]	**350 ppm** (maximum) and **45 ppm** (typical)
Residue Rate for berries [4]	**40.7 ppm** (maximum) and **5.4 ppm** (typical)
Aquatic biodegradation half-life	50 days (half-life, lake water), > 158 days and 2 days (half-lives in sediment and water, respectively, sediment-water microcosms) (Mackay et al. 1997); <15 to 32 days (Petit et al. 1995). Diquat did not degrade when incubated under anaerobic aquatic conditions for nine months at 25ºC; Diquat did not degrade under aerobic aquatic conditions for 31 days at 25ºC. (USEPA 1995a)

Notes:
Values presented in bold were used in risk assessment calculations.
[1] Residue rates selected are the high and mean values for long grass (Fletcher et al. 1994).
[2] Residue rates selected are the high and mean values for leaves and leafy crops (Fletcher et al. 1994).
[3] Residue rates selected are the high and mean values for forage such as legumes (Fletcher et al. 1994).
[4] Residue rates selected are the high and mean values for fruit (includes both woody and herbaceous; (Fletcher et al. 1994).

4.0 ECOLOGICAL RISK ASSESSMENT

This section presents a screening-level evaluation of the risks to ecological receptors from potential exposure to the herbicide diquat. The general approach and analytical methods for conducting the diquat ERA were based on the USEPA's *Guidelines for ERA* (hereafter referred to as the "Guidelines;" USEPA 1998).

The ERA is a structured evaluation of all currently available scientific data (exposure chemistry, fate and transport, toxicity, etc.) that leads to quantitative estimates of risk from environmental stressors to non-human organisms and ecosystems. The current Guidelines for conducting ERAs include three primary phases: problem formulation, analysis, and risk characterization. These phases are discussed in detail in the Methods Document (ENSR 2004c) and briefly in the following sub-sections.

4.1 Problem Formulation

Problem formulation is the initial step of the standard ERA process and provides the basis for decisions regarding the scope and objectives of the evaluation. The problem formulation phase for diquat assessment included:

- definition of risk assessment objectives;
- ecological characterization;
- exposure pathway evaluation;
- definition of data evaluated in the ERA;
- identification of risk characterization endpoints; and
- development of the conceptual model.

4.1.1 Definition of Risk Assessment Objectives

The primary objective of this ERA was to evaluate the potential ecological risks from diquat to the health and welfare of plants and animals and their habitats. This analysis is part of the process used by the BLM to determine which of the proposed treatment alternatives evaluated in the EIS should be used on BLM-managed lands.

An additional goal of this process was to provide risk managers with a tool that develops a range of generic risk estimates that vary as a function of site conditions. This tool primarily consists of Excel spreadsheets (presented in the ERA Worksheets; Appendix B), which may be used to calculate exposure concentrations and evaluate potential risks in the risk assessment. A number of the variables included in the worksheets can be modified by BLM land managers for future evaluations.

4.1.2 Ecological Characterization

As described in Section 2.2, diquat is proposed for use by the BLM for vegetation control in their Aquatics program. The proposed BLM program involves the general use and application of herbicides on public lands. This ERA was designed to address generic receptors, including RTE species (see Section 6.0) that could occur within a variety of habitats.

4.1.3 Exposure Pathway Evaluation

The following ecological receptor groups were evaluated:

- terrestrial animals;

- non-target terrestrial plants; and
- aquatic species (fish, invertebrates, and non-target aquatic plants).

These groups of receptor species were selected for evaluation because they: 1) are potentially exposed to herbicides within BLM management areas (directly or indirectly); 2) are likely to play key roles in site ecosystems; 3) have complex life cycles; 4) represent a range of trophic levels; and 5) are surrogates for other species likely to be found on BLM-managed lands.

The exposure scenarios considered in the ERA were primarily organized by potential exposure pathways. In general, the exposure scenarios describe how a particular receptor group may be exposed to the herbicide as a result of a particular exposure pathway. These exposure scenarios were developed to address potential acute and chronic impacts to receptors under a variety of exposure conditions that may occur within BLM-managed lands. Diquat is an aquatic herbicide; therefore, as discussed in detail in the Methods Document (ENSR 2004c), the following exposure scenarios were considered:

- direct contact with the herbicide or a contaminated waterbody;
- indirect contact with contaminated foliage;
- ingestion of contaminated food items;
- off-site drift of spray to terrestrial areas; and
- accidental spills to waterbodies.

Two generic waterbodies were considered in this ERA: 1) a small pond (1/4 ac pond of 1 meter [m] depth, resulting in a volume of 1,011,715 liters [L]) and 2) a small stream representative of Pacific Northwest low-order streams that provide habitat for critical life-stages of anadromous salmonids. The stream size was established at 2 m wide and 0.2 m deep with a mean water velocity of approximately 0.3 m per second (m/sec), resulting in a base flow discharge of 0.12 cubic meters per second (cms).

4.1.4 Definition of Data Evaluated in the ERA

Herbicide concentrations used in the ERA were based on typical and maximum application rates provided by the BLM (Table 2-1). These application rates were used to predict herbicide concentrations in various environmental media (e.g., soils, water). For the aquatic herbicides these calculations were fairly straightforward and generally required only simple algebraic calculations (e.g., water concentrations from direct aerial spray). However, off-site herbicide transport due to spray drift was modeled using the AgDRIFT® computer model. AgDRIFT® Version 2.0.05 is a product of the Cooperative Research and Development Agreement between the USEPA's Office of Research and Development and the Spray Drift Task Force (SDTF, a coalition of pesticide registrants; SDTF 2002).

4.1.5 Identification of Risk Characterization Endpoints

Assessment endpoints and associated measures of effect were selected to evaluate whether populations of ecological receptors are potentially at risk from exposure to proposed BLM applications of diquat. The selection process is discussed in detail in Methods Document (ENSR 2004c), and the selected endpoints are presented below.

Assessment Endpoint 1: Acute mortality to mammals, birds, invertebrates, non-target plants

- **Measures of Effect** included median lethal effect concentrations (e.g., LD_{50} and LC_{50}) from acute toxicity tests on target organisms or suitable surrogates.

Assessment Endpoint 2: Acute mortality to fish, aquatic invertebrates, and aquatic plants

- **Measures of Effect** included median lethal effect concentrations (e.g., LC_{50} and EC_{50}) from acute toxicity tests on target organisms or suitable surrogates (e.g., data from other coldwater fish to represent threatened and endangered salmonids).

Assessment Endpoint 3: Adverse direct effects on growth, reproduction, or other ecologically important sublethal processes

- **Measures of Effect** included standard chronic toxicity test endpoints such as the NOAEL for both terrestrial and aquatic organisms. Depending on data available for a given herbicide, chronic endpoints reflect either individual impacts (e.g., growth, physiological impairment, behavior) or population-level impacts (e.g., reproduction; Barnthouse 1993). For salmonids, careful attention was paid to smoltification (i.e., development of tolerance to seawater and other indications of change of parr [freshwater stage salmonids] to adulthood), thermoregulation (i.e., ability to maintain body temperature), and migratory behavior, if such data were available. With the exception of non-target plants, standard acute and chronic toxicity test endpoints were used for estimates of direct herbicide effects on RTE species. To add conservatism to the RTE assessment, levels of concern for RTE species were lower than for typical species. Lowest available germination NOAELs were used to evaluate non-target RTE plants. Impacts to RTE species are discussed in more detail in Section 6.0.

Assessment Endpoint 4: Adverse indirect effects on the survival, growth, or reproduction of salmonid fish

- **Measures of Effect** for this assessment endpoint depended on the availability of appropriate scientific data. Unless literature studies were found that explicitly evaluated the indirect effects of diquat on salmonids and their habitat, only qualitative estimates of indirect effects were possible. Such qualitative estimates were limited to a general evaluation of the potential risks to food (typically represented by acute and/or chronic toxicity to aquatic invertebrates) and cover (typically represented by potential for destruction of riparian vegetation). Similar approaches are already being applied by USEPA OPP for Endangered Species Effects Determinations and Consultations (Available at: http://www.epa.gov/oppfead1/endanger/effects.)

4.1.6 Development of the Conceptual Model

The diquat conceptual model (Figure 4-1) is presented as a series of working hypotheses about how diquat might pose hazards to the ecosystem and ecological receptors. The conceptual model indicates the possible exposure pathways for the herbicide, as well as the receptors evaluated for each exposure pathway. Figure 4-2 presents the trophic levels and receptor groups evaluated in the ERA.

The conceptual model for herbicide application on BLM lands is designed to display potential herbicide exposure through several pathways, although all pathways may not exist for all locations. The exposure pathways and ecological receptor groups considered in the conceptual model are also described in Section 4.1.3.

The aquatic herbicide conceptual model (Figure 4-1) presents essentially three mechanisms for the release of an herbicide into the environment: direct spray (either accidental or during normal applications), drift, and accidental spills. These release mechanisms may occur as the aquatic herbicide is applied to the intended pond area from a boat or from the shoreline. The aquatic herbicide considered in this risk assessment is not applied to streams.

As indicated in the conceptual model figure, accidental direct spray of terrestrial receptors may occur when the aquatic herbicide is being applied from a boat. This may result in herbicide exposure for wildlife or non-target terrestrial plants if they are directly sprayed during the application. Terrestrial wildlife may also be exposed to the herbicide by brushing against sprayed vegetation or by ingesting contaminated food items.

Direct spray of non-target receptors may also occur during shoreline applications of the aquatic herbicide. Herbicides may be applied to either a pond (normal application) or a stream (accidental application) resulting in exposure of

aquatic plants, fish, and aquatic invertebrates to impacted water. Piscivorous birds may also be impacted by ingesting contaminated fish from an exposed pond.

During normal application of aquatic herbicides, it is possible for a portion of the herbicide to drift outside of the treatment area and deposit onto non-target terrestrial receptors. This may occur during terrestrial or aerial applications and may result in exposure of non-target terrestrial plants to the aquatic herbicide.

Accidental spills may also occur during normal herbicide applications. Spills represent the worst-case transport mechanism for herbicide exposure. An accidental spill to a waterbody would result in exposure for aquatic plants, fish, and aquatic invertebrates to impacted water.

4.2 Analysis Phase

The analysis phase of an ERA consists of two principal steps: the characterization of exposure and the characterization of ecological effects. The exposure characterization describes the source, fate, and distribution of the herbicide using standard models that predict concentrations in various environmental media (e.g., AgDRIFT®). All EECs predicted by the models are presented in Appendix B. The ecological effects characterization consisted of compiling exposure-response relationships from all available toxicity studies on the herbicide.

4.2.1 Characterization of Exposure

The BLM uses herbicides in the Aquatics program with several different application methods (e.g., application by boat, plane, helicopter). In order to assess the potential ecological impacts of these herbicide uses, a variety of exposure scenarios were considered. These scenarios, which were selected based on actual BLM herbicide usage under a variety of conditions, are described in Section 4.1.3.

When considering the exposure scenarios and the associated predicted concentrations, it is important to recall that the frequency and duration of the various scenarios are not equal. For example, exposures associated with accidental spills will be very rare, while ingestion of contaminated vegetation may be more common. Similarly, direct spray events will be short-lived while ingestion of fish from a contaminated pond may occur over weeks or months following application. The ERA has generally treated these differences in a conservative manner (i.e., potential risks are presented despite their likely rarity and/or transience). Thus, tables and figures summarizing RQs may present both relatively common and very rare exposure scenarios. Additional perspective on the frequency and duration of exposures are provided in the narrative below.

As described in Section 4.1.3, the following ecological receptor groups were selected to address the potential risks due to unintended exposure to diquat: terrestrial animals, terrestrial plants, and aquatic species. A set of generic terrestrial animal receptors, listed below, were selected to cover a variety of species and feeding guilds that might be found on BLM-managed lands. Unless otherwise noted, receptor Body Weights (BWs) were selected from the *Wildlife Exposure Factors Handbook* (USEPA 1993a). This list includes surrogate species, although not all of these surrogate species will be present within each actual application area:

- A pollinating insect with a BW of 0.093 grams (g). The honeybee (*Apis mellifera*) was selected as the surrogate species to represent pollinating insects. This BW was based on the estimated weight of receptors required for testing in 40CFR158.590.

- A small mammal with a BW of 20 g that feeds on fruit (e.g., berries). The deer mouse (*Peromyscus maniculatus*) was selected as the surrogate species to represent small mammalian omnivores consuming berries.

- A large mammal with a BW of 70 kg that feeds on plants. The mule deer (*Odocolieus hemionus*) was selected as the surrogate species to represent large mammalian herbivores, including wild horses and burros (Hurt and Grossenheider 1976).

- A large mammal with a BW of 12 kg that feeds on small mammals. The coyote (*Canis latrans*) was selected as the surrogate species to represent large mammalian carnivores (Hurt and Grossenheider 1976).

- A small bird with a BW of 80 g that feeds on insects. The American robin (*Turdus migratorius*) was selected as the surrogate species to represent small avian insectivores.

- A large bird with a BW of approximately 3.5 kg that feeds on vegetation. The Canada goose (*Branta canadensis*) was selected as the surrogate species to represent large avian herbivores.

- A large bird with a BW of approximately 5 kg that feeds on fish. The Northern subspecies of the bald eagle (*Haliaeetus leucocephalus alascanus*) was selected as the surrogate species to represent large avian piscivores (Brown and Amadon 1968[2]).

In addition, potential impacts to non-target terrestrial plants were considered by evaluating two plant receptors: the "typical" non-target species, and the RTE non-target species. Cotton was the surrogate species chosen to represent terrestrial plants (toxicity data are only available for vegetable crop species). Since diquat is an aquatic herbicide, it is not expected that terrestrial plants will be exposed to the herbicide. It is possible that the noncropland species present on BLM managed lands may be more tolerant of diquat than the surrogate species used in the ERA.

Aquatic exposure pathways were evaluated using fish, aquatic invertebrates, and non-target aquatic plants in a pond or stream habitat (as defined in Section 4.1.3). Rainbow trout and walleyes (*Sander vitreus*) were surrogates for fish, the water flea (*Daphnia magna*) and waterscud (*Hyalella* spp.) were surrogates for aquatic invertebrates, and non-target aquatic plants and algae were represented by giant duckweed.

Section 3.0 of the Methods Document (ENSR 2004c) presents the details of the exposure scenarios considered in the risk assessments. The following sub-sections describe the scenarios that were evaluated for diquat.

4.2.1.1 Direct Spray

Wildlife and non-target plant species may be unintentionally impacted during normal application of an aquatic herbicide as a result of a direct spray of the receptor or the waterbody inhabited by the receptor, indirect contact with dislodgeable foliar residue after herbicide application, or consumption of food items sprayed during application. These exposures may occur within the application area (direct spray of waterbody) or outside of the application area (consumption of terrestrial food items accidentally sprayed by aquatic herbicide). Generally, impacts outside of the intended application area are accidental exposures and are not typical of BLM application practices. The following direct spray scenarios were evaluated:

<u>Exposure Scenarios Within the Application Area</u>

- Direct Spray to Pond (normal application)

- Consumption of Fish From Contaminated Pond

<u>Exposure Scenarios Outside the Application Area</u>

- Accidental Direct Spray of Terrestrial Wildlife

- Accidental Direct Spray of Non-Target Terrestrial Plants

- Indirect Contact With Foliage After Accidental Direct Spray

[2] As cited on the Virginia Tech Conservation Management Institute Endangered Species Information System website (http://fwie.fw.vt.edu/WWW/esis/).

- Ingestion of Food Items Contaminated by Accidental Direct Spray
- Accidental Direct Spray Over Stream (diquat is not indicated for use in streams)

4.2.1.2 Off-site Drift

During normal application of aquatic herbicides, it is possible for a portion of the herbicide to drift outside of the treatment area and deposit onto non-target terrestrial receptors. To simulate off-site herbicide transport as spray drift, AgDRIFT® software was used to evaluate a number of possible scenarios. Based on actual BLM uses of diquat, ground applications were modeled using a low- or high-placed boom and aerial application was modeled from both a helicopter and a fixed-wing plane over non-forested land. Ground applications were modeled using either a high boom (spray boom height set at 50 inches above the ground) or a low boom (spray boom height set at 20 inches above the ground). Deposition rates vary by the height of the application (the higher the application height, the greater the off-target drift). Drift deposition was modeled at 25, 100, and 900 ft from the application area for ground applications and 100, 300, and 900 ft from the application area for aerial applications. The AgDRIFT® model determined the fraction of the application rate that is deposited off-site without considering herbicide degradation, and this allowed evaluation of impacts to off-site terrestrial plants.

4.2.1.3 Accidental Spill to Pond

To represent worst-case potential impacts to ponds, two spill scenarios were considered. These consist of a truck or a helicopter spilling entire loads (200 gallon [gal] spill and 140 gal spill, respectively) of herbicide mixed for the maximum application rate into a 1/4 ac, 1 m deep pond.

4.2.2 Effects Characterization

The ecological effects characterization phase entailed a compilation and analysis of the stressor-response relationships and any other evidence of adverse impacts from exposure to each herbicide. For the most part, available data consisted of the toxicity studies conducted in support of USEPA pesticide registration described in Section 3.1. TRVs selected for use in the ERA are presented in Table 3-1. Appendix A presents the full set of toxicity information identified for diquat.

In order to address potential risks to ecological receptors, RQs were calculated by dividing the EEC for each of the previously described scenarios by the appropriate TRV presented in Table 3-1. An RQ was calculated by dividing the EEC for a particular scenario by an herbicide specific TRV. The TRV may be a surface water or surface soil effects concentration, or a species-specific toxicity value derived from the literature.

The RQs were then compared to Levels of Concern (LOC) established by the USEPA OPP to assess potential risk to non-target organisms. Table 4-1 presents the LOCs established for this assessment. Distinct USEPA LOCs are currently defined for the following risk presumption categories:

- **Acute high risk** - the potential for acute risk is high.
- **Acute restricted use** - the potential for acute risk is high, but may be mitigated through a restricted use designation.
- **Acute endangered species** – the potential for acute risk to endangered species is high.
- **Chronic risk** - the potential for chronic risk is high.

Additional uncertainty factors may also be applied to the standard LOCs to reflect uncertainties inherent in extrapolating from surrogate species toxicity data to obtain RQs (see Sections 6.3 and 7.0 for a discussion of uncertainty). A "chronic endangered species" risk presumption category for aquatic animals was added for this risk assessment. The LOC for this category was set to 0.5 to reflect the conservative two-fold difference in contaminant

sensitivity between RTE and surrogate test fishes (Sappington et al. 2001). Risk quotients predicted for acute scenarios (e.g., direct spray, accidental spill) were compared to the three acute LOCs, and the RQs predicted for chronic scenarios (e.g., long term ingestion) were compared to the two chronic LOCs. If all RQs were less than the most conservative LOC for a particular receptor, comparisons against other, more elevated LOCs were not necessary.

The RQ approach used in this ERA provides a conservative measure of the potential for risk based on a "snapshot" of environmental conditions (e.g., rainfall, slope) and receptor assumptions (e.g., BW, ingestion rates). Sections 6.3 and 7.0 discuss several of the uncertainties inherent in the RQ methodology.

To specifically address potential impacts to RTE species, two types of RQ evaluations were conducted. For RTE terrestrial plant species, the RQ was calculated using different toxicity endpoints and but keeping the same LOC (set at 1) for all scenarios. The plant toxicity endpoints were selected to provide extra protection to the RTE species. In the direct spray, spray drift, and wind erosion scenarios, the selected toxicity endpoints were an EC_{25} for "typical" species and a NOAEL for RTE species. In runoff scenarios, high and low germination NOAELs were selected to evaluate exposure for typical and RTE species, respectively.

The evaluation of RTE terrestrial wildlife and aquatic species is addressed using a second type of RQ evaluation. The same toxicity endpoint was used for both typical and RTE species in all scenarios, but the LOC was lowered for RTE species.

4.3 Risk Characterization

The ecological risk characterization integrates the results of the exposure and effects phases (i.e., risk analysis), and provides comprehensive estimates of actual or potential risks to ecological receptors. Risk quotients are summarized in Tables 4-2 to 4-5 and presented graphically in Figures 4-3 to 4-18. The results are discussed below for each of the evaluated exposure scenarios.

Box plots are used to graphically display the range of RQs obtained from evaluating each receptor and exposure scenario combination (Figures 4-3 to 4-18). These plots illustrate how RQ data are distributed about the mean and their relative relationships with LOCs. Outliers (data points outside the 90th or 10th percentile) were not discarded in this ERA; all RQ data presented in these plots were included in the risk assessment.

4.3.1 Direct Spray

As described in Section 4.2.1, potential impacts from direct spray were evaluated for exposure that could occur within the aquatic application area (direct spray of pond during normal application, consumption of fish from contaminated pond) and outside the intended application area (accidental direct spray of terrestrial wildlife and non-target terrestrial plants, indirect contact with foliage, ingestion of contaminated food items, accidental direct spray over stream). Table 4-2 presents the RQs for the above scenarios. Figures 4-3 to 4-7 present graphic representations of the range of RQs and associated LOCs.

4.3.1.1 Terrestrial Wildlife

Acute RQs for terrestrial wildlife (Figure 4-3) were above the most conservative LOC of 0.1 (acute endangered species) for several scenarios. Accidental direct spray of the pollinating insect resulted in elevated RQs at both the typical and maximum application rates. Risk was also predicted for the pollinating insect as a result of indirect contact with foliage accidentally sprayed at the maximum application rate. This is a highly conservative scenario assuming that the insect absorbs 100% of the herbicide after application with no degradation or limitations to uptake. This scenario may overestimate risk to the insect. No risks to the small mammal were predicted due to direct spray or indirect contact with foliage.

Acute exposure RQs were elevated above the associated LOC (0.1; acute risk to endangered species) for two scenarios using the typical application rate (large mammalian herbivore and small avian insectivore) and for five

scenarios at the maximum application rate (large and small mammalian herbivore, large avian herbivore, large mammalian carnivore, small avian insectivore).

Chronic exposure RQs were elevated above the associated LOC (1.0; chronic risk) for three scenarios using the typical application rate (large and small mammalian herbivore and large avian herbivore) and for four scenarios at the maximum application rate (large mammalian and avian herbivores, small mammalian herbivore, small avian insectivore).

This evaluation indicates that accidental direct spray impacts may pose a risk to insects, birds and wildlife, primarily when the maximum application rate is used. However, accidental spray of a terrestrial area during the application of an aquatic herbicide is an unlikely event.

4.3.1.2 Non-target Plants – Terrestrial and Aquatic

As expected, because of the mode of action of herbicides, RQs for non-target terrestrial and aquatic plants impacted by direct spray were above the plant LOC of 1 for all modeled scenarios. RQs for direct spray of non-target terrestrial plants (Figure 4-3) ranged from 213 to 2500. RQs for non-target aquatic plants (Figure 4-4) impacted by normal application to the pond or accidental direct spray of the stream ranged from 149 to 7,472 (Table 4-2). Therefore, direct spray impacts pose a risk to plants in both aquatic and terrestrial environments. It may be noted that the aquatic scenarios are particularly conservative because they evaluate an instantaneous concentration and do not consider flow, adsorption to particles, or degradation that may occur over time within the pond or stream. In addition, direct spray of terrestrial plants is an unlikely scenario.

4.3.1.3 Fish and Aquatic Invertebrates

Acute and chronic toxicity RQs for fish and aquatic invertebrates in the pond and stream (Figure 4-5 and 4-6) were above the most conservative associated LOCs (0.05 for acute endangered species; 0.5 for chronic risk endangered species).

These results indicate there is potential risk to aquatic species, especially endangered species, in a pond or stream sprayed with diquat. It may be noted that these spray scenarios are conservative because they are instantaneous concentrations and do not consider flow, adsorption to particles, or degradation that may occur over time. The herbicide concentration in the pond and stream are the instantaneous concentrations at the moment of the direct spray. The volume of the pond and the impacted segment of the stream were calculated and the mass of herbicide was calculated based on the surface area of the waterbody. There was no dilution due to degradation or stream flow. In addition, it is assumed that the pond and stream are adjacent to the herbicide application area.

4.3.1.4 Piscivorous Birds

Risk to piscivorous birds (Figure 4-3) was assessed by evaluating impacts from consumption of fish from a pond impacted by normal application of diquat. RQs for piscivorous birds were all well below the most conservative terrestrial animal LOC (0.1), indicating that diquat application is not likely to pose a risk to piscivorous birds.

4.3.2 Off-site Drift to Terrestrial Plants

As described in Section 4.2.1, AgDRIFT® software was used to evaluate a number of possible scenarios in which a portion of the applied herbicide drifts outside of the treatment area and deposits onto non-target receptors. Ground applications of diquat were modeled using both a low- and high-placed boom (spray boom height set at 20 and 50 inches above the ground, respectively), and aerial applications were modeled from both a helicopter and a fixed-wing plane over non-forested lands. Drift deposition was modeled at 25, 100, and 900 ft from the application area for ground applications and 100, 300, and 900 ft from the application area for aerial applications.

Table 4-3 presents the RQs for off-site drift to off-site soils and associated impacts to terrestrial plants. RQs for both typical and RTE terrestrial plant species (Figure 4-8) were elevated over the plant LOC of 1 for several scenarios. At

the typical application rate, RQs were elevated for typical and RTE plant species within 900 ft of the aerial application of the herbicide (helicopter and fixed-wing plane) and within 100 ft of ground applications (high boom). At the maximum application rate, RQs for typical plant species were elevated for all aerial applications and within 100 ft of ground applications (low and high booms). RQs for RTE plant species were elevated for all evaluated herbicide applications using the maximum rate, and for all but two scenarios at the typical application rate (high- and low-boom ground applications with 900 foot buffers). These results indicate that potential risk to non-target terrestrial plants exists due to off-site drift during application of this aquatic herbicide.

4.3.3 Accidental Spill to Pond

As described in Section 4.2.1, two spill scenarios were considered. These consist of a truck and a helicopter spilling entire loads (200 gal spill and 140 gal spill, respectively) of herbicide mixed for the maximum application rate into the 1/4 ac, 1 m deep pond. The herbicide concentration in the pond was the instantaneous concentration at the moment of the spill. The volume of the pond was determined and the volume of herbicide in the truck and the helicopter, respectively, were mixed into the pond volume.

Risk quotients for the truck spill scenario (Table 4-2) were 19.1 for fish, 102 for aquatic invertebrates (Figure 4-6 and 4-7) and 19,129 for non-target aquatic plants (Figure 4-5). Risk quotients for the helicopter spill scenario were higher at 67 for fish, 359 for aquatic invertebrates, and 66,952 for non-target aquatic plants. Potential risks to fish, aquatic invertebrates, and non-target aquatic plants were indicated for the truck and helicopter spills mixed for the maximum application rate. However, these scenarios are highly conservative and represent unlikely and worst case conditions (limited waterbody volume, tank mixed for maximum application).

4.3.4 Potential Risk to Salmonids from Indirect Effects

In addition to direct effects of herbicides on salmonids and other fish species in stream habitats (i.e., mortality due to herbicide concentrations in surface water), reduction in vegetative cover or food supply may indirectly impact individuals or populations. No literature studies were identified that explicitly evaluated the direct or indirect effects of diquat to salmonids and their habitat; therefore, only qualitative estimates of indirect effects are possible. These estimates were accomplished by evaluating predicted impacts to prey items and vegetative cover in the stream scenarios discussed above. Since terrestrial applications of aquatic herbicides are not planned, the primary scenario evaluated in this assessment was accidental direct spray over the stream (diquat is not generally intended for use in streams). An evaluation of impacts to non-target terrestrial plants was also included as part of the discussion of vegetative cover within the riparian zone. Prey items for salmonids and other potential RTE species may include other fish species, aquatic invertebrates, or aquatic plants. Additional discussion of RTE species is provided in Section 6.0.

4.3.4.1 Qualitative Evaluation of Impacts to Prey

Fish species were evaluated directly in the ERA using acute and chronic TRVs based on the most sensitive warm- or cold-water species identified during the literature search. Several laboratory studies with salmonids (rainbow trout, brown trout, coho salmon) were identified in the literature and considered in the selection of the fish TRVs (Appendix A). The chronic fish TRV was based on a reduction in swimming speed for the rainbow trout. The lowest acute toxicity value was for a warm-water fish species, the walleye, and resulted in an acute TRV of 0.75 mg a.i./L, based on a 96 hour LC_{50}. However, salmonid acute toxicity values (LC_{50}s) were much higher than the selected acute TRV, ranging from 19 mg a.i./L to >100 mg a.i./L. This suggests that acute, direct effects to salmonids may be overestimated in the risk assessment.

Aquatic invertebrates were also evaluated directly using acute and chronic TRVs based on the most sensitive aquatic invertebrate species. RQs in excess of the acute LOCs for fish and aquatic invertebrates were observed for the accidental direct spray scenario at both the typical and maximum application rates. However, this is an extremely conservative scenario in which it is assumed that a stream is accidentally directly sprayed by an aquatic herbicide intended for a pond. This is unlikely to occur as a result of BLM practices and represents a worst-case scenario. In

addition, stream flow would be likely to dilute the herbicide concentration and reduce potential impacts, but no reduction in herbicide concentration is calculated as a result of stream flow.

The only stream evaluation conducted for this risk assessment was an accidental direct spray scenario and may overestimate risk to aquatic stream receptors. However, this conservative evaluation predicts that fish and aquatic invertebrates may be directly impacted by herbicide concentrations in the stream. Accordingly, their availability as prey item populations may be impacted and there may be an indirect effect on salmonids.

4.3.4.2 Qualitative Evaluation of Impacts to Vegetative Cover

A qualitative evaluation of indirect impacts to salmonids due to destruction of riparian vegetation and reduction of available cover was made by considering impacts to terrestrial and aquatic plants. Aquatic plant RQs for accidental direct spray scenarios were above the plant LOC at both the typical and maximum application rates, indicating the potential for a reduction in the aquatic plant community. However, this is a conservative scenario in which it is assumed that a stream is accidentally directly sprayed by a herbicide used for pond applications. This is unlikely to occur as a result of BLM practices and represents a worst-case scenario. In addition, no reduction in herbicide concentration is calculated due to stream flow in this scenario. Nonetheless, there would be the potential for indirect impacts to salmonids due to a reduction in available cover if the stream is accidentally sprayed.

Although not specifically evaluated in the stream scenarios of the ERA, terrestrial plants were evaluated for their potential to provide overhanging cover for salmonids. A reduction in riparian cover has the potential to indirectly impact salmonids within the stream. RQs for terrestrial plants were elevated above the LOC for accidental direct spray scenarios at both the typical and maximum application rates, indicating the potential for a reduction in this plant community and potential indirect impacts to salmonids. However, as discussed above, this event is unlikely to occur as a result of BLM practices and represents a worst-case scenario.

4.3.4.3 Conclusions

This qualitative evaluation indicates that salmonids may be indirectly impacted by a reduction in food supply (i.e., fish and aquatic invertebrates) and a reduction in vegetative cover. However, this evaluation is based on worst-case accidental exposure scenarios, which are not likely to occur as a result of BLM practices. Decreasing the application rate and avoiding application on non-target areas would reduce the likelihood of these impacts.

In addition, the effects of aquatic herbicides in water are expected to be relatively transient and stream flow is likely to reduce herbicide concentrations over time. Only very persistent pesticides would be expected to have effects beyond the year of their application. An OPP report on the impacts of a terrestrial herbicide on salmonids indicated that if a listed salmonid was not present during the year of application, there would likely be no concern (Turner 2003). Therefore, it is expected that potential adverse impacts to food and aquatic cover would not be occur beyond the season of application.

TABLE 4-1
Levels of Concern

	Risk Presumption	RQ	LOC
Terrestrial Animals [1]			
Birds	Acute High Risk	EEC/LC_{50}	0.5
	Acute Restricted Use	EEC/LC_{50}	0.2
	Acute Endangered Species	EEC/LC_{50}	0.1
	Chronic Risk	EEC/NOAEL	1
Wild Mammals	Acute High Risk	EEC/LC_{50}	0.5
	Acute Restricted Use	EEC/LC_{50}	0.2
	Acute Endangered Species	EEC/LC_{50}	0.1
	Chronic Risk	EEC/NOAEL	1
Aquatic Animals [2]			
Fish and Aquatic Invertebrates	Acute High Risk	EEC/LC_{50} or EC_{50}	0.5
	Acute Restricted Use	EEC/LC_{50} or EC_{50}	0.1
	Acute Endangered Species	EEC/LC_{50} or EC_{50}	0.05
	Chronic Risk	EEC/NOAEL	1
	Chronic Risk, Endangered Species	EEC/NOAEL	0.5
Plants [3]			
Terrestrial/Semi-Aquatic Plants	Acute High Risk	EEC/EC_{25}	1
	Acute Endangered Species	EEC/NOAEL	1
Aquatic Plants	Acute High Risk	EEC/EC_{50}	1
	Acute Endangered Species	EEC/NOAEL	1

[1] Estimated Environmental Concentration (EEC) is in mg $_{prey}$/kg $_{BW}$ for acute scenarios and mg $_{prey}$/kg $_{BW}$/day for chronic scenarios.
[2] EEC is in mg/L.
[3] EEC is in lbs/ac.

TABLE 4-2
Risk Quotients for Direct Spray and Spill Scenarios

Terrestrial Animals	Typical Application Rate	Maximum Application Rate
Direct Spray of Terrestrial Wildlife		
Small mammal - 100% absorption	2.48E-02	9.93E-02
Pollinating insect - 100% absorption	**3.14E-01**	**1.26E+00**
Small mammal - 1st order dermal adsorption	1.19E-04	4.76E-04
Indirect Contact With Foliage After Direct Spray		
Small mammal - 100% absorption	2.48E-03	9.93E-03
Pollinating insect - 100% absorption	3.14E-02	**1.26E-01**
Small mammal - 1st order dermal adsorption	1.19E-05	4.76E-05
Ingestion of Food Items Contaminated by Direct Spray		
Small mammalian herbivore - acute exposure	1.60E-02	**4.82E-01**
Small mammalian herbivore - chronic exposure	**1.01E+00**	**3.05E+01**
Large mammalian herbivore - acute exposure	**1.03E-01**	**2.25E+00**
Large mammalian herbivore - chronic exposure	**4.20E+00**	**9.19E+01**
Small avian insectivore - acute exposure	**1.36E-01**	**4.23E+00**
Small avian insectivore - chronic exposure	7.15E-01	**2.23E+01**
Large avian herbivore - acute exposure	3.99E-02	**1.35E+00**
Large avian herbivore - chronic exposure	**6.02E+00**	**2.04E+02**
Large mammalian carnivore - acute exposure	6.66E-02	**2.67E-01**
Large mammalian carnivore - chronic exposure	3.13E-02	1.25E-01

Semi-Aquatic Wildlife	Typical Application Rate	Maximum Application Rate
Ingestion of Prey Items Contaminated by Normal Application to Pond		
Avian piscivore – chronic exposure	1.52E-02	6.08E-02

TABLE 4-2 (Cont.)
Risk Quotients for Direct Spray and Spill Scenarios

Terrestrial Plants	Typical Species		RTE Species	
	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Direct Spray of Terrestrial Plants				
Accidental direct spray	**2.13E+02**	**8.51E+02**	**6.25E+02**	**2.50E+03**

Aquatic Species	Fish		Aquatic Invertebrates		Non-Target Aquatic Plants	
	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Direct Spray Over Pond – Normal Application						
Acute	**1.49E-01**	**5.98E-01**	**8.01E-01**	**3.20E+00**	**1.49E+02**	**5.98E+02**
Chronic	**6.59E-01**	**2.64E+00**	**2.55E+01**	**1.02E+02**	**3.74E+02**	**1.49E+03**
Direct Spray Over Stream – Accidental Spray						
Acute	**7.47E-01**	**2.99E+00**	**4.00E+00**	**1.60E+01**	**7.47E+02**	**2.99E+03**
Chronic	**3.30E+00**	**1.32E+01**	**1.27E+02**	**5.09E+02**	**1.87E+03**	**7.47E+03**
Accidental spill						
Truck spill into pond	--	**1.91E+01**	--	**1.02E+02**	--	**1.91E+04**
Helicopter spill into pond	--	**6.70E+01**	--	**3.59E+02**	--	**6.70E+04**

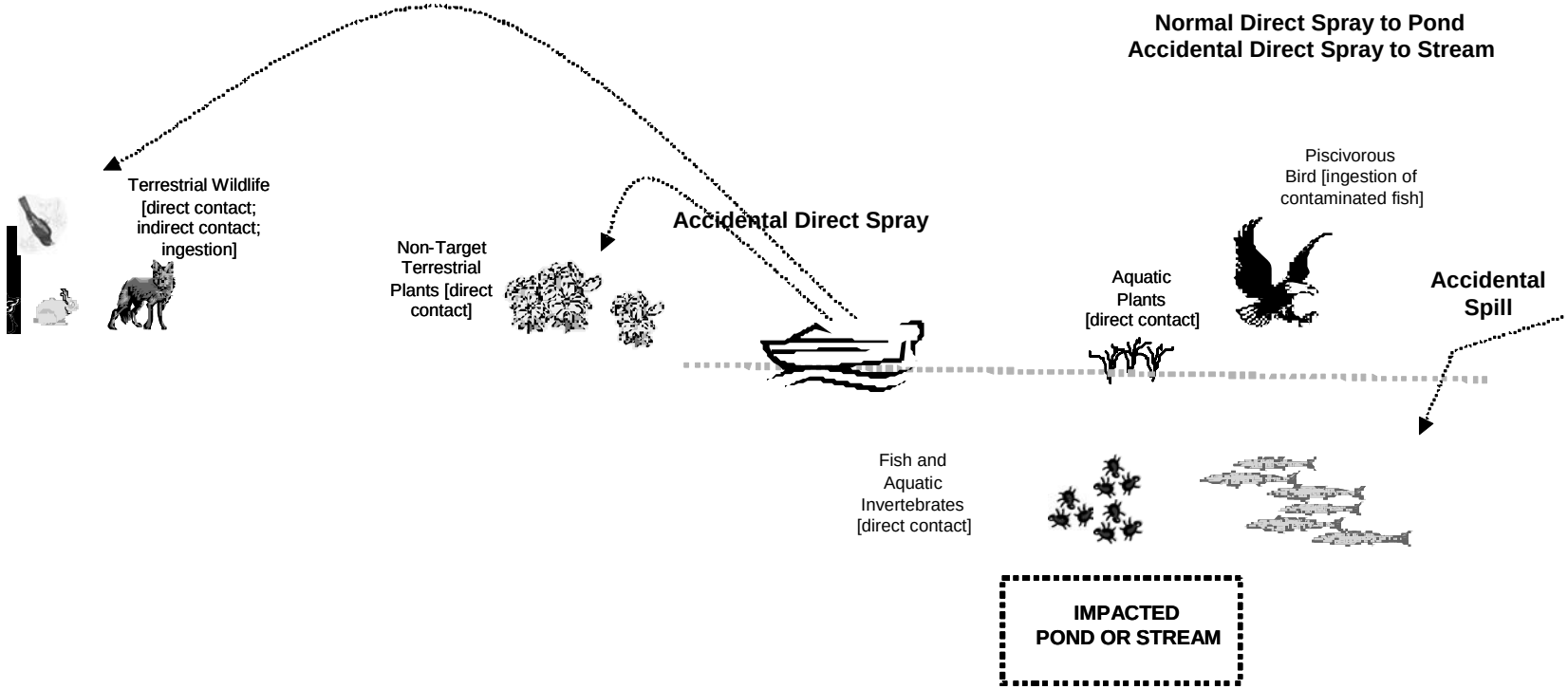
Shading and boldface indicates terrestrial animal acute RQs greater than 0.1 (LOC for acute risk to endangered species - most conservative).
Shading and boldface indicates terrestrial animal chronic RQs greater than 1 (LOC for chronic risk).
Shading and boldface indicates plant RQs greater than 1 (LOC for all plant risks).
Shading and boldface indicates acute RQs greater than 0.05 for fish and invertebrates (LOC for acute risk to endangered species - most conservative).
Shading and boldface indicates chronic RQs greater than 0.5 for fish and invertebrates (LOC for chronic risk to endangered species).
RTE – Rare, threatened, and endangered.
-- indicates the scenario was not evaluated

TABLE 4-3
Risk Quotients for Off-Site Drift Scenarios

Potential Risk to Terrestrial Plants						
			Typical Species		Rare, Threatened, and Endangered Species	
Mode of Application	Application Height or Type	Distance From Receptor (ft)	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Spray Drift to Off-Site Soil						
Plane	Non-Forested	100	**2.09E+01**	**9.68E+01**	**6.13E+01**	**2.84E+02**
Plane	Non-Forested	300	**9.49E+00**	**4.37E+01**	**2.79E+01**	**1.28E+02**
Plane	Non-Forested	900	**3.80E+00**	**1.14E+01**	**1.12E+01**	**3.35E+01**
Helicopter	Non-Forested	100	**1.90E+01**	**8.35E+01**	**5.58E+01**	**2.45E+02**
Helicopter	Non-Forested	300	**7.59E+00**	**3.23E+01**	**2.23E+01**	**9.48E+01**
Helicopter	Non-Forested	900	**3.80E+00**	**5.69E+00**	**1.12E+01**	**1.67E+01**
Ground	Low Boom	25	**1.90E+00**	**1.14E+01**	**5.58E+00**	**3.35E+01**
Ground	Low Boom	100	9.43E-01	**3.80E+00**	**2.77E+00**	**1.12E+01**
Ground	Low Boom	900	1.45E-01	5.81E-01	4.26E-01	**1.71E+00**
Ground	High Boom	25	**3.80E+00**	**1.71E+01**	**1.12E+01**	**5.02E+01**
Ground	High Boom	100	**1.49E+00**	**5.69E+00**	**4.37E+00**	**1.67E+01**
Ground	High Boom	900	1.86E-01	7.42E-01	5.45E-01	**2.18E+00**

Shading and boldface indicates plant RQs greater than 1 (LOC for all plant risks).
RTE – Rare, Threatened, and Endangered

FIGURE 4-1. Conceptual Model for Aquatic Herbicides.



Application of aquatic herbicides may occur by aerial (i.e., plane, helicopter) ground (i.e., truck, backpack), or boat methods.

See Figure 4-2 for simplified food web & evaluated receptors.

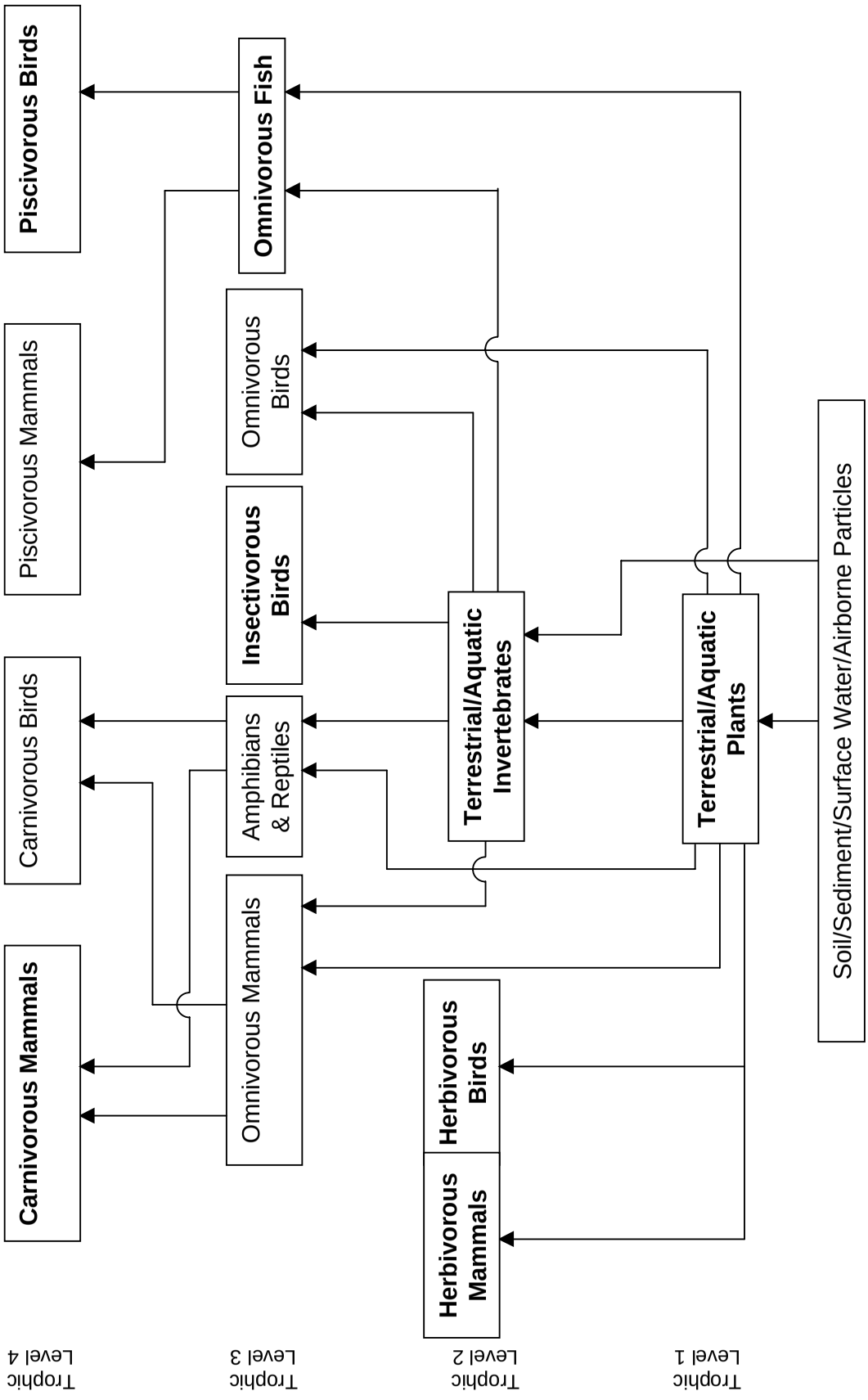


FIGURE 4-2. Simplified Food Web.

FIGURE 4-3. Direct Spray - Risk Quotients for Terrestrial Animals.

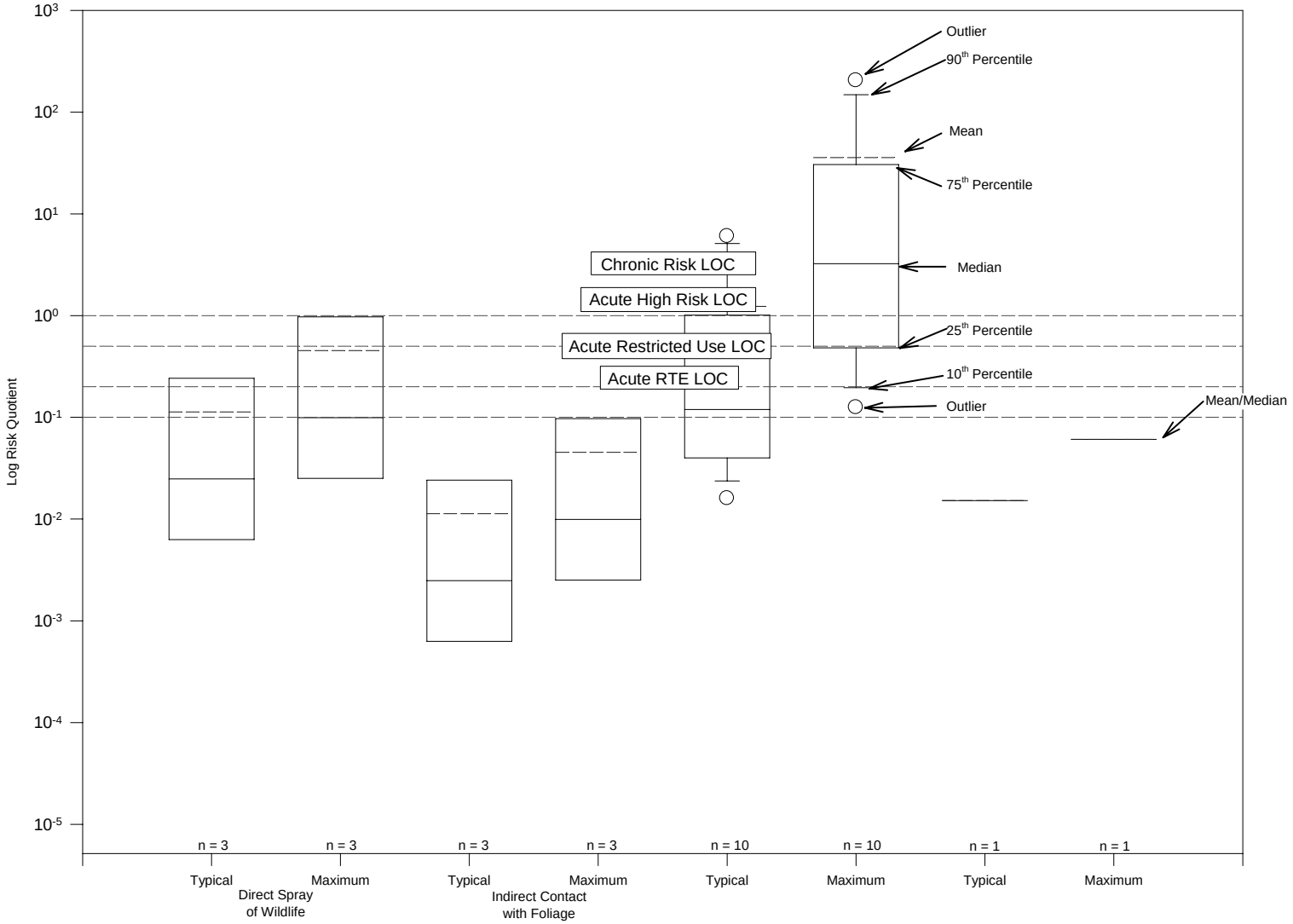


FIGURE 4-4. Direct Spray - Risk Quotients for Non-Target Terrestrial Plants.

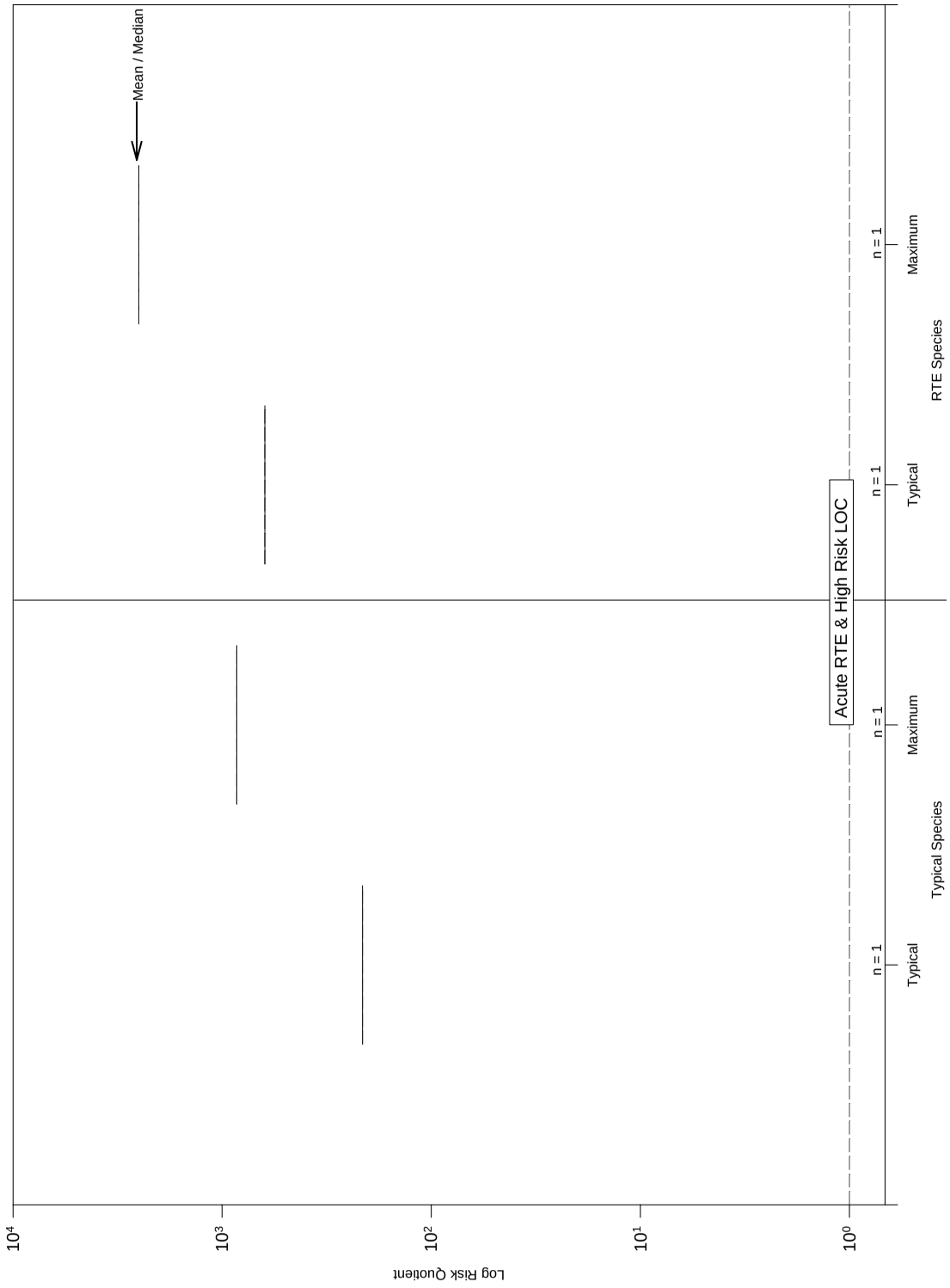


FIGURE 4-5. Accidental Direct Spray and Spills - Risk Quotients for Non-Target Aquatic Plants.

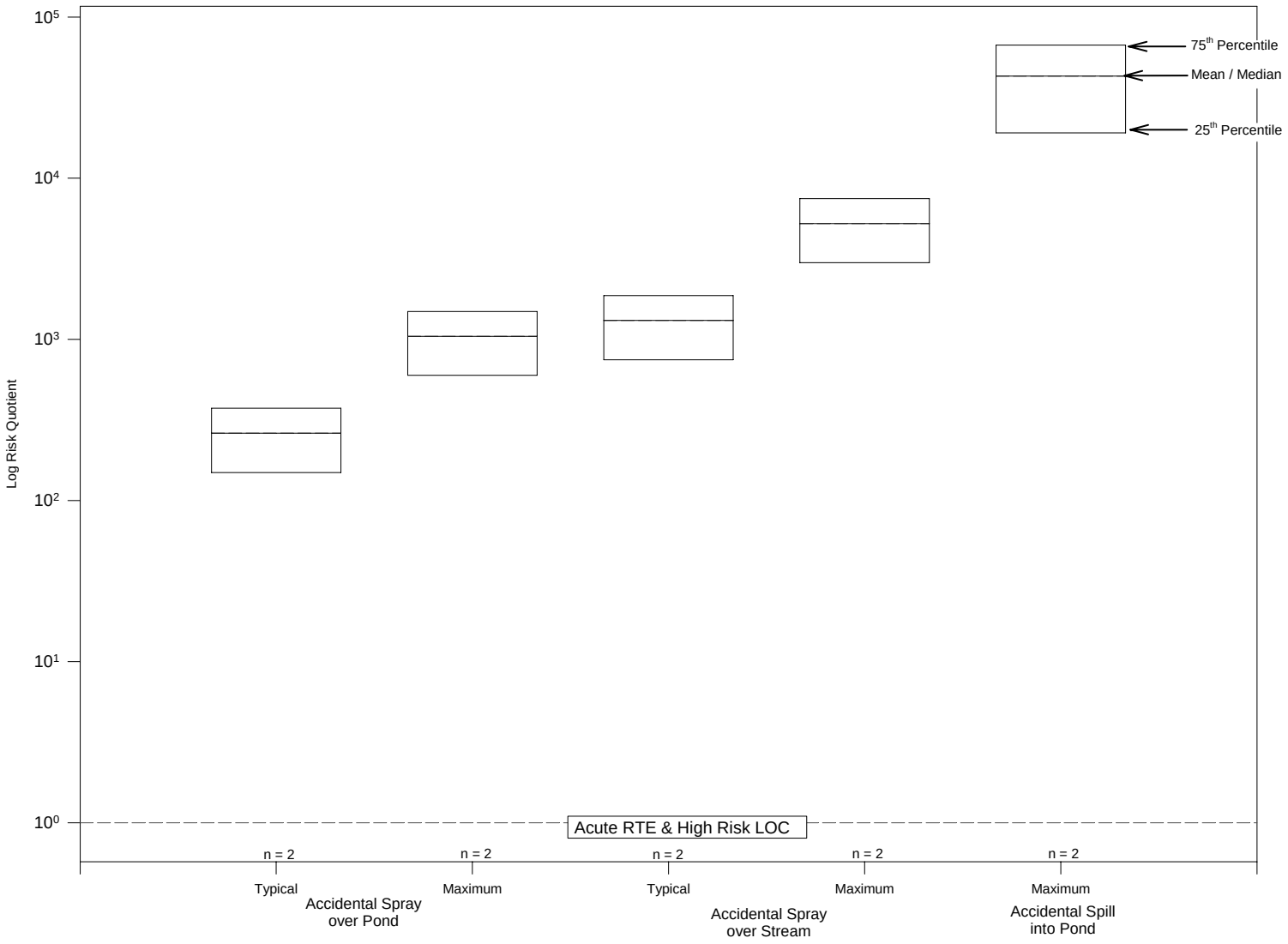


FIGURE 4-6. Accidental Direct Spray and Spills - Risk Quotients for Fish.

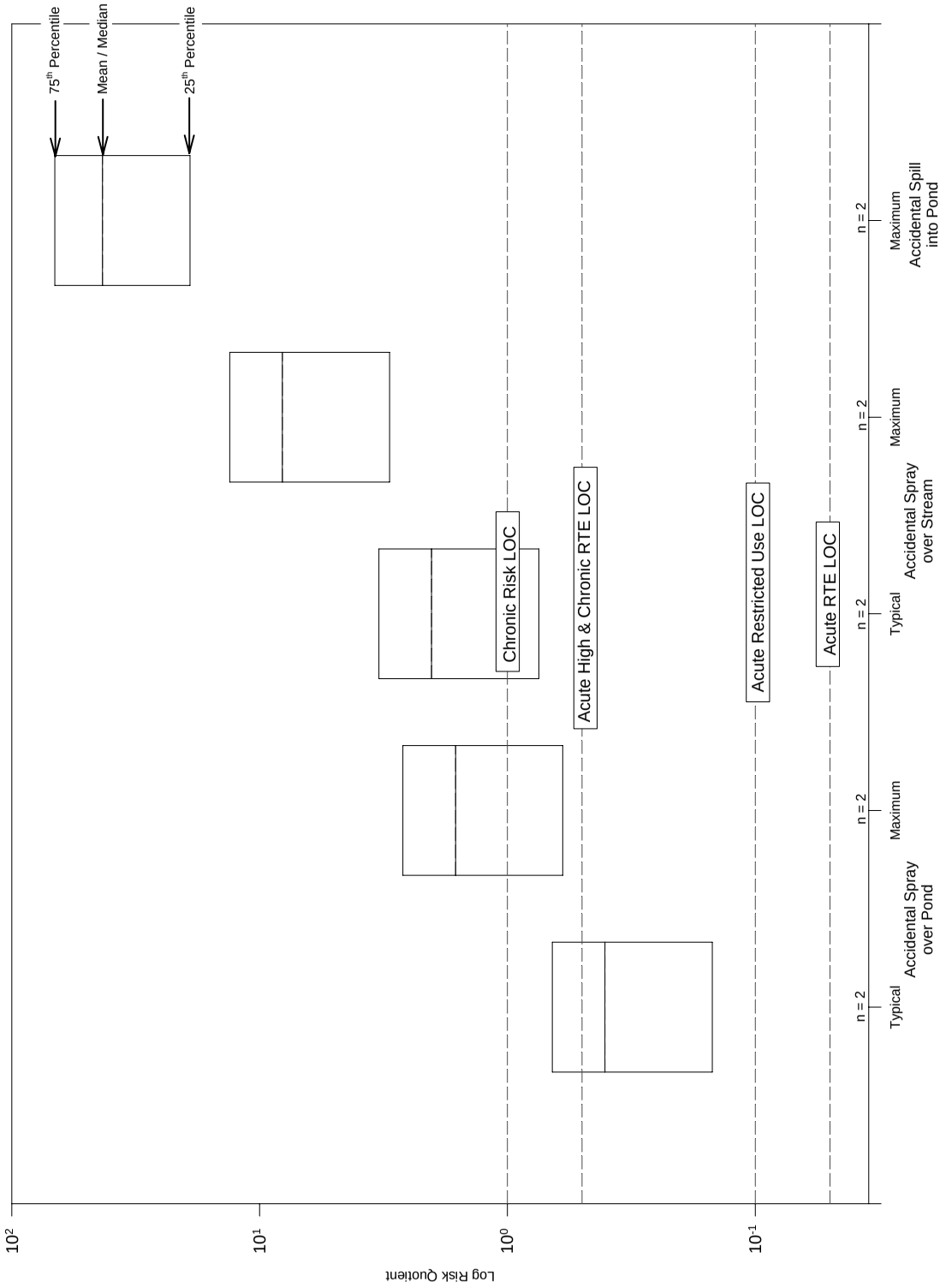
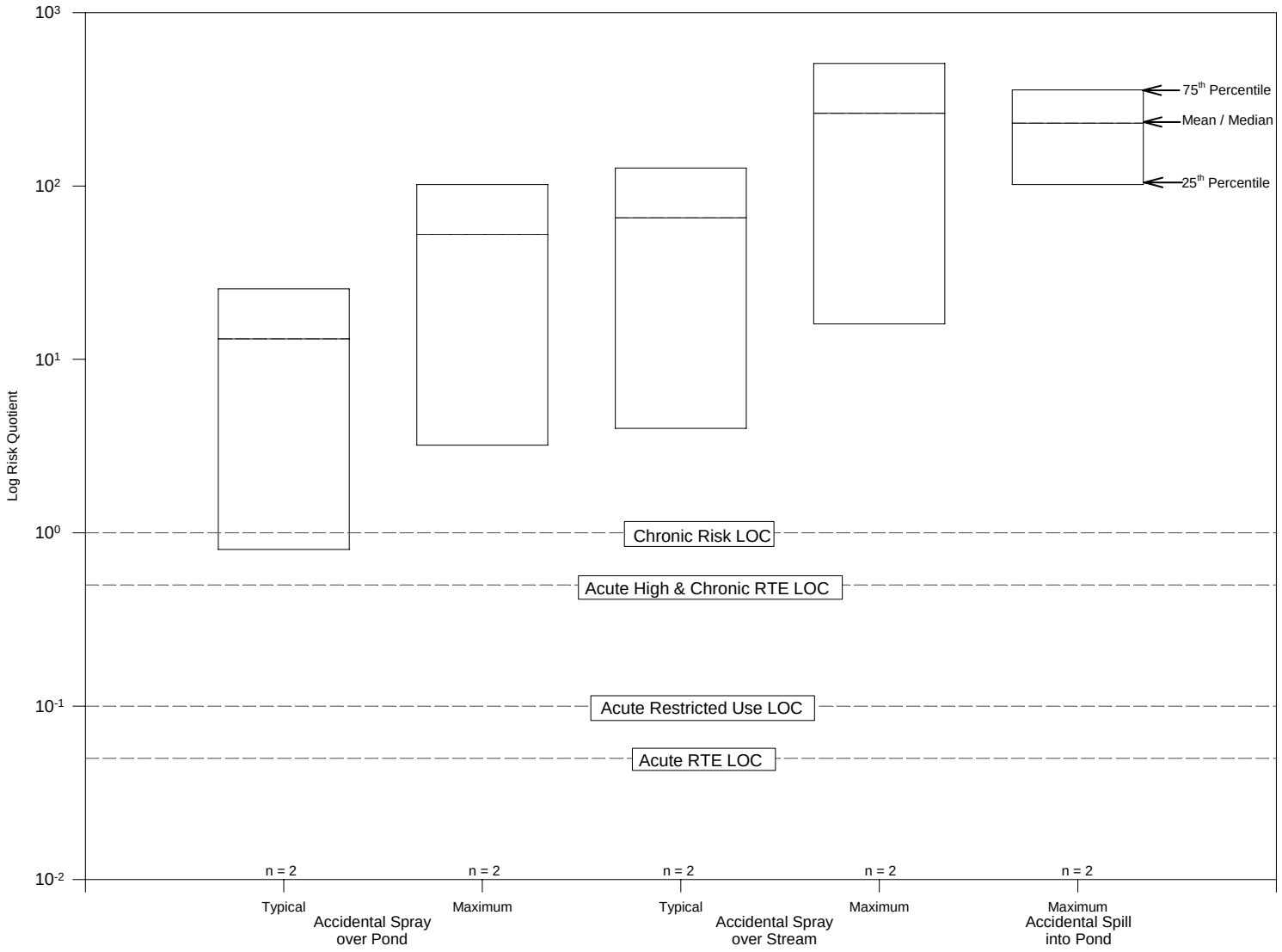


FIGURE 4-7. Accidental Direct Spray and Spills - Risk Quotients for Aquatic Invertebrates.



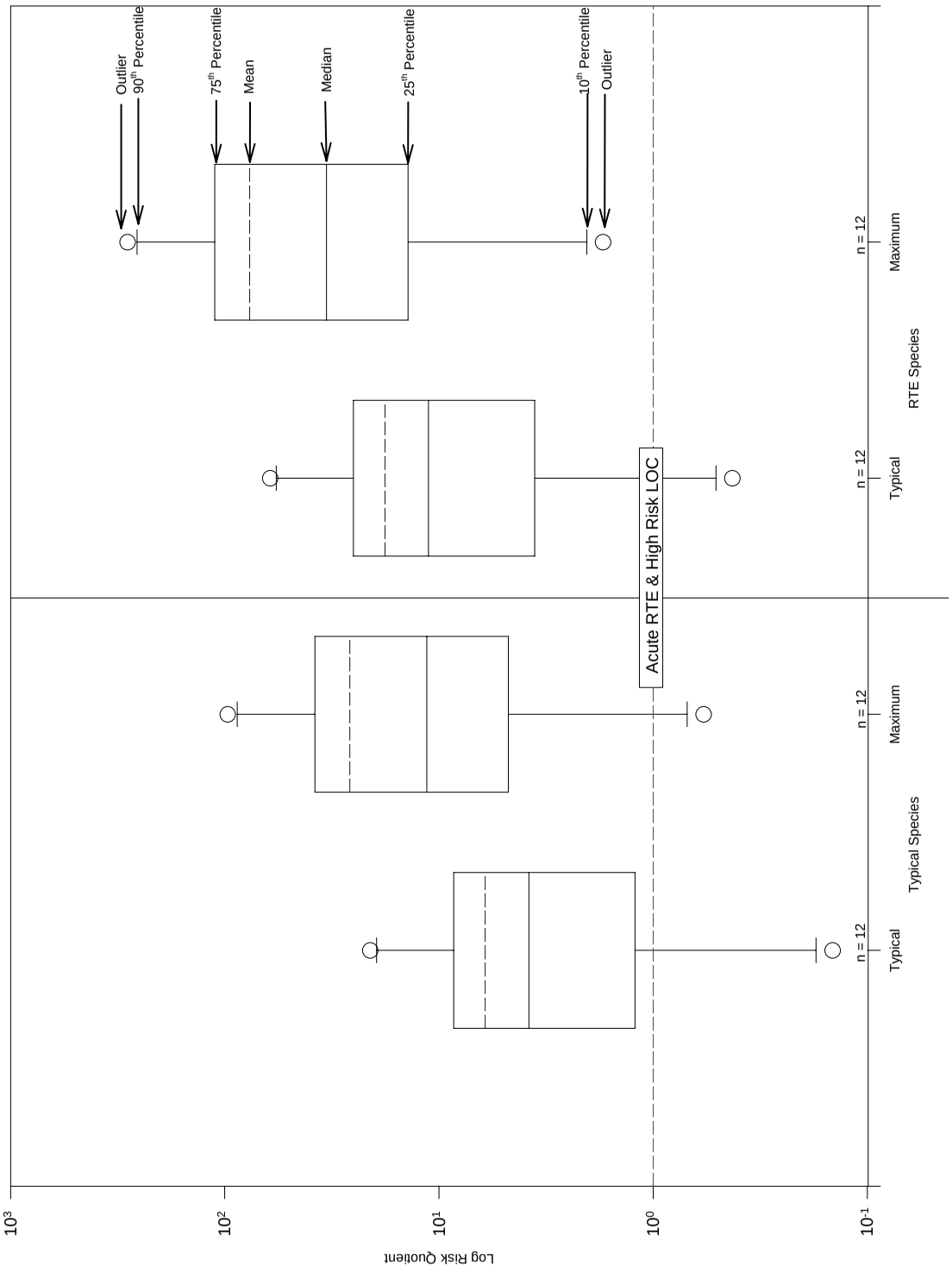


FIGURE 4-8. Off-Site Drift - Risk Quotients for Non-Target Terrestrial Plants.

5.0 SENSITIVITY ANALYSIS

The sensitivity analysis was designed to determine which factors most greatly affect exposure concentrations. Changes in herbicide concentrations were modeled with respect to changes in pond and stream area and depth. The effects of off-site drift on terrestrial species were estimated using the AgDRIFT® model. A base case for the AgDRIFT® model was established, and from this base case various input factors were changed independently, thereby resulting in an estimate of the importance of that factor on exposure concentrations. Information regarding the AgDRIFT® model, its specific use and any inputs and assumptions made during the application of this model is provided in the Methods Document (ENSR 2004c).

5.1 Pond Volume and Stream Flow Sensitivity

The sensitivity analysis was designed to determine how pond and stream volumes affect exposure concentrations. A base case for each model was established. Input factors (e.g., area, depth) were changed independently, thereby resulting in an estimate of the importance of that factor on exposure concentrations. As described previously, surface runoff and wind erosion were not considered as transport mechanisms for the aquatic herbicides. The scenarios for the aquatic herbicides are relatively simplistic and essentially represent an instantaneous concentration in the waterbody due to direct applications. The predicted surface water concentrations are based on the application rate, and the surface area and depth of the waterbody. The surface water concentrations predicted in these scenarios are likely to be an overestimate since stream flow, degradation, and adsorption are not considered.

The base case for the pond consisted of a ¼ ac pond 1 m deep. Table 5-1 presents the variations in the pond surface water concentrations as the area and depth of the pond are changed. This analysis indicates that changing the area of the pond does not alter the predicted surface water concentration because as more herbicide is sprayed over a larger area, there is a larger pond volume in which the herbicide is dissipated. However, changing the depth does have an impact on the pond concentration because the pond volume changes, but the amount of herbicide sprayed on the pond is unchanged. For example, an increase in the pond depth will decrease the associated herbicide concentration in the surface water.

The base case for the stream consisted of a stream 2 m wide and 0.2 m deep. The base case length was based on one side of a 100 ac square application area (636 m). Table 5-2 presents the variations in the stream surface water concentrations as the width, length, and depth of the impacted stream are changed. As observed in the pond sensitivity analysis, changes to stream area accomplished by varying the length or width do not result in changes to the surface water concentrations. Changes to the stream depth do result in associated changes to the stream concentrations. As the depth is increased, the stream concentration decreases and as the depth decreases, the stream concentration increases.

The results of this sensitivity analysis indicate that the size of the impacted water body does not have an effect on the surface water concentration (assuming that the entire waterbody is sprayed). However, depth has a dramatic impact on the associated surface water concentration (doubling the depth decreased the water concentration by ½). This indicates that shallow ponds and streams are more likely to be impacted by herbicide spray.

5.2 AgDRIFT® Sensitivity

Changes to individual input parameters of predictive models have the potential to substantially influence the results of an analysis such as that conducted in this ERA. This is particularly true for models such as AgDRIFT® which are intended to represent complex problems such as the prediction of off-target spray drift of herbicides. Predicted off-target spray drift and downwind deposition can be substantially altered by a number of variables intended to represent the herbicide application process including, but not limited to: nozzle type used in the spray application of an herbicide mixture, ambient wind speed, release height (application boom height), and evaporation. Hypothetically, any variable in the model that is intended to represent some part of the physical process of spray drift and deposition can substantially alter predicted downwind drift and deposition patterns. This section will present the changes that

occur to the EEC with changes to important input parameters and assumptions used in the AgDRIFT® model. It is important to note that changes in the EEC directly affect the estimated RQ. Thus, this information is presented to help local land managers understand the factors that are likely to be related to higher potential ecological risk. Table 5-3 summarizes the relative change in exposure concentrations, and therefore ecological risk, based on specific model input parameters (e.g., mode of application, application rate).

Factors that are thought to have the greatest influence on downwind drift and deposition are: spray drop-size distribution, release height, and wind speed (Teske and Barry 1993; Teske et al. 1998; Teske and Thistle 1999, *as cited in SDTF 2002*). To better quantify the influence of these and other parameters, a sensitivity analysis was undertaken by the SDTF and documented in the AgDRIFT® user's manual. In this analysis AgDRIFT® Tier II model input parameters (model input parameters are discussed in Appendix B of the HHRA) were varied by 10% above and below the default assumptions (four different drop-size distributions were evaluated). The findings of this analysis indicate the following:

- The largest variation in predicted downwind drift and deposition patterns occurred as a result of changes in the shape and content of the spray drop size distribution.
- The next greatest change in predicted downwind drift and deposition patterns occurred as a result of changes in boom height (the release height of the spray mixture).
- Changes in spray boom length resulted in significant variations in drift and deposition within 200 ft downwind of the hypothetical application area.
- Changes in the assumed ambient temperature and relative humidity resulted in small variation in drift and deposition at distances greater than 200 ft downwind of the hypothetical application area.
- Varying the assumed number of application swaths (aircraft flight lines), application swath width, and wind speed resulted in little change in predicted downwind drift and deposition.
- Variation in nonvolatile fraction of the spray mixture showed no effect on downwind drift and deposition.

These results, except for the minor to negligible influence of varying wind speed and nonvolatile fraction, were consistent with previous observations. The 10% variation in wind speed and nonvolatile fraction was likely too small to produce substantial changes in downwind drift and deposition. It is expected that varying these by a larger percentage would eventually produce some effect. In addition, changes in wind speed resulted in changes in application swath width and offset, which masked the effect of wind speed alone on downwind drift and deposition.

Based on these findings, and historic field observations, the hierarchy of parameters that have the greatest influence on downwind drift and deposition patterns is as follows:

1. Spray drop size distribution
2. Application boom height
3. Wind speed
4. Spray boom length
5. Relative humidity
6. Ambient temperature
7. Nonvolatile fraction

An additional limitation of the AgDRIFT® user's manual sensitivity analysis is the focus on distances less than 200 ft downwind of a hypothetical application area. From a land management perspective, distance downwind from the point of deposition may be considered to represent a hypothetical buffer zone between the application area and a potentially sensitive habitat. In this ERA, distances as great as 900 ft downwind of a hypothetical application were considered. In an effort to expand on the existing AgDRIFT® sensitivity analysis provided in the user's manual, the sensitivity of mode of application, application height or vegetation type, and application rate were evaluated. Results of this supplemental analysis are provided in Table 5-3.

The results of the expanded sensitivity analysis indicate that deposition and corresponding ecological risk drop off substantially between 25 and 900 ft downwind of hypothetical application area. Thus, from a land management perspective, the size of a hypothetical buffer zone (the downwind distance from a hypothetical application area to a potentially sensitive habitat) may be the single most controllable variable (other than the application rate, equipment and herbicide mixtures chosen) that has a substantial impact on ecological risk (Table 5-3).

The most conservative case at the typical application rate (using the smallest downwind distance measured in this ERA – 25 ft) was then evaluated using two different boom heights. Predicted concentrations were greater with high vs. low boom height (Table 5-3); ecological risk, therefore, increases with boom height. The effect of mode of application was evaluated using plane, helicopter and ground dispersal (using the typical application rate, smallest downwind distance, and non-forested cover or high boom height). Plane dispersal resulted in the highest predicted exposure concentrations, and therefore, represents the greatest risk. Ground applications resulted in the lowest predicted exposure concentrations. The effect of application rate (maximum vs. typical) was also tested, and as expected, predicted concentrations (and ecological risk) increase with increased application rates (Table 5-3). Concentrations were approximately four times greater using maximum application rates than using typical application rates. In general, the evaluation presented in Table 5-3 indicates that there is a decrease in herbicide migration and associated ecological risk, with increased downward distance (i.e., buffer zone) and an increase in herbicide migration with increasing application height and rate.

TABLE 5-1
Relative Effects of Pond Variables on Herbicide Exposure Concentrations using Typical BLM Application Rate

Pond area (acres)	Pond depth (m)	Pond volume (L)	Mass sprayed on pond (mg)	Concentration in pond (mg/L)	Comments
0.25	1	1,011,714	113,398	0.11	Base case
100	1	404,685,642	45,359,237	0.11	Increased pond area; No change in concentration
1,000	1	4,046,856,422	453,592,370	0.11	Increased pond area; No change in concentration
0.25	0.5	2,023,428,211	453,592,370	0.22	Decreased pond depth; Increased concentration
0.25	2	2,023,428	113,398	0.056	Increased pond depth; decreased concentration
0.25	4	4,046,856	113,398	0.028	Increased pond depth; decreased concentration

TABLE 5-2
Relative Effects of Stream Variables on Herbicide Exposure Concentrations using Typical BLM Application Rate

Stream width (m)	Stream depth (m)	Length of impacted stream (m) [1]	Stream volume (L)	Mass sprayed on stream (mg)	Concentration in stream (mg/L)	Comments
2	0.2	636	254,460	142,606	0.56	Base case
4	0.2	636	508,920	285,212	0.56	Increased stream width; No change in concentration
1	0.2	636	127,230	71,303	0.56	Decreased stream width; No change in concentration
2	0.4	636	508,920	142,606	0.28	Increased stream depth; Decreased concentration
2	0.1	636	127,230	142,606	1.12	Decreased stream depth; Increased concentration
2	0.2	201	80,468	45,096	0.56	Increased stream length; No change in concentration
2	0.2	2,012	804,672	450,959	0.56	Decreased stream length; No change in concentration

(1) – Length of impacted stream is based on size of application area. 10 ac application area = 201 m impacted; 100 ac application area = 636 m impacted; 1,000 ac application area = 2,012 m impacted.

TABLE 5-3
Herbicide Exposure Concentrations used during the Supplemental AgDRIFT® Sensitivity Analysis

Mode of Application	Application Height or Vegetation Type	Minimum Downwind Distance	Maximum Downwind Distance	Minimum Downwind Distance Concentration Pond (mg/L)	Maximum Downwind Distance Concentration Pond (mg/L)
Typical Application Rate					
Plane	Forest	100	900	NA	NA
	Non-Forest	100	900	8.08E-03	1.96E-03
Helicopter	Forest	100	900	NA	NA
	Non-Forest	100	900	6.82E-03	1.58E-03
Ground	Low Boom	25	900	6.82E-04	7.22E-05
	High Boom	25	900	1.09E-03	9.16E-05
Maximum Application Rate					
Plane	Forest	100	900	NA	NA
	Non-Forest	100	900	3.89E-02	5.85E-03
Helicopter	Forest	100	900	NA	NA
	Non-Forest	100	900	3.23E-02	2.55E-03
Ground	Low Boom	25	900	2.73E-03	2.89E-04
	High Boom	25	900	4.38E-03	3.66E-04

Effect of Downwind Distance

Mode of Application	Application Height or Vegetation Type	Minimum Downwind Distance	Maximum Downwind Distance	Concentration $_{900}$/ Concentration $_{25 \text{ or } 100}$	Relative Change in Concentration
Typical Application Rate					
Plane	Forest	100	900	NA	NA
	Non-Forest	100	900	0.2426	-
Helicopter	Forest	100	900	NA	NA
	Non-Forest	100	900	0.2317	-
Ground	Low Boom	25	900	0.1059	-
	High Boom	25	900	0.0840	-
Maximum Application Rate					
Plane	Forest	100	900	NA	NA
	Non-Forest	100	900	0.1504	-
Helicopter	Forest	100	900	NA	NA
	Non-Forest	100	900	0.0789	-
Ground	Low Boom	25	900	0.1059	-
	High Boom	25	900	0.0836	-

TABLE 5-3 (Cont.)
Herbicide Exposure Concentrations used during the Supplemental AgDRIFT® Sensitivity Analysis

Effect of Application Height (Vegetation Type or Boom Height)

Mode of Application	Application Height or Vegetation Type	Concentration Ratio[1]	Relative Change in Concentration
Typical Application Rate			
Plane	Forest/ Non-Forest	NA	NA
Helicopter	Forest/ Non-Forest	NA	NA
Ground	High/Low Boom	1.5982	+
Maximum Application Rate			
Plane	Forest/ Non-Forest	NA	NA
Helicopter	Forest/ Non-Forest	NA	NA
Ground	High/Low Boom	1.6044	+

Effect of Mode of Application

	Concentration Ratio[2]	Relative Difference
Typical Application Rate		
Plane vs. Helicopter	1.1848	+
Plane vs. Ground	7.4128	+
Helicopter vs. Ground	6.2569	+
Maximum Application Rate		
Plane vs. Helicopter	1.2043	+
Plane vs. Ground	8.8813	+
Helicopter vs. Ground	7.3744	+

Effect of Application Rate

	Application Rate[3]	Relative Difference
Maximum vs. Typical	4.0183	+

[1] using minimum buffer width concentrations.
[2] using minimum buffer width and non-forest or high boom concentrations.
[3] using ground dispersal, minimum buffer width and high boom concentrations
"+" = Increase in concentration = increase in RQ = increase in ecological risk.
"-" = Decrease in concentration = decrease in RQ = decrease in ecological risk.

6.0 RARE, THREATENED, AND ENDANGERED SPECIES

Rare, threatened, and endangered (RTE) species have the potential to be impacted by herbicides applied for vegetation control. RTE species are of potential increased concern to screening level ERAs, which utilize surrogate species and generic assessment endpoints to evaluate potential risk, rather than examining site- and species-specific effects to individual RTE species. Several factors complicate our ability to evaluate site- and species-specific effects:

- Toxicological data specific to the species (and sometimes even class) of organism are often absent from the literature.
- The other assumptions involved in the ERA (e.g., rate of food consumption, surface-to-volume ratio) may differ for RTE species relative to selected surrogates and/or data for RTE species may be unavailable.
- The high level of protection afforded RTE species by regulation and policy suggests that secondary effects (e.g., potential loss of prey or cover), as well as site-specific circumstances that might result in higher rates of exposure, should receive more attention.

A common response to these issues is to design screening level ERAs, including this one, to be highly conservative. This includes assumptions such as 100% exposure to an herbicide by simulating scenarios where the organism lives year-round in the most affected area (i.e., area of highest concentration), or that the organism consumes only food items that have been impacted by the herbicide. The diquat screening level ERA incorporates additional conservatism in the assumptions used in the herbicide concentration models such as AgDRIFT® (Appendix A; ENSR 2004c). Even with highly conservative assumptions in the ERA, however, concern may still exist over the potential risk to specific RTE species.

To help address this potential concern, the following section will discuss the ERA assumptions as they relate to the protection of RTE species. The goals of this discussion are as follows:

- Present the methods the ERA employs to account for risks to RTE species and the reasons for their selection.
- Define the factors that might motivate a site- and/or species-specific evaluation[3] of potential herbicide impacts to RTE species and provide perspective useful for such an evaluation.
- Present information that is relevant to assessing the uncertainty in the conclusions reached by the ERA with respect to RTE species.

The following sections describe information used in the ERA to provide protection to RTE species, including mammals, birds, plants, reptiles, amphibians and fish (e.g., salmonids) potentially occurring on BLM lands. It includes a discussion of the quantitative and qualitative factors used to provide additional protection to RTE species and a discussion of potential secondary effects of herbicide use on RTE species.

Section 6.1 provides a review of the selection of LOCs and TRVs with respect to providing additional protection to RTE species. Section 6.2 provides a discussion of species-specific traits and how they relate to the RTE protection strategy in this ERA. Section 6.2 also includes discussion of the selection of surrogate species (6.2.1), the RTE taxa of

[3] Such an evaluation might include site-specific estimation of exposure point concentrations using one or more models, more focused consideration of potential risk to individual RTE species; and/or more detailed assessment of indirect effects to RTE species, such as those resulting from impacts to habitat.

concern, and the surrogates used to represent them (6.2.2), and the biological factors that affect the exposure to and response of organisms to herbicides (6.2.3). This includes a discussion of how the ERA was defined to assure that consideration of these factors resulted in a conservative assessment. Mechanisms for extrapolating toxicity data from one taxon to another are briefly reviewed in Section 6.3. The potential for impacts, both direct and secondary, to salmonids is discussed in Section 6.4. Section 6.5 provides a summary of the section.

6.1 Use of LOCs and TRVs to Provide Protection

Potential direct impacts to receptors, including RTE species, are the measures of effect typically used in screening level ERAs. Direct impacts, such as those resulting from direct or indirect contact or ingestion were assessed in the diquat ERA by comparing calculated RQs to receptor-specific LOCs. As described in the methodology document for this ERA (ENSR 2004c), RQs are calculated as the potential dose or EEC divided by the TRV selected for that pathway. An RQ greater than the LOC indicates the potential for risk to that receptor group via that exposure pathway. As described below, the selection of TRVs and the use of LOCs were pursued in a conservative fashion in order to provide a greater level of protection for RTE species.

The LOCs used in the ERA (Table 4-1) were developed by the USEPA for the assessment of pesticides (LOC information obtained from Michael Davy, USEPA OPP on 13 June 2002). In essence, the LOCs act as uncertainty factors often applied to TRVs. For example, using an LOC of 0.1 provides the same result as dividing the TRV by 10. The LOC for avian and mammalian RTE species is 0.1 for acute and chronic exposures. For RTE fish and aquatic invertebrates, acute and chronic LOCs were 0.05 and 0.5, respectively. Therefore, up to a 20-fold uncertainty factor has been included in the TRVs for animal species. As noted below, such uncertainty factors provide a greater level of protection to the RTE species to account for the factors listed in the introduction to this section.

For RTE plants, the exposure concentration, TRVs, and LOCs provided a direct assessment of potential impacts. For all exposure scenarios, the maximum modeled concentrations were used as the exposure concentrations. The TRVs used for RTE plants were selected based on highly sensitive endpoints, such as germination, rather than direct mortality of seedlings or larger plants. Conservatism has been built into the TRVs during their development (Section 3.1); the lowest suitable endpoint concentration available was used as the TRV for RTE plant species. Therefore, the RQ calculated for RTE plant exposure is intrinsically conservative. Given the conservative nature of the RQ, and consistent with USEPA policy, no additional levels of protection were required for the LOC (i.e., all plant LOCs are 1).

6.2 Use of Species Traits to Provide Protection to RTE Species

Over 500 RTE species currently listed under the Federal Endangered Species Act have the potential to occur in the 17 states covered under this Programmatic ERA. These species include 287 plants, 80 fish, 30 birds, 47 mammals, 15 reptiles, 13 amphibians, 34 insects, 10 arachnids (spiders), and 22 aquatic invertebrates (12 mollusks and 10 crustaceans)[4]. Some marine mammals are included in the list of RTE species; but due to the limited possibility these species would be exposed to herbicides applied to BLM lands, no surrogates specific to marine species are included in this ERA. However, the terrestrial mammalian surrogate species identified for use in the ERA include species that can be considered representative of these marine species as well. The complete list is presented in Appendix D.

Of the over 500 species potentially occurring in the 17 states, just over 300 species may occur on lands managed by the BLM. These species include 7 amphibians, 19 birds, 6 crustaceans, 65 fish, 30 mammals, 10 insects, 13 mollusks, 5 reptiles, and 151 plants[4]. Protection of these species is an integral goal of the BLM, and they are the focus of the RTE evaluation for the ERA and EIS. These species are different from one another in regards to home range, foraging strategy, trophic level, metabolic rate, and other species-specific traits. Several methods were used in the ERA to take these differences into account during the quantification of potential risk. Despite this precaution, these traits are

[4] The number of RTE species may have changed slightly since the writing of this document.

reviewed in order to provide a basis for potential site- and species-specific risk assessment. Review of these factors provides a supplement to other sections of the ERA that discuss the uncertainty in the conclusions specific to RTE species.

6.2.1 Identification of Surrogate Species

Use of surrogate species in a screening ERA is necessary to address the broad range of species likely to be encountered on BLM-managed lands as well as to accommodate the fact that toxicity data may be restricted to a limited number of species. In this ERA, surrogates were selected to account for variation in the nature of potential herbicide exposure (e.g., direct contact, food chain) as well as to ensure that different taxa, and their behaviors, are considered. As described in Section 3.0 of the Methods document (ENSR 2004c), surrogate species were selected to represent a broad range of taxa in several trophic guilds that could potentially be impacted by herbicides on BLM lands. Generally, the surrogate species that were used in the ERA are species commonly used as representative species in ERA. Many of these species are common laboratory species, or are described in USEPA (1993a, b) Exposure Factors Handbook for Wildlife. Other species were included in the California Wildlife Biology, Exposure Factor, and Toxicity Database (CA OEHHA 2003),[5] or are those recommended by USEPA OPP for tests to support pesticide registration. Surrogate species were used to derive TRVs, and in exposure scenarios that involve organism size, weight, or diet, surrogate species were exposed to the herbicide in the models to represent potential impact to other species that may be present on BLM lands.

Toxicity data from surrogate species were used in the development of TRVs because few, if any, data are available that demonstrate the toxicity of chemicals to RTE species. Most reliable toxicity tests are performed under controlled conditions in a laboratory, using standardized test species and protocols; RTE species are not used in laboratory toxicity testing. In addition, field-generated data, which are very limited in number but may include anecdotal information about RTE species, are not as reliable as laboratory data because uncontrolled factors may complicate the results of the tests (e.g., secondary stressors such as unmeasured toxicants, imperfect information on rate of exposure).

As described below, inter-species extrapolation of toxicity data often produces unknown bias in risk calculations. This ERA approached the evaluation of higher trophic level species by life history (e.g., large animals vs. small animals, herbivore vs. carnivores). Then surrogate species were used to evaluate all species of similar life history potentially found on BLM-managed lands, including RTE species. This procedure was not done for plants, invertebrates, and fish, as most exposure of these species to herbicides is via direct contact (e.g., foliar deposition, dermal deposition, dermal/gill uptake) rather than ingestion of contaminated food items. Therefore, altering the life history of these species would not result in more or less exposure.

The following subsections describe the selection of surrogate species used in two separate contexts in the ERA.

6.2.1.1 Species Selected in Development of TRVs

As presented in Appendix A of the ERA, limited numbers of species are used for toxicity testing of chemicals, including herbicides. Species are typically selected because they tolerate laboratory conditions well. The species used in laboratory tests have relatively well-known response thresholds to a variety of chemicals. Growth rates, ingestion rates, and other species-specific parameters are known; therefore, test duration and endpoints of concern (e.g., mortality, germination) have been established in protocols for many of these laboratory species. Data generated during a toxicity test, therefore, can be compared to data from other tests and relative species sensitivity can be compared. Of course, in the case of RTE species, it would be unacceptable to subject individuals to toxicity tests.

The TRVs used in the ERA were selected after reviewing available ecotoxicological literature for diquat. Test quality was evaluated, and tests with multiple substances were not considered for the TRV. For most receptor groups, the lowest value available for an appropriate endpoint (e.g., mortality, germination) was selected as the TRV. Using the

[5] On-line http://www.oehha.org/cal_ecotox/default.htm

most sensitive species provides a conservative level of protection for all species. The surrogate species used in the diquat TRVs are presented in Table 6-1.

6.2.1.2 Species Selected as Surrogates in the ERA

Plants, fish, insects, and other aquatic invertebrates were evaluated on a generic level. That is, the surrogate species evaluated to create the TRVs were selected to represent all potentially exposed species. For vertebrate terrestrial animals, in addition to these surrogate species, specific species were selected to represent the populations of similar species. The species used in the ERA are presented in Table 6-2.

The surrogate terrestrial vertebrate species selected for the ERA include species from several trophic levels that represent a variety of foraging strategies. Whenever possible, the species selected are found throughout the range of land included in the EIS; all species selected are found in at least a portion of the range. The surrogate species are common species whose life histories are well documented (USEPA 1993a, b; CA OEHHA 2003). Because species-specific data, including BW and food ingestion rates, can vary for a single species throughout its range, data from studies conducted in western states or with western populations were selected preferentially. As necessary, site-specific data can be used to estimate potential risk to species known to occur locally.

6.2.2 Surrogates Specific to Taxa of Concern

Protection levels for different species and individuals vary. Some organisms are protected on a community level; that is, slight risk to individual species may be acceptable if the community of organisms (e.g., wildflowers, terrestrial insects) is protected. Generally, community level organisms include plants and invertebrates. Other organisms are protected on a population level; that is, slight risk to individuals of a species may be acceptable if the population, as a whole, is not endangered. However, RTE species are protected as individuals; that is, risk to any single organism is considered unacceptable. This higher level of protection motivates much of the conservative approach taken in this ERA. Surrogate species were grouped by general life strategy: sessile (i.e., plants), water dwelling (i.e., fish), and mobile terrestrial vertebrates (i.e., birds, mammals, and reptiles). The approach to account for RTE species was divided along the same lines.

Plants, fish, insects, and aquatic invertebrates were assessed using TRVs developed from surrogate species. All species from these taxa (identified in Appendix C) were represented by the surrogate species presented in Table 6-1. The evaluation of terrestrial vertebrates used surrogate species to develop TRVs and to estimate potential risk using simple food chain models. Tables 6-3 and 6-4 present the listed birds and mammals found on BLM-managed lands and their appropriate surrogate species.

Very few laboratory studies have been conducted using reptiles or amphibians. Therefore, data specific to the adverse effects of a chemical on species of these taxa are often unavailable. These animals, being cold-blooded, have very different rates of metabolism than mammals or birds (i.e., they require lower rates of food consumption). Nonetheless, mammals and birds were used as the surrogate species for reptiles and adult amphibians because of the lack of data for these taxa. Fish were used as surrogates for juvenile amphibians. For each trophic level of RTE reptile or adult amphibian, a comparable mammal or bird was selected to represent the potential risks. Table 6-5 presents the 7 listed reptiles found on BLM-managed lands and the surrogate species chosen to represent them in the ERA. Table 6-6 presents the listed amphibians found on BLM-managed lands and their surrogate species.

The sensitivity of reptiles and amphibians relative to other species is generally unknown. Some information about reptilian exposures to pesticides, including herbicides, is available. The following provides a brief summary of the data (as cited in Sparling et al. 2000), including data for pesticides not evaluated in this ERA:

- Mountain garter snakes (*Thamnophis elegans elegans*) were exposed to the herbicide thiobencarb in the field and in the laboratory. No effects were noted in the snakes fed contaminated prey or those caged and exposed directly to treated areas.

- No adverse effects to turtles were noted in a pond treated twice with the herbicide Kuron (2,4,5-T).

- Tortoises in Greece were exposed in the field to atrazine, paraquat, Kuron, and 2,4-D. No effects were noted on the tortoises exposed to atrazine or paraquat. In areas treated with Kuron and 2,4-D, no tortoises were noted following the treatment. The authors of the study concluded it was a combination of direct toxicity (tortoises were noted with swollen eyes and nasal discharge) and loss of habitat (much of the vegetation killed during the treatment had provided important ground cover for the tortoises).

- Reptilian LD_{50} values from six organochlorine pesticides were compared to avian LD_{50} values. Of the six pesticides, five lizard LD_{50}s were higher, indicating lower sensitivity. Overlapping data were available for turtle exposure to one organochlorine pesticide; the turtle was less sensitive than the birds or lizards.

- In general, reptiles were found to be less sensitive than birds to cholinesterase inhibitors.

Unfortunately, these observations do not provide any sort of rigorous review of dose and response. On the other hand, there is little evidence that reptiles are more sensitive to pesticides than other, more commonly tested organisms.

As with reptiles, some toxicity data are available describing the effects of herbicides on amphibians. The following provides a brief summary of the data (as cited in Sparling et al. 2000):

- Leopard frog tadpoles exposed to up to 0.075 mg/L atrazine showed no adverse effects.

- In a field study, it was noted that frog eggs in a pond where atrazine was sprayed nearby suffered 100% mortality.

- Common frog (*Rana temporaria)* tadpoles showed behavioral and growth effects when exposed to 0.2 to 20 mg/L cyanatryn.

- Caged common frog and common toad (*Bufo bufo)* tadpoles showed no adverse effects when exposed to 1.0 mg/L diquat or 1.0 mg/L dichlobenil.

- All leopard frog eggs exposed to 2.0 to 10 mg/L diquat or 0.5 to 2.0 mg/L paraquat hatched normally, but showed adverse developmental effects. It was noted that commercial formulations of paraquat were more acutely toxic than technical grade paraquat. Tadpoles, however, showed significant mortality when fed paraquat-treated parrot feather watermilfoil (*Myriophyllum).*

- 4-chloro-2-methylphenoaxyacetic acid (MCPA) is relatively non-toxic to the African clawed frog (*Xenopus laevis)* with an LC_{50} of 3,602 mg/L and slight growth retardation at 2,000 mg/L.

- Approximately 86% of juvenile toads died when exposed to monosodium methanearsonate (ANSAR 259® HC) at 12.5% of the recommended application rate.

- Embryo hatch success, tadpole mortality, growth, paralysis, and avoidance behavior were studied in three species of ranid frogs (*Rana* sp.) exposed to hexazinone and triclopyr. No effects were noted in hexazinone exposure up to 100 mg/L. Two species showed 100% mortality at 2.4 mg/L triclopyr; no significant mortality was observed in the third species.

No conclusions can be drawn regarding the sensitivity of amphibians to exposure to diquat relative to the surrogate species selected for the ERA. Amphibians are particularly vulnerable to changes in their environment (chemical and physical) because they have skin with high permeability, making them at risk to dermal contact, and have complex life cycles, making them vulnerable to developmental defects during the many stages of metamorphosis. However, there is no evidence that the organisms evaluated in the ERA fail to provide reasonable protection as surrogates. Given the very low risks to animals in the modeled exposures, it is unlikely the concentrations of diquat predicted to occur as a result of regular herbicide usage would cause adverse effects to amphibians. Nonetheless, it should be noted that certain amphibians can be sensitive to pesticides, and site- and species-specific risk assessment should be carefully considered in the event that amphibian RTE species are present near a site of application.

With the exception of the piscivorous birds, ingestion pathway RQs exceeded LOCs for all terrestrial vertebrate surrogate species evaluated in the ERA. The elevated RQs, however, are based on a direct spray of diquat onto the food source of these species. This scenario was included in the ERA to provide a worst-case scenario for terrestrial wildlife exposure, and many uncertainties, as described in Section 7.0, may result in overestimation of the calculated RQs. Although the uncertainties associated with the potential risk to RTE mammals, birds, reptiles, and amphibians are valid, the vertebrate RQs generated in the ERA for diquat do exceed LOCs. Careful use of diquat in aquatic systems should minimize terrestrial wildlife exposure and avert potential risks to terrestrial vertebrate RTE wildlife species.

6.2.3 Biological Factors Affecting Impact from Herbicide Exposure

The potential for ecological receptors to be exposed to, and affected by, herbicide is dependent upon many factors. Many of these factors are independent of the biology or life history of the receptor (e.g., timing of herbicide use, distance to receptor). These factors were explored in the ERA by simulating scenarios that vary these factors (ENSR 2004c), and these scenarios are discussed in Section 5.0 of this document. However, there are differences in life history among and between receptors that also influence the potential for exposure. Therefore, individual species have a different potential for exposure as well as response. In order to provide perspective on the assumptions made here, as well as the potential need to evaluate alternatives, receptor traits that may influence species-specific exposure and response were examined. These traits are presented and discussed in Table 6-7.

In addition to providing a review of the approach used in the ERA, the factors listed in Table 6-7 can be evaluated in order to assess whether a site- and species-specific ERA should be considered to address potential risks to a given RTE. They also provide perspective on the uncertainty associated with applying the conclusions of the ERA to a broad range of RTE species.

6.3 Review of Extrapolation Methods Used to Calculate Potential Exposure and Risk

Ecological risk assessment relies on extrapolation of observations from one system (e.g., species and toxicity endpoint) to another (see Table 6-7). While every effort has been made to anticipate bias in these extrapolations and to use them to provide an overestimate of risk, it is worth evaluating alternative approaches.

Toxicity Extrapolations in Terrestrial Systems (Fairbrother and Kaputska 1996) is an opinion paper that describes the difficulties associated with trying to quantitatively evaluate a particular species when toxicity data for that species, and/or for the endpoint of concern, are not available. The authors provide an overview of uncertainty factors and methods of data extrapolation used in terrestrial organism TRV development, and suggest an alternative approach to establishing inter-species TRVs. The following subsections summarize their findings for relevant methods of extrapolation.

6.3.1 Uncertainty Factors

Uncertainty factors are used often in both human health and ERA. The uncertainty factor most commonly used in ERA is 10. This value has little empirical basis, but was developed and adopted by the risk assessment community because it seemed conservative and was "simple to use."[6] Six situations in which uncertainty factors may be applied in ecotoxicology were identified: (1) accounting for intraspecific heterogeneity, (2) supporting interspecific extrapolation, (3) converting acute to chronic endpoints and vice versa, (4) estimating LOAEL from NOAEL, (5) supplementing professional judgment, and (6) extrapolating laboratory data to field conditions. No extrapolation of toxicity data among Classes (i.e., between birds, mammals, and reptiles) was discussed. The methods to extrapolate

[6] Section 2, Fairbrother and Kaputska 1996, Page 7.

available laboratory toxicity data to suit the requirements of the TRVs in this ERA are discussed in Section 3. For this reason, extrapolation used to develop TRVs is not discussed in this section.

Empirical data for each of the situations discussed in the Fairbrother and Kaputska paper (as applicable) are presented in Tables 6-8 through 6-12. In each of these tables, Fairbrother and Kaputska (1996) have presented the percentage of the available data that is included within a stated factor. For example, 90% of the observed LD_{50} for bird species lie within a factor of ten (i.e., the highest LD_{50} within the central 90% of the population is 10-fold higher than the lowest value). This can be compared to the approach used in this ERA. For example, for aquatic invertebrates, a LOC was defined of 0.05. This is analogous to application of an uncertainty factor 20 to the relevant TRV. In this case, the selected TRV is not the highest or the mid-point of the available values but a value at the lower end of the available range. Thus, dividing the TRV by a factor of 20 is very likely to place it well below any observed TRV. With this perspective, the ranges (or uncertainty factors) provided by Fairbrother and Kaputska (1996) generally appear to support the approach used in the ERA (i.e., select low TRVs and consider comparison to an LOC < 1.0).

6.3.2 Allometric Scaling

Allometric scaling provides a formula based on BW that allows translation of doses from one animal species to another. In this ERA, allometric scaling was used to extrapolate the terrestrial vertebrate TRVs from the laboratory species to the surrogate species used to estimate potential risk. The Environmental Sciences Division of the Oak Ridge National Laboratory (ORNL) (Opresko et al. 1994; Sample et al. 1996) has used allometric scaling for many years to establish benchmarks for vertebrate wildlife. The USEPA has also used allometric scaling in development of wildlife water quality criteria in the *Great Lakes Water Quality Initiative* (USEPA 1995b) and in the development of ecological soil screening levels (USEPA 2000).

The theory behind allometric scaling is that metabolic rate is proportional to body size.[7] However, assumptions are made that toxicological processes are dependent on metabolic rate, and that toxins are equally bioavailable among species. Similar to other types of extrapolation, allometric scaling is sensitive to the species used in the toxicity test selected to develop the TRV. Given the limited amount of data, using the lowest value available for the most sensitive species is the best approach[4], although the potential remains for site-specific receptors to be more sensitive to the toxin. Further uncertainty is introduced to allometric scaling when the species-specific parameters (e.g., BW, ingestion rate) are selected. Interspecies variation of these parameters can be considerable, especially among geographic regions. Allometric scaling is not applicable between classes of organisms (i.e., bird to mammal). However, given these uncertainties, allometric scaling remains the most reliable easy-to-use means to establish TRVs for a variety terrestrial vertebrate species (Fairbrother and Kaputska 1996).

6.3.3 Recommendations

Fairbrother and Kaputska (1996) provided a critical evaluation of the existing, proposed, and potential means for intra-species toxicity value extrapolation. The paper they published describes the shortcomings of many methods of intra-specific extrapolation of toxicity data for terrestrial organisms. Using uncertainty factors or allometric scaling for extrapolation can often over- or underpredict the toxic effect to the receptor organism. Although using physiologically-based models may be a more scientifically correct way to predict toxicity, the logistics involved with applying them to an ERA on a large-scale make them impractical. In this ERA, extrapolation was performed using techniques most often employed by the scientific risk assessment community. These techniques included the use of uncertainty factors (i.e., potential use of LOC < 1.0) and allometric scaling.

[7] In the 1996 update to the ORNL terrestrial wildlife screening values document (Sample et al. 1996), studies by Mineau et al. (1996) using allometric scaling indicated that, for 37 pesticides studied, avian LD_{50}s varied from 1 to 1.55, with a mean of 1.148. The LD_{50} for birds is now recommended to be 1 across all species.

6.4 Indirect Effects on Salmonids

In addition to the potential direct toxicity associated with herbicide exposure, organisms may be harmed from indirect effects, such as habitat degradation or loss of prey. Under Section 9 of the Endangered Species Act (ESA) of 1973, it is illegal to take an endangered species of fish or wildlife. "Take" is defined as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." (16 USC 1532(19)). The NOAA Fisheries (NOAA 1999) published a final rule clarifying the definition of "harm" as it relates to take of endangered species in the ESA. NOAA Fisheries defines "harm" as any act that injures or kills fish and wildlife. Acts may include "significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering." To comply with the ESA, potential secondary effects to salmonids were evaluated to ensure that use of diquat on BLM-managed lands would not cause harm to these endangered fish.

Indirect effects can generally be categorized into effects caused by biological or physical disturbance. Biological disturbance includes impacts to the food chain; physical disturbance includes impacts to habitat.[8] (Freeman and Boutin 1994). NOAA Fisheries (2002) has internal draft guidance for their Section 7 pesticide evaluations. The internal draft guidance describes the steps that should be taken in an ERA to ensure salmonids are addressed appropriately. The following subsections describe how, consistent with internal draft guidance from NOAA Fisheries, the diquat ERA dealt with the indirect effects assessment.

6.4.1 Biological Disturbance

Potential direct effects to salmonids were evaluated in the ERA. Sensitive endpoints were selected for the RTE species RQ calculations, and worst-case scenarios were assumed. Indirect effects caused by disturbance to the surrounding biological system were evaluated by looking at potential damage to the food chain.

The majority of the salmonid diet consists of aquatic invertebrates and other fish. Sustaining the aquatic invertebrate population is vital to minimizing biological damage to salmonids from herbicide use. Consistent with ERA guidance (USEPA 1997, 1998), protection of non-RTE species, such as the aquatic invertebrates and fish serving as prey to salmonids, is at the population or community level, not the individual level. Sustainability of the numbers (population) or types (community) of aquatic invertebrates and fish is the assessment endpoint. Therefore, unless acute risks are present, it is unlikely the herbicide will cause harm to the prey base of salmonids from direct damage to the aquatic invertebrates and fish. As discussed in Section 4.3, aquatic invertebrate and fish acute and chronic scenario RQs exceeded respective LOCs suggesting potential direct impacts to the forage of salmonids. The only stream evaluation conducted for this risk assessment was an accidental spray scenario and may overestimate risk to aquatic stream receptors. Nonetheless, this conservative evaluation predicts that fish and aquatic invertebrates may be directly impacted by herbicide concentrations in the stream. Accordingly, their availability as prey item populations may be impacted and there may be an indirect effect on salmonids.

As primary producers and the food base of aquatic invertebrates, disturbance to aquatic vegetation may affect the aquatic invertebrate population, thereby affecting salmonids. As diquat is an aquatic herbicide, high RQs for aquatic plants by normal application and other scenarios (i.e., accidental spill or spray) are anticipated. The greatest potential for risk to aquatic vegetation would occur under an accidental spill of diquat into a pond. RQs for aquatic vegetation exceeded LOCs by four orders of magnitude under this spill scenario. RQs in the direct spray to a pond scenario exceeded LOCs by two orders of magnitude, and RQs for accidental spray of a stream exceeded LOCs by three orders of magnitude. Therefore, the use of diquat in streams (the primary salmonid habitat) would be likely to impact aquatic

[8] Physical damage to habitat may also be covered under an evaluation of critical habitat. Since all reaches of streams and rivers on BLM land may not be listed as critical habitat, a generalized approach to potential damage to any habitat was conducted. This should satisfy a general evaluation of critical habitats. Any potential for risk due to physical damage to habitat should be addressed specifically for areas deemed critical habitat.

vegetation, and potentially indirectly impact salmonids. However, diquat is not used directly to control aquatic vegetation in streams (it is primarily used in ponds); therefore, responsible use of diquat should preclude risks to salmonids.

Although not specifically evaluated in the stream scenarios of the ERA, terrestrial plants were evaluated for their potential to provide overhanging cover for salmonids. A reduction in the riparian cover has the potential to indirectly impact salmonids within the stream. RQs for terrestrial plants were elevated above the LOC for accidental direct spray scenarios at both the typical and maximum application rates, indicating the potential for a reduction in this plant community. The potential for adverse effects on terrestrial plants from spray drift of diquat was also evaluated. In the scenarios using aerial application, non-target terrestrial plant RQs exceeded LOCs for all scenarios. In scenarios where diquat is applied from the ground, there is relatively little risk to typical terrestrial species as close as 100-ft from the source at the typical application rate. It is therefore important to monitor carefully the use of diquat near stream riparian zones. Preferential use of ground applications (instead of aerial applications) and typical application rates would decrease the off-site drift risk to terrestrial plants and the indirect risk to salmonids from loss of vegetative cover.

6.4.2 Physical Disturbance

The potential for indirect effects to salmonids due to physical disturbance is less easy to define that the potential for direct biological effects. Salmonids have distinct habitat requirements; any alteration to the coldwater streams in which they spawn and live until returning to the ocean as adults can be detrimental to the salmonid population. Out of the potential effects of herbicide application, it is likely the killing of instream and riparian vegetation would cause the most important physical disturbances. The potential adverse effects could include, but would not necessarily be limited to: loss of primary producers (Section 4.6.1); loss of overhead cover, which may serve as refuge from predators or shade to provide cooling to the waterbodies; and increased sedimentation due to loss of riparian vegetation.

Adverse effects caused by herbicides can be cumulative, both in terms of toxicity stress from break-down products and other chemical stressors that may be present, and in terms of the use of herbicide on lands already stressed on a larger scale. Cumulative watershed effects (CWEs) often arise in conjunction with other land use practices, such as prescribed burning[9]. In forested areas, herbicides are generally used in areas that have been previously altered, such as cut or burned, during vegetative succession when invasive species may dominate. The de-vegetation of these previously stressed areas can delay the stabilization of the substrate, increasing the potential for erosion and resulting sedimentation in adjacent waterbodies.

Based on the results of the ERA, there is potential for risk to non-target terrestrial and aquatic receptors (animal and plant) in extreme circumstances, such as incidents of spills or accidental direct spray (Sections 4.3.1 and 4.3.5). Therefore, while it is unlikely that responsible use of diquat by BLM land managers will indirectly affect RTE salmonids through the killing of in-stream or riparian vegetation, using diquat frequently or in large amounts (particularly if applied aerially) may increase risk to RTE species (salmonids) as a result of impacts to riparian vegetation. It may be productive to develop a more site- and/or species-specific ERA in order to assure that the proposed herbicide application will not result in secondary impacts to salmonids associated with loss of riparian cover.

6.5 Conclusions

The diquat ERA evaluated the potential risks to many species using many exposure scenarios. Some exposure scenarios are likely to occur, whereas others are unlikely to occur but were included to provide a level of conservatism to the ERA. Individual RTE species were not directly evaluated. Instead, toxicity data for surrogate species were used

[9] The following website provides a more detailed discussion of CWEs http://www.humbolt1.com/~heyenga/Herb.Drft.8_12_99.html.

to indirectly evaluate RTE species exposure. Higher trophic level receptors were also evaluated based on their life history strategies; RTE species were represented by one of several avian or mammalian species commonly used in ERAs. To provide a layer of conservatism to the evaluation, lower LOCs and TRVs were used to assess the potential impacts to RTE species.

Uncertainty factors and allometric scaling were used to adjust the toxicity data on a species-specific basis when they were likely to improve applicability and/or conservatism. As discussed in Section 3.1, TRVs were developed using the best available data; uncertainty factors were applied to toxicity data consistent with recommendation of Chapman et al. (1998).

Potential primary and secondary effects of diquat use should be of concern for the protection of RTE species. Habitat disturbance and disruptions in the food chain are often the cause of declines of populations and species. For RTE species, habitat or food chain disruptions should be avoided to the extent practical. Some relationships among species are mutualistic, commensalistic, or otherwise symbiotic. For example, many species rely on a particular food source or habitat. Without that food or habitat species, the dependent species may be unduly stressed or extirpated. For RTE species, these obligatory habitats are often listed by USFWS as critical habitats. Critical habitats are afforded certain protection under the ESA. All listed critical habitat, as well as habitats that would likely support RTE species, should be avoided, as disturbance to the habitat may have an indirect adverse effect on RTE species.

Aquatic herbicides may harm primary producers in the waterbodies or reduce riparian zones. The results of the ERA indicate that non-target terrestrial and aquatic plants are at risk from diquat, especially when accidents occur, such as spills or accidental spraying. Accidents also pose some risk to fish (including RTE salmonids) and aquatic invertebrates, both directly and indirectly via impacts to aquatic plants.

However, the effects of aquatic herbicides in water are expected to be relatively transient and stream flow is likely to reduce herbicide concentrations over time. Only very persistent pesticides would be expected to have effects beyond the year of their application. An OPP report on the impacts of a terrestrial herbicide on salmonids indicated that if a listed salmonid was not present during the year of application, there would likely be no concern (Turner 2003). Therefore, it is expected that potential adverse impacts to food and aquatic cover would not be occur beyond the season of application.

Based on the results of the ERA, it is important that diquat be used in the most appropriate and responsible manner to prevent harm to RTE species on BLM-managed lands. Certain application guidelines and restrictions (e.g., application rate, buffer distance, avoidance of designated critical habitat) for appropriate and responsible use of the herbicide diquat on BLM-managed lands would reduce risk to some non-target species (see Section 8).

TABLE 6-1
Surrogate Species Used to Derive Diquat TRVs

Species in Diquat Laboratory/Toxicity Studies		Surrogate for
Honeybee	*Apis mellifera*	Pollinating insects
Rat	*Rattus norvegicus* spp.	Mammals
Dog	*Canis familiaris*	Mammals
Ring-necked pheasant	*Phasianus colchicus*	Birds
Japanese Quail	*Coturnix coturnix*	Birds
Bobwhite Quail	*Colinus virginianus*	Birds
Mallard	*Anas platyrhynchos*	Birds
Rabbit	*Leporidae sp.*	Mammals
Cotton	*Gossypium* spp.	Non-target terrestrial plants
Amphipod	*Hyalella azteca*	Aquatic invertebrates
Walleye	*Stizostedion vitreum*	Fish
Daphnid	*Daphnia magna*	Aquatic invertebrates
Giant Duckweed	*Lemna sp.*	Non-target aquatic plants
Rainbow trout	*Oncorhynchus mykiss*	Fish/Salmonids

TABLE 6-2
Surrogate Species Used in Quantitative ERA Evaluation

Species		Trophic Level/Guild	Pathway Evaluated
American robin	*Turdus migratorius*	Avian invertivore/ vermivore/ insectivore	Ingestion
Canada goose	*Branta canadensis*	Avian granivore/ herbivore	Ingestion
Deer mouse	*Peromyscus maniculatus*	Mammalian frugivore/ herbivore	Direct contact and Ingestion
Mule deer	*Odocolieus hemionus*	Mammalian herbivore/ gramivore	Ingestion
Bald eagle (northern)	*Haliaeetus leucocephalus alascanus*	Avian carnivore/ piscivore	Ingestion
Coyote	*Canis latrans*	Mammalian carnivore	Ingestion

TABLE 6-3
Rare, Threatened, and Endangered Birds and Selected Surrogates

RTE Avian Species Potentially Occurring on BLM-managed lands		RTE Trophic Guild	Surrogates
Marbled murrelet	*Brachyramphus marmoratus marmoratus*	Piscivore	Bald eagle
Western snowy plover	*Charadrius alexandrinus nivosus*	Insectivore/piscivore	American robin
Piping plover	*Charadrius melodus*	Insectivore	American robin
Mountain plover	*Charadrius montanus*	Insectivore	American robin
Southwestern willow flycatcher	*Empidonax traillii extimus*	Insectivore	American robin
Northern aplomado falcon	*Falco femoralis septentrionalis*	Carnivore	Bald eagle Coyote
Cactus ferruginous pygmy-owl	*Glaucidium brasilianum cactorum*	Carnivore	Bald eagle Coyote
Whooping crane	*Grus Americana*	Piscivore	Bald eagle
California condor	*Gymnogyps californianus*	Carnivore	Bald eagle Coyote
Bald eagle	*Haliaeetus leucocephalus*	Piscivore	Bald eagle
Brown pelican	*Pelecanus occidentalis*	Piscivore	Bald eagle
Inyo California towhee	*Pipilo crissalis eremophilus*	Omnivore [Granivore/insectivore]	Canada goose American robin
Coastal California gnatcatcher	*Polioptila californica californica*	Insectivore	American robin
Stellar's eider	*Polysticta stelleri*	Piscivore	Bald eagle
Yuma clapper rail	*Rallus longirostris yumanensis*	Carnivore	Bald eagle Coyote
Spectacled eider	*Somateria fischeri*	Omnivore [Insectivore/herbivore]	American robin Canada goose
Least tern	*Sterna antillarum*	Piscivore	Bald eagle
Northern spotted owl	*Strix occidentalis caurina*	Carnivore	Bald eagle Coyote
Mexican spotted owl	*Strix occidentalis lucida*	Carnivore	Bald eagle Coyote
Least Bell's vireo	*Vireo bellii pusillus*	Insectivore	American robin

TABLE 6-4
Rare, Threatened, and Endangered Mammals and Selected Surrogates

RTE Mammalian Species Potentially Occurring on BLM-managed lands		RTE Trophic Guild	Surrogates
Sonoran pronghorn	*Antilocapra americana sonoriensis*	Herbivore	Mule deer
Pygmy rabbit	*Brachylagus idahoensis*	Herbivore	Mule deer
Marbled murrelet	*Brachyramphus marmoratus marmoratus*	Piscivore	Bald eagle
Gray wolf	*Canis lupus*	Carnivore	Coyote
Utah prairie dog	*Cynomys parvidens*	Herbivore	Deer mouse
Morro Bay kangaroo rat	*Dipodomys heermanni morroensis*	Omnivore [Herbivore/ Insectivore]	Deer mouse American robin
Giant kangaroo rat	*Dipodomys ingens*	Granivore/herbivore	Deer mouse
Fresno kangaroo rat	*Dipodomys nitratoides exilis*	Granivore/herbivore	Deer mouse
Tipton kangaroo rat	*Dipodomys nitratoides nitratoides*	Granivore/herbivore	Deer mouse
Stephens' kangaroo rat	*Dipodomys stephensi (incl. D. cascus)*	Granivore	Deer mouse
Southern sea otter	*Enhydra lutris nereis*	Carnivore/piscivore	Coyote Bald eagle
Steller sea-lion	*Eumetopias jubatus*	Carnivore/piscivore	Coyote Bald eagle
Sinaloan jaguarondi	*Herpailurus (=Felis) yaguarundi tolteca*	Carnivore	Coyote
Ocelot	*Leopardus (=Felis) pardalis*	Carnivore	Coyote
Lesser long-nosed bat	*Leptonycteris curosoae yerbabuenae*	Frugivore/nectivore	Deer mouse
Mexican long-nosed bat	*Leptonycteris nivalis*	Herbivore	Deer mouse
Canada lynx	*Lynx canadensis*	Carnivore	Coyote
Amargosa vole	*Microtus californicus scirpensis*	Herbivore	Deer mouse
Hualapai Mexican vole	*Microtus mexicanus hualpaiensis*	Herbivore	Deer mouse
Black-footed ferret	*Mustela nigripes*	Carnivore	Coyote
Riparian (=San Joiquin Valley) woodrat	*Neotoma fuscipes riparia*	Herbivore	Deer mouse
Columbian white-tailed deer	*Odocolieus virginianus leucurus*	Herbivore	Mule deer
Bighorn sheep	*Ovis canadensis*	Herbivore	Mule deer
Bighorn sheep	*Ovis canadensis californiana*	Herbivore	Mule deer
Jaguar	*Panthera onca*	Carnivore	Coyote
Woodland caribou	*Rangifer tanandus caribou*	Herbivore	Mule deer
Northern Idaho ground squirrel	*Spermophilus brunneus brunneus*	Herbivore	Deer mouse
Grizzly bear	*Ursus arctos horribilis*	Omnivore [herbivore/ insectivore/piscivore]	American robin Mule deer Bald eagle
San Joaquin kit fox	*Vulpes macrotis mutica*	Carnivore	Coyote
Preble's meadow jumping mouse	*Zapus hudsonius preblei*	Omnivore [herbivore/ insectivore]	Deer mouse American robin

Note: Four whales and one seal are also listed species in the 17 states evaluated in this ERA. However, it is unlikely any exposure to herbicide would occur to marine species.

TABLE 6-5
Rare, Threatened, and Endangered Reptiles and Selected Surrogates

RTE Reptilian Species Potentially Occurring on BLM-managed lands		RTE Trophic Guild	Surrogates
New Mexican ridge-nosed rattlesnake	*Crotalus willardi obscurus*	Carnivore/insectivore	Coyote Bald eagle American robin
Blunt-nosed leopard lizard	*Gambelia silus*	Carnivore/insectivore	Coyote Bald eagle American robin
Desert tortoise	*Gopherus agassizii*	Herbivore	Canada goose
Giant garter snake	*Thamnophis gigas*	Carnivore/insectivore/piscivore	Coyote American robin Bald eagle
Coachella Valley fringe-toed lizard	*Uma inornata*	Insectivore	American robin

Note: Five sea turtles are also listed species in the 17 states evaluated in this ERA. However, it is unlikely any exposure to herbicide would occur to marine species.

TABLE 6-6
Rare, Threatened, and Endangered Amphibians and Selected Surrogates

RTE Amphibious Species Potentially Occurring on BLM-managed lands		RTE Trophic Guild	Surrogates
California tiger salamander	*Ambystoma californiense*	Invertivore[1]	Bluegill sunfish Rainbow trout[3]
		Vermivore[2]	American robin[4]
Sonoran tiger salamander	*Ambystoma tigrinum stebbinsi*	Invertivore/insectivore[1]	Bluegill sunfish Rainbow trout[3]
		Carnivore/ranivore[2]	American robin[4]
Desert slender salamander	*Batrachoseps aridus*	Invertivore	American robin[4,5]
Wyoming toad	*Bufo baxteri*	Insectivore	Bluegill sunfish Rainbow trout[3] American robin[4]
Arroyo toad (=Arroyo southwestern toad)	*Bufo californicus*	Herbivore[1]	Bluegill sunfish Rainbow trout[3]
		Invertivore[2]	American robin[4]
California red-legged frog	*Rana aurora draytonii*	Herbivore[1]	Bluegill sunfish Rainbow trout[3]
		Invertivore[2]	American robin[4]
Chiricahua leopard frog	*Rana chiricahuensis*	Herbivore[1]	Bluegill sunfish Rainbow trout[3]
		Invertivore[2]	American robin[4]

(1) Diet of juvenile (larval) stage.
(2) Diet of adult stage.
(3) Surrogate for juvenile stage.
(4) Surrogate for adult stage.
(5) *Bratrachoseps aridus* is a lungless salamander that has no aquatic larval stage, and is terrestrial as an adult.

TABLE 6-7
Species and Organism Traits That May Influence Herbicide Exposure and Response

Characteristic	Mode of Influence	ERA Solution
Body size	Larger organisms have more surface area potentially exposed during a direct spray exposure scenario. However, larger organisms have a smaller surface area to volume ratio, leading to a lower per BW dose of herbicide per application event.	To evaluate potential impacts from direct spray, small organisms were selected (i.e., honeybee and deer mouse).
Habitat preference	Not all of BLM-managed lands are subject to nuisance vegetation control.	It was assumed that all organisms evaluated in the ERA were present in habitats subject to herbicide treatment.
Duration of potential exposure/ home range	Some species are migratory or present during only a fraction of year, and larger species have home ranges that likely extend beyond application areas, thereby reducing exposure duration.	It was assumed that all organisms evaluated in the ERA were present within the zone of exposure full-time.
Trophic level	Many chemical concentrations increase in higher trophic levels.	Although the herbicides evaluated in the ERA have very low potential to bioaccumulate, BCFs were selected to estimate uptake to trophic level 3 fish (prey item for the piscivores), and several trophic levels (primary producers through top-level carnivore) were included in the ERA.
Food preference	Certain types of food or prey may be more likely to attract and retain herbicide.	It was assumed that all types of food were susceptible to high deposition and retention of herbicide.
Food ingestion rate	On a mass ingested per BW basis, organisms with higher food ingestion rates (e.g., mammals versus reptiles) are more likely to ingest large quantities of food (therefore, herbicide).	Surrogate species were selected that consume large quantities of food, relative to body size. When ranges of ingestion rates were provided in the literature, the upper end of the values was selected for use in the ERA.
Foraging strategy	The way an organism finds and eats food can influence its potential exposure to herbicide. Organisms that consume insects or plants that are underground are less likely to be exposed via ingestion than those that consume exposed prey items, such as grasses and fruits.	It was assumed all food items evaluated in the ERA were fully exposed to herbicide during spray or runoff events.
Metabolic and excretion rate	While organisms with high metabolic rates may ingest more food, they may also have the ability to excrete herbicides quickly, lowering the potential for chronic impact.	It was assumed that no herbicide was excreted readily by any organism in the ERA.
Rate of dermal uptake	Different organisms will assimilate herbicides across their skins at different rates. For example, thick scales and shells of reptiles and the fur of mammals are likely to present a barrier to uptake relative to bare skin.	It was assumed that uptake across the skin was unimpeded by scales, shells, fur, or feathers.
Sensitivity to herbicide	Species respond to chemicals differently; some species may be more sensitive to certain chemicals.	The literature was searched and the lowest values from appropriate toxicity studies were selected as TRVs. Choosing the sensitive species as surrogates for the TRV development provides protection to more species.
Mode of toxicity	Response sites to chemical exposure may not be the same among all species. For instance, the presence of aryl hydrocarbon (Ah) receptors in an organism increases its susceptibility to compounds that bind to proteins or other cellular receptors. However, not all species, even within a given taxonomic group (e.g., mammals) have Ah receptors.	Mode of toxicity was not specifically addressed in the ERA. Rather, by selecting the lowest TRVs, it was assumed that all species evaluated in the ERA were also sensitive to the mode of toxicity.

TABLE 6-8
Summary of Findings: Interspecific Extrapolation Variability

Type of Data	Percentage of Data Variability Accounted for Within a Factor of:								
	2	4	10	15	20	50	100	250	300
Bird LD_{50}	--	--	90%	--	--	--	99%	100%	--
Mammal LD_{50}	--	58%	--	--	90%	--	96%	--	--
Bird and Mammal Chronic	--	--	--	--	--	94%	--	--	--
Plants	93%[a] 80%[b]	--	--	80%[c]	--	--	--	--	80%[d]

(a) Intra-genus extrapolation.
(b) Intra-family extrapolation.
(c) Intra-order extrapolation.
(d) Intra-class extrapolation.

TABLE 6-9
Summary of Findings: Intraspecific Extrapolation Variability

Type of Data	Percentage of Data Variability Accounted for Within Factor of 10	Citation from Fairbrother and Kaputska 1996
490 probit log-dose slopes	92%	Dourson and Starta 1983 *as cited in Abt Assoc., Inc. 1995*
Bird LC_{50}:LC_1	95%	Hill et al. 1975
Bobwhite quail LC_{50}:LC_1	71.5%	Shirazi et al. 1994

TABLE 6-10
Summary of Findings: Acute-to-chronic Extrapolation Variability

Type of Data	Percentage of Data Variability Accounted for Within Factor of 10	Citation from Fairbrother and Kaputska 1996
Bird and mammal dietary toxicity NOAELs (n=174)	90%	Abt Assoc., Inc. 1995

TABLE 6-11
Summary of Findings: LOAEL-to-NOAEL Extrapolation Variability

Type of Data	Percentage of Data Variability Accounted for Within Factor of:		Citation from Fairbrother and Kaputska 1996
	6	10	
Bird and mammal LOAELs and NOAELs	80%	97%	Abt Assoc., Inc. 1995

TABLE 6-12
Summary of Findings: Laboratory to Field Extrapolations

Type of Data	Response	Citation from Fairbrother and Kaputska 1996
Plant EC_{50} Values	3 of 20 EC_{50} lab study values were 2-fold higher than field data. 3 of 20 EC_{50} values from field data were 2-fold higher than lab study data.	Fletcher et al. 1990
Bobwhite quail	Shown to be more sensitive to cholinesterase-inhibitors when cold-stressed (i.e., more sensitive in the field).	Maguire and Williams 1987
Gray-tailed vole and deer mouse	Laboratory data overpredicted risk.	Edge et al. 1995

7.0 UNCERTAINTY IN THE ECOLOGICAL RISK ASSESSMENT

Every time an assumption is made, some level of uncertainty is introduced into the risk assessment. A thorough description of uncertainties is a key component that serves to identify possible weaknesses in the ERA analysis, and to elucidate what impact such weaknesses might have on the final risk conclusions. This uncertainty analysis lists the uncertainties, with a discussion of what bias—if any—the uncertainty may introduce into the risk conclusions. This bias is represented in qualitative terms that best describe whether the uncertainty might 1) underestimate risk, 2) overestimate risk, or 3) be neutral with regard to the risk estimates, or whether it cannot be determined without additional study.

Uncertainties in the ERA process are summarized in Table 7-1. Several of the uncertainties warrant further evaluation and are discussed below. In general, the assumptions made in this risk assessment have been designed to yield a conservative evaluation of the potential risks to the environment from herbicide application.

7.1 Toxicity Data Availability

The majority of the available toxicity data was obtained from studies conducted as part of the USEPA pesticide registration process. There are a number of uncertainties related to the use of this limited data set in the risk assessment. In general, it would often be preferable to base any ecological risk analysis on reliable field studies that clearly identify and quantify the amount of potential risk from particular exposure concentrations of the chemical of concern. However, in most risk assessments it is more common to extrapolate the results obtained in the laboratory to the receptors found in the field. It should be noted, however, that laboratory studies often actually overestimate risk relative to field studies (Fairbrother and Kapustka 1996).

Ten diquat incident reports were available from the USEPA's Environmental Fate and Effects Division (EFED) (Table 2-2). Incident reports can be used to validate exposure models and hazards to ecological receptors. These reports, described in Section 2.3, indicated that in seven incidents, mortality of fish and other fauna were attributed to diquat; three incidents referenced plant damage. Two of the seven incidents had references to additional pesticide use (malathion and copper sulfate). The incident reports listed the likelihood that diquat caused the observed damaged as "probable" in seven incidents and "possible" in three incidents. These results support the risk assessment predictions of risk to fish, aquatic invertebrates and aquatic plants due to direct spray of the stream and pond. However, since the incident reports provide limited information, and diquat was mixed with other products, it is impossible to correlate the impacts predicted in the ERA with the incident reports.

Species for which toxicity data are available may not necessarily be the most sensitive species to a particular herbicide. These species have been selected as laboratory test organisms because they are generally sensitive to stressors, yet they can be maintained under laboratory conditions. However, the selected toxicity value for a receptor was based on a thorough review of the available data by qualified toxicologists and the selection of the most appropriate sensitive surrogate species. The surrogate species used in the registration testing are not an exact match to the wildlife receptors included in the ERA. For example, the only avian data available is for two primarily herbivorous birds: the mallard duck and the bobwhite quail. However, TRVs based on these receptors were also used to evaluate risk to insectivorous and piscivorous birds. Species with alternative feeding habits or species from different taxonomic groups may be more or less sensitive to the herbicide than those species tested in the laboratory. As discussed previously, diquat is an aquatic herbicide, and it is not expected that terrestrial plants will be exposed to this herbicide. It is possible that the non-cropland species present on BLM managed lands may be more tolerant of diquat than the surrogate species used in the ERA.

In general, the most sensitive available endpoint for the appropriate surrogate test species was used to derive TRVs. This approach is conservative since there may be a wide range of data and effects for different species. As described

in Section 4.3.3.1, although salmonids are often considered to be highly sensitive receptors, the acute fish TRV is actually based on a warmwater species. The selected LC_{50} for the walleye, 0.17 mg a.i./L, is significantly lower than the lowest salmonid LC_{50}, 19 mg a.i./L. This selection criterion for the TRVs has the potential to overestimate risk within the ERA.

There is also some uncertainty in the conversion of food concentration-based toxicity values (mg herbicide per kg food) to dose-based values (mg herbicide per kg BW) for birds and mammals. Converting the concentration-based endpoint to a dose-based endpoint is dependent upon certain assumptions, specifically the test animal ingestion rate and test animal BW. Default ingestion rates for different test species were used in the conversions unless test-specific values were measured and given. The ingestion rate was assumed to be constant throughout a test. However, it is possible that a test chemical may positively or negatively affect ingestion, thus resulting in an over- or underestimation of total dose.

For the purposes of pesticide registration, tests are conducted according to specific test protocols. For example, in the case of an avian oral LD_{50} study, test guidance follows the harmonized Office of Pollution Prevention and Toxic Substances (OPPTS) protocol 850.2100, Avian Acute Oral Toxicity Test or its Toxic Substances Control Act (TSCA) or FIFRA predecessor (e.g, 40 CFR 797.2175 and OPP 71-1). In this test the bird is given a single dose, by gavage, of the chemical and the test subject is observed for a minimum of 14 days. The LD_{50} derived from this test is the true dose (mg herbicide per kg BW). However, dietary studies were selected preferentially for this ERA and historical dietary studies followed 40 CFR 797.2050, OPP 71-2, or OECD 205, the procedures for which are harmonized in OPPTS 850.2200, Avian Dietary Toxicity Test. In this test, the test organism is presented with the dosed food for 5 days, with 3 days of additional observations after the chemical-laden food is removed. The endpoint for this assay is reported as an LC_{50} representing mg herbicide per kg food. For this ERA, the concentration-based value was converted to a dose-based value following the methodology presented in the Methods Document (ENSR 2004c)[10]. Then the dose-based value was multiplied by the number of days of exposure (generally 5) to result in an LD_{50} value representing the full herbicide exposure over the course of the test.

As indicated in Section 3.1, the toxicity data within the ERAs are presented in the units used in the reviewed studies. Attempts were not made to adjust toxicity data to the % a.i. since it was not consistently provided in all reviewed materials. In most cases the toxicity data applies to the a.i. itself; however, some data corresponds to a specific product containing the a.i. under consideration, and potentially other ingredients (e.g., other active ingredients or inert ingredients). The assumption has been made that the toxicity observed in the tests is due to the a.i. under consideration. However, it is possible that the additional ingredients in the different formulations also had an effect. The OPP's Ecotoxicity Database (a source of data for the ERAs) does not adjust the toxicity data to the % a.i. and presents the data directly from the registration study in order to capture the potential effect caused by various inerts, additives, or other active ingredients in the tested product. In many cases the tested material represents the highest purity produced and higher exposure to the a.i. would not be likely.

For diquat, the percent active ingredients, listed in Appendix A when available from the reviewed study, ranged from 0.02% to 99.6%, with most formulations in the 25% to 45% range. As indicated in Section 3.1, test materials for diquat dibromide frequently contain 40% or less of diquat cation, and this is the highest purity produced (USEPA 1995a). These toxicity data likely represent the potential impacts due to the types of formulations that BLM would likely use. However, the concentrations of diquat presented in the spreadsheets represent the a.i. itself, not the formulation. Therefore, TRVs based on a product with relatively low % diquat could underestimate potential risks. A review of the data identified three TRVs that were based on data presented on a product, not a.i., basis. These TRVs were used to evaluate acute impacts to aquatic invertebrates and acute and chronic impacts to aquatic plants. However, impacts are already predicted for both aquatic invertebrates and aquatic plants and algae, so lowering the TRVs (based on 41.4% and 35.3% a.i., respectively) would not change the overall conclusions of the risk assessment significantly. The remaining TRVs are based on studies presenting data on an a.i. basis.

[10] Dose-based endpoint $_{(mg/kg\ BW/day)}$ = [Concentration-based endpoint $_{(mg/kg\ food)}$ x Food Ingestion Rate $_{(kg\ food/day)}$]/BW $_{(kg)}$

7.2 Potential Indirect Effects on Salmonids

No actual field studies or ecological incident reports on the effects of diquat on salmonids were identified during the ERA. Therefore, any discussion of direct or indirect impacts to salmonids was limited to qualitative estimates of potential impacts on salmonid populations and communities. The chronic fish TRV used in the risk assessment was based on laboratory studies conducted with a salmonid, the rainbow trout, reducing the uncertainties in this evaluation. The acute fish TRV is based on toxicity values lower than those observed for salmonids, indicating that acute risks to salmonids may be overestimated.

A discussion of the potential indirect impacts to salmonids is presented in Section 4.3.4, and Section 6.4 provides a discussion of RTE salmonid species. These evaluations indicated that, in the conservative accidental exposure scenarios evaluated, salmonids may be indirectly impacted by a reduction in food supply (i.e., fish and aquatic invertebrates) or a reduction in vegetative cover. It is anticipated that these qualitative evaluations overestimate the potential risk to salmonids due to the conservative selection of TRVs for salmonid prey and terrestrial vegetation, application of additional LOCs (with uncertainty/safety factors applied) to assess risk to RTE species, and the use of conservative stream characteristics in the exposure scenarios (i.e., low order stream, relatively small instantaneous volume, limited consideration of herbicide degradation or absorption in models).

7.3 Ecological Risks of Degradates, Inert Ingredients, Adjuvants, and Tank Mixtures

In a detailed herbicide risk assessment, it is preferable to estimate risks not just from the a.i. of an herbicide, but also from the cumulative risks of inert ingredients, adjuvants, and degradates. Other herbicides may also factor into the risk estimates, as many herbicides are tank mixed to expand the level of control and to accomplish multiple identified tasks. However, using currently available models (e.g., AgDRIFT®) it is only practical to compare deterministic risk calculations (i.e., exposure modeling, effects assessment, and RQ calculations) for a single a.i..

In addition, information on inerts, adjuvants, surfactants, and degradates is often limited by the availability of, and access to, reliable toxicity data for these constituents. The sections below present a qualitative evaluation of potential effects for risks due to degradates, inert ingredients, adjuvants, and tank mixtures.

7.3.1 Degradates

The potential toxicity of degradates, also called herbicide transformation products (TPs), should be considered when selecting an herbicide. However, it is beyond the scope of this risk assessment to evaluate all of the possible degradates of the various herbicide formulations containing diquat. Degradates may be more or less mobile and more or less toxic in the environment than their source herbicides (Battaglin et al. 2003). Differences in environmental behavior (e.g., mobility) and toxicity between parent herbicides and TPs makes prediction of potential TP impacts challenging. For example, a less toxic, but more mobile bioaccumulative, or persistent TP may have the potential to have a greater adverse impact on the environment resulting from residual concentrations in the environment. A recent study indicated that 70% of TPs had either similar or reduced toxicity to fish, daphnids, and algae than the parent pesticide. However, 4.2% of the TPs were more than an order of magnitude more toxic than the parent pesticide, with a few instances of acute toxicity values below 1 mg/L (Sinclair and Boxall 2003). No evaluation of impacts to terrestrial species was conducted in this study. The lack of data on the toxicity of degradates of diquat represents a source of uncertainty in the risk assessment.

7.3.2 Inerts

Pesticide products contain both active and inert ingredients. The terms “a.i.” and “inert ingredient” have been defined by Federal law—the FIFRA—since 1947. An a.i. is one that prevents, destroys, repels or mitigates the effects of a

pest, or is a plant regulator, defoliant, desiccant, or nitrogen stabilizer. By law, the a.i. must be identified by name on the label, together with its percentage by weight. An inert ingredient is simply any ingredient in the product that is not intended to affect a target pest. For example, isopropyl alcohol may be an a.i. and antimicrobial pesticide in some products; however, in other products, it is used as a solvent and may be considered an inert ingredient. The law does not require inert ingredients to be identified by name and percentage on the label, but the total percentage of such ingredients must be declared.

In September 1997, the USEPA issued Pesticide Regulation Notice 97-6, which encouraged manufacturers, formulators, producers, and registrants of pesticide products to voluntarily substitute the term "other ingredients" as a heading for the inert ingredients in the ingredient statement. The USEPA made this change after learning the results of a consumer survey on the use of household pesticides. Many consumers are mislead by the term "inert ingredient," believing it to mean "harmless." Since neither the federal law nor the regulations define the term "inert" on the basis of toxicity, hazard or risk to humans, non-target species, or the environment, it should not be assumed that all inert ingredients are non-toxic. Whether referred to as "inerts" or "other ingredients," these components within an herbicide have the potential to be toxic.

BLM scientists received clearance from the USEPA to review CBI on inert compounds in the following herbicides under consideration in ERAs: bromacil, chlorsulfuron, diflufenzopyr, Overdrive® (a mix of dicamba and diflufenzopyr), diquat, diuron, fluridone, imazapic, sulfometuron-methyl, and tebuthiuron. The information received listed the inert ingredients, their chemical abstract number, supplier, USEPA registration number, percentage of the formulation and purpose in the formulation. This information is confidential, and is therefore not disclosed in this document. However, a review of available data for the herbicides is included in Appendix D.

The USEPA has a listing of regulated inert ingredients at http://www.epa.gov/opprd001/inerts/index.html. This listing categorizes inert ingredients into four lists. The listing of categories and the number of inert ingredients found among the ingredients listed for the herbicides are shown below:

- List 1 – Inert Ingredients of Toxicological Concern: None.
- List 2 – Potentially Toxic Inert Ingredients: None.
- List 3 – Inerts of Unknown Toxicity. 12.
- List 4 – Inerts of Minimal Toxicity. Over 50.

Nine inerts were not found on EPA's lists.

Toxicity information was also searched in the following sources:

- TOMES (a proprietary toxicological database including EPA's Integrated Risk Information System [IRIS], the HSDB, the Registry of Toxic Effects of Chemical Substances [RTECS]).
- EPA's ECOTOX database, which includes AQUIRE (a database containing scientific papers published on the toxic effects of chemicals to aquatic organisms).
- TOXLINE (a literature searching tool).
    - Material Safety Data Sheets (MSDS) from suppliers.
    - Other sources, such as the Farm Chemicals Handbook.
    - Other cited literature sources.

Relatively little toxicity information was found. A few acute studies on aquatic or terrestrial species were reported. No chronic data, no cumulative effects data and almost no indirect effects data (food chain species) were found for the inerts in the herbicides.

A number of the List 4 compounds (Inerts of Minimal Toxicity) are naturally-occurring earthen materials (e.g. clay materials or simple salts) that would produce no toxicity at applied concentrations. However, some of the inerts, particularly the List 3 compounds and unlisted compounds, may have moderate to high potential toxicity to aquatic species based on MSDSs or published data.

As a tool to evaluate List 3 and unlisted inerts in the ERA, the exposure concentration of the inert compound was calculated and compared to toxicity information. As described in more detail in Appendix D, toxicity information from the above sources was used in addition to the work of Muller (1980), Lewis (1991), Dorn et al. (1997), and Wong et al. (1997) concerning aquatic toxicity of surfactants. These sources generally suggested that acute toxicity to aquatic life for surfactants and anti-foam agents ranged from 1 to 10 mg/L, and that chronic toxicity ranged as low as 0.1 mg/L.

Appendix D presents the following general observation for diquat: low application rates for diquat resulted in low exposure concentrations of inerts of much less than 1 mg/L in all modeled cases. This indicates that inerts associated with the application of diquat are not predicted to occur at levels that would cause acute toxicity to aquatic life. However, given the lack of specific inert toxicity data, it is not possible to state that the inerts in diquat will not result in adverse ecological impacts. It is assumed that toxic inerts would not represent a substantial percentage of the herbicide, and that minimal impacts to the environment would result from these ingredients.

7.3.3 Adjuvants and Tank Mixtures

Evaluating the potential additional/cumulative risks from mixtures and adjuvants of pesticides is substantially more difficult than evaluating the inerts in the herbicide composition. While many herbicides are present in the natural environment along with other pesticides and toxic chemicals, the composition of such mixtures is highly site-specific, and thus nearly impossible to address at the level of the programmatic EIS.

Herbicide label information indicates whether or not a particular herbicide can be tank mixed with other pesticides. Adjuvants (e.g., surfactants, crop oil concentrates, fertilizers) may also be added to the spray mixture to improve the herbicide efficacy. Without product specific toxicity data, it is impossible to quantify the potential impacts of these mixtures. In addition, a quantitative analysis could only be conducted if reliable scientific evidence allowed a determination of whether the joint action of the mixture was additive, synergistic, or antagonistic. Such evidence is not likely to exist unless the mode of action is common among the chemicals and receptors.

7.3.3.1 Adjuvants

Adjuvants generally function to enhance or prolong the activity of an a.i.. For terrestrial herbicides, adjuvants aid in the absorption of the a.i. into plant tissue. Adjuvant is a broad term and includes surfactants, selected oils, anti-foaming agents, buffering compounds, drift control agents, compatibility agents, stickers, and spreaders. Adjuvants are not under the same registration guidelines as pesticides and the USEPA does not register or approve the labeling of spray adjuvants. Individual herbicide labels identify which types of adjuvants are approved for use with the particular herbicide.

In reviewing the labels for Reward® (Syngenta 2001), the following adjuvants (only non-ionic surfactants) were identified on the labels:

- Spot spray – 1 to 2 quarts Reward® plus the labeled rate of a 75% or greater nonionic surfactant per 100 gal of water, or 0.75 oz Reward® plus the labeled rate of a 75% or greater nonionic surfactant per 1 gal of water.

- Broadcast Spray – 1 to 2 pints Reward® in a minimum of 15 gal of water per ac. Add labeled rate of a 75% or greater nonionic surfactant per 100 gal of water.

- Broadcast Spray for Ornamental Seed Crops– 1.5 to 2 pints Reward® plus the labeled rate of a 75% or greater nonionic surfactant per ac in sufficient water (minimum of 5 gal by air or 15 gal by ground).

In general, adjuvants compose a relatively small portion of the volume of herbicide applied. However, it is recommended that an adjuvant with low toxic potential be selected. Potential toxicity of any material should be considered prior to its use as an adjuvant.

As described in Section 7.3.2, sources (Muller 1980; Lewis 1991; Dorn et al. 1997; Wong et al. 1997) generally suggested that acute toxicity to aquatic life for surfactants and anti-foam agents ranged from 1 to 10 mg/L, and that chronic toxicity ranged as low as 0.1 mg/L. Since no application rates were provided for the nonionic surfactants, the maximum application rate for diquat was used (4.0 mg a.i./L). With a 75% nonionic surfactant, this predicted a maximum concentration of 3.0 mg/L, within the range indicated for acute toxicity to aquatic life. This concentration is likely an overestimate of the concentration of any inert that would be present because the Reward® label did not provide application rate information for adjuvants. This calculation was performed assuming that the adjuvant application rate equals the diquat application rate and the adjuvant was present at 75% of the diquat concentration.

This evaluation indicates that, for herbicides with high application rates, adjuvants have the potential to cause acute and potentially chronic risk to aquatic species. However, more specific modeling and toxicity data would be necessary to define the level of uncertainty. Selection of adjuvants is under the control of the BLM land managers and it is recommended that land managers follow all label instructions and abide by any warnings. Selection of adjuvants with limited toxicity and low volumes is recommended to reduce the potential for the adjuvant to increase the toxicity of the herbicide.

7.3.3.2 Tank Mixtures

According to the labels, diquat, as the a.i. in Reward®, may be mixed with pre-emergent herbicides (specific herbicides are not indicated). However, it is not generally within BLM practice to tank mix diquat with any other products. Therefore, additional modeling of tank mixes was not performed for diquat.

In general it may be noted that selection of tank mixes, like adjuvants, is under the control of BLM land managers. To reduce uncertainties and potential negative impacts, it is required that land managers follow all label instructions and abide by any warnings. Labels for tank mixed products should be thoroughly reviewed and mixtures with the least potential for negative effects should be selected. This is especially relevant when a mixture is applied in a manner that may already have the potential for risk when using an individual herbicide (e.g., runoff to ponds in sandy watersheds). Use of a tank mix under these conditions is likely to increase the level of uncertainty in the potential unintended risk to the environment.

7.4 Uncertainty Associated with Herbicide Exposure Concentration Models

The ERA relies on different models to predict the off-site impacts of herbicide use. These models have been developed and applied in order to develop a conservative estimate of herbicide loss from the application area to the off-site locations.

As in any screening or higher-tier ERA, a discussion of potential uncertainties from fate and exposure modeling is necessary to identify potential overestimates or underestimates of risk. In particular, the uncertainty analysis focused on which environmental characteristics (e.g., soil type, annual precipitation) exert the biggest numeric impact on model outputs. This has important implications not only for the uncertainty analysis itself, but also for the ability to apply risk calculations to different site characteristics from a risk management point of view.

7.4.1 AgDRIFT®

Off-site spray drift and resulting terrestrial deposition rates and waterbody concentrations (hypothetical pond or stream) were predicted using the computer model, AgDRIFT® Version 2.0.05 (SDTF 2002). As with any complex ERA model, a number of simplifying assumptions were made to ensure that the risk assessment results would be protective of most environmental settings encountered in the BLM land management program.

Predicted off-site spray drift and downwind deposition can be substantially altered by a number of variables intended to simulate the herbicide application process including, but not limited to: nozzle type used in the spray application of an herbicide mixture; ambient wind speed; release height (application boom height); and evaporation. Hypothetically, any variable in the model that is intended to represent some part of the physical process of spray drift and deposition can substantially alter predicted downwind drift and deposition patterns. Recognizing the lack of absolute knowledge regarding all of the scenarios likely to be encountered in the BLM land management program, these assumptions were developed to be conservative and likely result in overestimation of actual off-site spray drift and environmental impacts.

7.5 Summary of Potential Sources of Uncertainty

The analysis presented in this section has identified several potential sources of uncertainty that may introduce bias into the risk conclusions. This bias has the potential to 1) underestimate risk, 2) overestimate risk, or 3) be neutral with regard to the risk estimates, or be undetermined without additional study. In general, few of the sources of uncertainty in this ERA are likely to underestimate risk to ecological receptors. Risk is more likely to be overestimated or the impacts of the uncertainty may be neutral or impossible to predict.

The following bullets summarize the potential impacts on the risk predictions based on the analysis presented above:

- Toxicity Data Availability – Although the species for which toxicity data are available may not necessarily be the most sensitive species to a particular herbicide, the TRV selection methodology has focused on identifying conservative toxicity values that are likely to be protective of most species; the use of various LOCs contributes an additional layer of protection for species that may be more sensitive than the tested species (i.e., RTE species).

- Potential Indirect Effects on Salmonids - Only a qualitative evaluation of indirect risk to salmonids was possible since no relevant studies or incident reports were identified; it is likely that this qualitative evaluation overestimates the potential risk to salmonids due to the numerous conservative assumptions related to TRVs and exposure scenarios and the application of additional LOCs (with uncertainty/safety factors applied) to assess risk to RTE species.

- Ecological Risks of Degradates, Inerts, Adjuvants, and Tank Mixtures - Only limited information is available regarding the toxicological effects of degradates, inerts, adjuvants, and tank mixtures; in general, it is unlikely that highly toxic degradates or inerts are present in approved herbicides. Also, selection of tank mixes and adjuvants is under the control of BLM land managers and to reduce uncertainties and potential risks products should be thoroughly reviewed and mixtures with the least potential for negative effects should be selected.

- Uncertainty Associated with Herbicide Exposure Concentration Models - Environmental characteristics (e.g., wind speed, nozzle type) will impact the models used to predict the off-site drift impacts of herbicide use (i.e., AgDRIFT®); in general, the assumptions used in the models were developed to be conservative and likely result in overestimation of actual off-site environmental impacts.

- General ERA Uncertainties – The general methodology used to conduct the ERA is more likely to overestimate risk than to underestimate risk due to the use of conservative assumptions (i.e., entire home range and diet is assumed to be impacted, aquatic waterbodies are relatively small, herbicide degradation over time is not applied in most scenarios).

TABLE 7-1
Potential Sources of Uncertainty in the ERA Process

Potential Source of Uncertainty	Direction of Effect	Justification
Physical-chemical properties of the active ingredient	Unknown	Available sources were reviewed for a variety of parameters. However, not all sources presented the same value for a parameter (e.g., water solubility) and some values were estimated.
Food chain assumed to represent those found on BLM lands	Unknown	BLM lands cover a wide variety of habitat types. A number of different exposure pathways have been included, but additional pathways may occur within management areas.
Receptors included in food chain model assumed to represent those found on BLM lands	Unknown	BLM lands cover a wide variety of habitat types. A number of different receptors have been included, but alternative receptors may occur within management areas.
Food chain model exposure parameter assumptions	Unknown	Some exposure parameters (e.g., BW, food ingestion rates) were obtained from the literature and some were estimated. Efforts were made to select exposure parameters representative of a variety of species or feeding guilds.
Assumption that receptor species will spend 100% of time in impacted terrestrial or aquatic area (home range = application area)	Overestimate	These model exposure assumptions do not take into consideration the ecology of the wildlife receptor species. Organisms will spend varying amounts of time in different habitats, thus affecting their overall exposures. Species are not restricted to one location within the application area, may migrate freely off-site, may undergo seasonal migrations (as appropriate), and are likely to respond to habitat quality in determining foraging, resting, nesting, and nursery activities. A likely overly conservative assumption has been made that wildlife species obtain all their food items from the application area.
Waterbody characteristics	Overestimate	The pond and stream were designed with conservative assumptions resulting in relatively small volumes. Larger waterbodies are likely to exist within application areas.
Extrapolation from test species to representative wildlife species	Unknown	Species differ with respect to absorption, metabolism, distribution, and excretion of chemicals. The magnitude and direction of the difference may vary with species. It should be noted, though, that in most cases, laboratory studies actually overestimate risk relative to field studies (Fairbrother and Kapustka 1996).
Consumption of contaminated food	Unknown	Toxicity to food receptors may result in sickness or mortality. Fewer food items would be available for predators. Predators may stop foraging in areas with reduced prey populations, discriminate against, or conversely, select contaminated food items.
No evaluation of inhalation exposure pathways	Underestimate	The inhalation exposure pathways are generally considered insignificant due to the low concentration of contaminants under natural atmospheric conditions. However, under certain conditions, these exposure pathways may occur.
Assumption of 100% drift for chronic ingestion scenarios	Overestimate	It is unlikely that 100% of the application rate would be deposited on a plant or animal used as food by another receptor. As indicated with the AgDRIFT® model, off-site drift is only a fraction of the applied amount.

TABLE 7-1 (Cont.)
Potential Sources of Uncertainty in the ERA Process

Potential Source of Uncertainty	Direction of Effect	Justification
Ecological exposure concentration	Overestimate	It is unlikely any receptor would be exposed continuously to the full predicted EEC.
Over-simplification of dietary composition in the food web models	Unknown	Assumptions were made that contaminated food items (i.e., vegetation, fish) were the primary food items for wildlife. In reality, other food items are likely consumed by these organisms.
Degradation or adsorption of herbicide	Overestimate	Risk estimates for direct spray and off-site drift scenarios generally do not consider degradation or adsorption. Concentrations will tend to decrease over time from degradation. Organic carbon in water or soil/sediment may bind to herbicide and reduce bioavailability.
Bioavailability of herbicides	Overestimate	Most risk estimates assume a high degree of bioavailability. Environmental factors (e.g., binding to organic carbon, weathering) may reduce bioavailablity.
Limited evaluation of dermal exposure pathways	Unknown	The dermal exposure pathway is generally considered insignificant due to natural barriers found in fur and feathers of most ecological receptors. However, under certain conditions (e.g., for amphibians), these exposure pathways may occur.
Amount of receptor's body exposed	Unknown	More or less than ½ of the honeybee or small mammal may be affected in the accidental direct spray scenarios.
Lack of toxicity information for amphibian and reptile species	Unknown	Information is not available on the toxicity of herbicides to reptile and amphibian species resulting from dietary or direct contact exposures.
Lack of toxicity information for RTE species	Unknown	Information is not available on the toxicity of herbicides to RTE species resulting from dietary or direct contact exposures. Uncertainty factors have been applied to attempt to assess risk to RTE receptors. See Section 7.2 for additional discussion of salmonids.
Safety factors applied to TRVs	Overestimate	Assumptions regarding the use of 3-fold uncertainty factors are based on precedent, rather than scientific data.
Use of lowest toxicity data to derive TRVs	Overestimate	The lowest data point observed in the laboratory may not be representative of the actual toxicity that might occur in the environment. Using the lowest reported toxicity data point as a benchmark concentration is a very conservative approach, especially when there is a wide range in reported toxicity values for the relevant species. See Section 7.1 for additional discussion.
Use of NOAELs	Overestimate	Use of NOAELs may overestimate effects since this measurement endpoint does not reflect any observed impacts. LOAELs may be orders of magnitudes above observed literature-based NOAELs, yet NOAELs were generally selected for use in the ERA.
Use of chronic exposures to estimate effects of herbicides on receptors	Overestimate	Chronic toxicity screening values assume that ecological receptors experience continuous, chronic exposure. Exposure in the environment is unlikely to be continuous for many species that may be transitory and move in and out of areas of maximum herbicide concentration.
Use of measures of effect	Overestimate	Although an attempt was made to have measures of effect reflect assessment endpoints, limited available ecotoxicological literature resulted in the selection of certain measures of effect that may overestimate assessment endpoints.

TABLE 7-1 (Cont.)
Potential Sources of Uncertainty in the ERA Process

Potential Source of Uncertainty	Direction of Effect	Justification
Lack of toxicity information for mammals or birds	Unknown	TRVs for certain receptors were based on a limited number of studies conducted primarily for pesticide registration. Additional studies may indicate higher or lower toxicity values. See Section 7.1 for additional discussion.
Lack of seed germination toxicity information	Unknown	TRVs were based on a limited number of studies conducted primarily for pesticide registration. A wide range of germination data was not always available. Emergence or other endpoints were also used and may be more or less sensitive to the herbicide.
Species used for testing in the laboratory assumed to be equally sensitive to herbicide as those found within application areas.	Unknown	Laboratory toxicity tests are normally conducted with species that are highly sensitive to contaminants in the media of exposure. Guidance manuals from regulatory agencies contain lists of the organisms that they consider to be sensitive enough to be protective of naturally occurring organisms. However, reaction of all species to herbicides is not known, and species found within application areas may be more or less sensitive than those used in the laboratory toxicity testing. See Section 7.1 for additional discussion.
Risk evaluated for individual receptors only	Overestimate	Effects on individual organisms may occur with little population or community level effects. However, as the number of affected individuals increases, the likelihood of population-level effects increases.
Lack of predictive capability	Unknown	The RQ approach provides a conservative estimate of risk based on a "snapshot" of conditions; this approach has no predictive capability.
Unidentified stressors	Unknown	It is possible that physical stressors other than those measured may affect ecological communities.
Effect of decreased prey item populations on predatory receptors	Unknown	Adverse population effects to prey items may reduce the foraging population for predatory receptors, but may not necessarily adversely impact the population of predatory species.
Multiple conservative assumptions	Overestimate	Cumulative impact of multiple conservative assumptions predicts high risk to ecological receptors.
Impact of the other ingredients (e.g., inerts, adjuvants) in the application of the herbicide	Unknown	Only the active ingredient has been investigated in the ERA. Inerts, adjuvants, and tank mixtures may increase or decrease the impacts of the active ingredient. These uncertainties are discussed further in Section 7.3.

8.0 SUMMARY

Based on the ERA conducted for diquat, there is the potential for risk to ecological receptors from exposure to herbicides under specific conditions on BLM-managed lands. Table 8-1 summarizes the relative magnitude of risk predicted for ecological receptors for each route of exposure. This was accomplished by comparing the RQs against the most conservative LOC, and ranking the results for each receptor-exposure route combination from 'no potential' to 'high potential' for risk. As expected due to the mode of action of herbicides, the highest risk is predicted for non-target terrestrial and aquatic plant species, generally under accidental exposure scenarios (i.e., direct spray and accidental spills). Minimal risk was predicted for terrestrial animals. Risk to fish and aquatic invertebrates was predicted in the direct spray and spill scenarios.

The following bullets further summarize the risk assessment findings for diquat under these conditions:

- Direct Spray – Risks were predicted for pollinating insects due to direct spray and indirect contact with contaminated foliage. Acute risks were predicted for 5 of 10 wildlife scenarios, and chronic risks were predicted for 9 of 10 wildlife scenarios (risk is somewhat lower at the typical application rate versus the maximum rate). Risk to terrestrial and aquatic non-target plants, fish, and aquatic invertebrates is likely when waterbodies are accidentally or intentionally (pond applications) sprayed. No risks were predicted for piscivorous wildlife.

- Off-Site Drift to Non-Target Terrestrial Plants – Risks to typical and RTE terrestrial plant species were predicted within 900 ft of all aerial applications at both the typical and maximum application rates. RQs were also elevated for typical and RTE plant species within 100 ft of ground applications (low and high booms).

- Accidental Spill to Pond – Risk to fish, aquatic invertebrates, and non-target aquatic plants is likely when herbicides are spilled directly into the pond.

In addition, species that depend on non-target species for habitat, cover, and/or food may be indirectly impacted by a possible reduction in terrestrial or aquatic vegetation, particularly in accidental direct spray and spill scenarios. For example, RTE salmonids may be indirectly impacted by a reduction in food supply (i.e., fish and aquatic invertebrates) or a reduction in vegetative cover in the relatively unlikely case of an accidental spill to the stream.

Based on the results of the ERA, it is unlikely that RTE species would be harmed by appropriate use of the herbicide diquat on BLM-managed lands. Although non-target terrestrial plants have the potential to be adversely affected by off-site drift of diquat, adherence to certain application guidelines (e.g., defined application rates, equipment, herbicide mixture, and downwind distance to potentially sensitive habitat) would minimize the potential effects on non-target plants and associated indirect effects on species that depend on those plants for food, habitat, and cover.

8.1 Recommendations

The following recommendations are designed to reduce potential unintended impacts to the environment from the application of diquat:

- Select herbicide products carefully to minimize additional impacts from adjuvants. This is especially important for application scenarios that already predict potential risk from the a.i. itself.

- Review, understand, and conform to "Environmental Hazards" section on herbicide label. This section warns of known pesticide risks to wildlife receptors or to the environment and provides practical ways to avoid harm to organisms or the environment.

- Avoid accidental direct spray and spill conditions to reduce the greatest potential impacts.

- Use the typical application rate, rather than the maximum application rate, to reduce risk to some wildlife receptors (e.g., large carnivore, small bird).

- Use ground application methods at the typical or maximum application rate with buffer zones of more than 100 ft (no risk predicted at 900 ft) to reduce potential risks to typical terrestrial plants from off-site drift.

- To reduce potential risks to RTE terrestrial plants from off-site drift during ground applications, use buffer zones of more than 100 ft at the typical rate, or buffer zones of at least 1,000 ft when using the maximum application rate (based on simple regression evaluation of RQs and distance).

- Buffer zones of greater than 900 ft may be necessary if aerial application is planned. Regression analysis indicates that a buffer zone of 1,200 ft should be protective of typical and RTE plant species.

- Avoid application to ponds where RTE species have been identified.

The results from this ERA assist the evaluation of proposed alternatives in the EIS and contribute to the development of a BA), specifically addressing the potential impacts to proposed and listed RTE species on western BLM treatment lands. Furthermore, this ERA will inform BLM field offices on the proper application of diquat to ensure that impacts to plants and animals and their habitat are minimized to the extent practical.

TABLE 8-1
Typical Risk Levels Resulting from Diquat Application

Exposure Category / Receptor Group	Direct Spray/Spill		Off-Site Drift		Surface Runoff		Wind Erosion	
	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Terrestrial Animals	0 [10: 16]	M [7: 16]	NA	NA	NA	NA	NA	NA
Terrestrial Plants (Typical Species)	H [1: 1]	H [1: 1]	L [7: 12]	M [7: 12]	NA	NA	NA	NA
Terrestrial Plants (RTE Species)	H [1: 1]	H [1: 1]	M [7: 12]	M [7: 12]	NA	NA	NA	NA
Fish In The Pond	L [2: 2]	H [2: 4]	NA	NA	NA	NA	NA	NA
Fish In The Stream	M [1: 2]	M [2: 2]	NA	NA	NA	NA	NA	NA
Aquatic Invertebrates In The Pond	M [2: 2]	H [3: 4]	NA	NA	NA	NA	NA	NA
Aquatic Invertebrates In The Stream	H [1: 2]	H [2: 2]	NA	NA	NA	NA	NA	NA
Aquatic Plants In The Pond	H [2: 2]	H [4: 4]	NA	NA	NA	NA	NA	NA
Aquatic Plants In The Stream	H [2: 2]	H [2: 2]	NA	NA	NA	NA	NA	NA
Piscivorous Bird	NA	NA	NA	NA	NA	NA	NA	NA

Risk Levels:
0 = No Potential for Risk (majority of RQs < most conservative LOC).
L = Low Potential for Risk (majority of RQs 1-10 times the most conservative LOC).
M = Moderate Potential for Risk (majority of RQs 10-100 times the most conservative LOC).
H = High Potential for Risk (majority of RQs >100 times the most conservative LOC).
The reported Risk Level is based on the risk level of the majority of the RQs for each exposure scenario within each of the above receptor groups and exposure categories (i.e., direct spray/spill, off-site drift, surface runoff, wind erosion). As a result, risk may be higher than the reported risk category for some scenarios within each category. The reader should consult the risk tables in Section 4 to determine the specific scenarios that result in the displayed level of risk for a given receptor group.
Number in brackets represents Number of RQs in the Indicated Risk Level: Number of Scenarios Evaluated.
NA = Not applicable. No RQs calculated for this scenario.
In cases of a tie, the more conservative (higher) risk level was selected.

9.0 REFERENCES

Abt Assoc., Inc. 1995. Technical Basis for Recommended Ranges of Uncertainty Factors Used in Deriving Wildlife Criteria for the Great Lakes Water Quality Initiative. Draft Report Submitted to U.S. Environmental Protection Agency (USEPA) Office of Water, March 11, 1995 by Abt Associates, Inc. Bethesda, Maryland.

Barnthouse, L. 1993. Population-level Effects. Pages 247-274 *In* G. W. Suter, II (ed.). Ecological Risk Assessment. Lewis Publishers. Boca Raton, Florida.

Battaglin, A.W., E.M. Thurman, S.J. Kalkhoff, and S.D. Porter. 2003. Herbicides and Transformation Products in Surface Waters of the Midwestern United States. Journal of the American Water Resources Association August 2003:743 – 756.

The British Crop Protection Council and The Royal Society of Chemistry. 1994. The Pesticide Manual Incorporating the Agrochemicals Handbook. Tenth Edition. Surrey and Cambridge, United Kingdom.

Brown, L., and D. Amadon. 1968. Eagles, Hawks and Falcons of the World. Volume 1. Hamlyn Publishing Group Limited, New York, New York.

California Department of Pesticide Registration (DPR.). 2003. USEPA/OPP Pesticide Related Database. Updated weekly. Available at: http://www.cdpr.ca.gov/docs/epa/epamenu.htm.

California Office of Environmental Health Hazard Assessment (CA OEHHA). 2003. California Wildlife Biology, Exposure Factor, and Toxicity Database (Cal/Ecotox). State of California Office of Environmental Health Hazard Assessment and University of California at Davis. http://www.oehha.ca.gov/cal_ecotox/default.htm

Chapman, P.M., A. Fairbrother, and D. Brown. 1998. A Critical Evaluation of Safety (Uncertainty) Factors for Ecological Risk Assessment. Environmental Toxicology and Chemistry 17:99-108.

Compendium of Pesticide Common Names. 2003. A Website Listing All ISO-approved Names of Chemical Pesticides. Available at: http://www.hclrss.demon.co.uk.

Dial, N.A., and C.A. Bauer Dial. 1987. Lethal Effects of Diquat and Paraquat on Developing Frog Embryos and 15-day-old Tadpoles, *Rana pipiens*. Bulletin of Environmental Contamination and Toxicology 38:1006-1011.

Dodson, J.J., and C.I. Mayfield. 1979. Modification of the Rheotropic Response of Rainbow Trout (*Salmo gairdneri*) by Sublethal Doses of the Aquatic Herbicides Diquat and Simazine. Environmental Pollution 18:147-157.

Dorn, P. B., J. H. Rodgers, Jr., W.B. Gillespie, Jr., R. E. Lizotte, Jr., and A. W. Dunn. 1997. The Effects of C12-13 Linear Alcohol Ethoxylate Surfactant on Periphyton, Macrophytes, Invertebrates and Fish in Stream Mesocosms. Environmental Toxicology and Chemistry 16(8):1634-1645.

Dourson, M.L., and J.F. Starta. 1983. Regulatory History and Experimental Support of Uncertainty (Safety) Factors. Regulatory Toxicology and Pharmacology 3:224-238.

Edge, W.D., R.L. Carey, J.O. Wolff, L.M. Ganio, and T. Manning. 1995. Effects of Guthion 2S on *Microtus canicaudus*: A Risk Assessment Validation. Journal of Applied Ecology 32.

ENSR. 2005a. Vegetation Treatments Programmatic EIS Human Health Risk Assessment. Prepared for the Bureau of Land Management, Reno, Nevada. Westford, Massachusetts.

_____. 2005b. Vegetation Treatments Programmatic EIS Ecological Risk Assessment Methodology Final Report. Prepared for the Bureau of Land Management, Reno, Nevada. Westford, Massachusetts.

EXTOXNET. 1996. A pesticide information project (PIP) of Cooperative Extension Offices of Cornell University, Oregon State University, the University of Idaho, the University of California at Davis, and the Institute for Environmental Toxicology at Michigan State University. Downloaded from http://ace.ace.orst.edu/-info/extoxnet/ on August 8, 2003.

Fairbrother, A., and L.A. Kapustka. 1996. Toxicity Extrapolations in Terrestrial Systems. Ecological Planning and Toxicology, Inc. (ept). July 5, 1996.

Fletcher, J.S., F.L. Johnson, and J.C. McFarlane. 1990. Influence of Greenhouse Versus Field Testing and Taxonomic Differences on Plant Sensitivity to Chemical Treatment. Environmental Toxicology and Chemistry 9:769-776.

_____, J.E. Nellessen, and T.G. Pfleeger. 1994. Literature Review and Evaluation of the EPA Food-Chain (Kenaga) Nomogram: An Instrument for Estimating Pesticide Residue on Plants. Environmental Toxicology and Chemistry 13(9):1383–1391.

Freeman, K.E., and C. Boutin. 1994. Impacts of Agricultural Herbicide Use on Terrestrial Wildlife: A Review with Special Reference to Canada. Canada Minister of the Environment, Canadian Wildlife Service. Technical Report 196.

Gaines, T.B., and R.E. Linder. 1986. Acute Toxicity of Pesticides in Adult and Weanling Rats. Fundamental and Applied Toxicology 7:299-308.

Hazardous Substance Data Bank (HSDB). 2003. Database Prepared by the U.S. National Library of Medicine, Office of Health & Human Services, National Institute of Health. Available at website: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?hsdbb.htm.

Hill, E.F., R.G. Heath, J.W. Spann, and J.D. Williams. 1975. Lethal Dietary Toxicities of Environmental Pollutants to Birds. U.S. Fish and Wildlife Service, Special Scientific Report No. 191. Washington, DC.

Hornsby, A., R. Wauchope, and A. Herner. 1996. Pesticide Properties in the Environment. Springer-Verlag, New York.

Howard, P. (ed.). 1991. Handbook of Physical Properties of Organic Chemicals. CRC Lewis Publishers. Boca Raton. Florida.

Hurt, W.H., and R.P Grossenheider, 1976. A Field Guide to the Mammals: North American North of Mexico. Third Edition. Houghton Mifflin Company. Boston, Massachusets.

Langeland, K.A., A.M. Fox, F.B. Laroche, B.B. Martin, D.F. Martin, C.D. Norris, and C. Wang. 1994. Diquat Distribution in Water After Application to Submersed Weeds. Water Resources Bulletin 30(1):93-97.

_____, and JP Warner. 1986. Persistence of Diquat, Endothall, and Fluridone in Ponds. Journal of Aquatic Plant Management 24:43-46.

Lewis, M.A. 1991. Chronic and Sublethal Toxicities of Surfactants to Aquatic Animals: A Review and Risk Assessment. Water Research 25(1):101-113.

Mackay, D., S. Wan-Ying, and M. Kuo-ching. 1997. Handbook of Environmental Fate and Exposure Data for Organic Chemicals. Volume III. Pesticides. Lewis Publishers. Chelsea, Michigan.

Maguire, C.C., and B.A. Williams. 1987. Response of Thermal Stressed Juvenile Quail to Dietary Organophosphate Exposure. Environmental Pollution 47:25-39.

Montgomery, J.H. (ed.). 1997. Illustrated Handbook of Physical-chemical Properties and Environmental Fate for Organic Chemicals. Volume V. Pesticide Chemicals. Lewis Publishers. Boca Raton, Florida.

Moss, J.L. 1978. Toxicity of Selected Chemicals to the Fairy Shrimp, *Streptocephalus seali*, Under Laboratory and Field Conditions. The Progressive Fish-Culturist 40(4):158-160.

Muller, R. 1980. Fish Toxicity and Surface Tension of Non-ionic Surfactants: Investigations of Anti-foam Agents. Journal of Fish Biology 16:585-589.

National Oceanic and Atmospheric Administration National Marine Fisheries (NOAA Fisheries). 1999. Endangered and Threatened Wildlife and Plants; Definition of 'Harm.' NOAA Fisheries, Department of Commerce. Federal Register 64(215) Rules and Regulations: 60,727-60,731.

_____. 2002. Pesticides and Pacific Salmon: Technical Guidance for NOAA Fisheries Section 7 Pesticide Consultations (Draft). Environmental Conservation Division. Seattle, Washington.

Opresko, D.M., B.E. Sample, and G.W. Suter. 1994. Toxicological Benchmarks for Wildlife. Oak Ridge National Laboratory. ES/ER/TM-86/R1. Oak Ridge, Tennessee.

Paul, E.A., H.A. Simonin, J. Symula, and R.W. Bauer. 1994. The Toxicity of Diquat, Endothall, and Fluridone to the Early Life Stages of Fish. Journal of Freshwater Ecology 9:229-239.

Petit, V., R. Cabridenc, R.P.J. Swannell, and R.S. Sokhi. 1995. Review of Strategies for Modeling the Environmental Fate of Pesticides Discharged into Riverine Systems. Environment International 21(2):167-176.

Reinert, K.H. 1989. Environmental Behavior of Aquatic Herbicides in Sediments. Chapter 13 *In* Reactions and Movements of Organic Chemicals in Soils. Soil Science Society of American and American Society of Agronomy, Special Publication No. 22. Madison, Wisconsin.

Ritter, A.M., J.L. Shaw, W.M. Williams, and K.Z. Travis. 2000. Characterizing Aquatic Ecological Risks from Pesticides Using a Diquat Dibromide Case Study. 1. Probabilistic Exposure Estimates. Environmental Toxicology and Chemistry 19(3):749-759.

Sample, B.E., D.M. Opresko, and G.W. Suter. 1996. Toxicological benchmarks for wildlife: 1996 Revision. Risk Assessment Program. Document ES/ER/TM-86/R-3 [http://www.hsrd.ornl.gov/ecorisk/reports.html]. Oak Ridge National Laboratory. Oak Ridge, Tennessee.

Sappington, L.C., F.L. Mayer, F.J. Dwyer, D.R. Buckler, J.R. Jones, and M.R. Ellersieck. 2001. Contaminant Sensitivity of Threatened and Endangered Fishes Compared to Standard Surrogate Species. Environmental Toxicology and Chemistry 20:2869-2876.

Sheley, R., J. Petroff, and M. Borman. 1999. Introduction to Biology and to Management of Noxious Rangeland Weeds. Corvallis, Oregon.

Shirazi, M.A., R.S. Bennett, and R.K. Ringer. 1994. An Interpretation of Toxicity Response of Bobwhite Quail with Respect to Duration of Exposure. Archives of Environmental Contamination and Toxicology 26:417-424.

Simsiman, G.V., and G. Chesters. 1976. Persistence of Diquat in the Aquatic Environment. Water Research 10:105-112.

Sinclair, C.J., and A.B.A. Boxall. 2003. Assessing the Ecotoxicity of Pesticide Transformation Products. Environmental Science and Technology 37:4617-4625.

Smith, S.N., A.J.E. Lyon, and I.B. Sahid. 1976. The Breakdown of Paraquat and Diquat by Soil Fungi. New Phytologist 77:735-740.

Sparling, D.W., G. Linder, and C.A. Bishop (eds.). 2000. Ecotoxicology of amphibians and reptiles. Society of Environmental Toxicology and Chemistry (SETAC), Pensacola, FL. 904 pp.

Spray Drift Task Force (SDTF). 2002. A User's Guide for AgDRIFT 2.0.05: A Tiered Approach for the Assessment of Spray Drift of Pesticides. Regulatory Version.

Swann, R., D. Laskowski, R. McCall, K. Vander Kuy, and J. Dishburger. 1983. A Rapid Method for the Estimation of the Environmental Parameters Octanol/Water Partition Coefficient, Soil Sorption Constant, Water-to-Air Ratio, and Water Solubility. Residue Reviews 85:17-28.

Syngenta. 2001. Specimen label for Reward®. Landscape and Aquatic Herbicide. Downloaded from http://www.syngentaprofessionalproducts.com/labels/ on September 5, 2003. Syngenta Crop Protection. Greensboro North Carolina.

Teske, M.E., and J.W. Barry. 1993. Parametric Sensitivity in Aerial Application. Transactions of the American Society of Agricultural Engineers (ASAE) 36(1):27-33.

_____, and H.W. Thistle. 1999. A Simulation of Release Hand Wind Speed Effects for Drift Minimization. Transactions of the ASAE 42(3):583-591.

_____, _____, J.W. Barry, and B. Eav. 1998. A Simulation of Boom Length Effects for Drift Minimization. Transactions of the ASAE 41(3):545-551.

Tomlin, C. (ed.). 1994. The Agrochemicals Desk Reference. 2nd Edition. Lewis Publishers. Boca Raton, Florida.

Turner, L. 2003. Diuron Analysis of Risks to Endangered and Threatened Salmon and Steelhead. Environmental Field Branch. Office of Pesticide Programs. July 30, 2003.US Code Title 16, Chapter 35, Section 1532, Paragraph 19.

U.S. Department of the Interior Bureau of Land Management (USDI BLM). 1991. Final Environmental Impact Statement, Vegetation Treatment on BLM Lands in Thirteen Western States. United States Department of the Interior, Bureau of Land Management. May 1991.

_____. 2005. Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States Draft Programmatic EIS. Reno, Nevada.

USEPA. 1993a. Wildlife Exposure Factors Handbook. Volume I. EPA/600-R/R-93/187a,187b. Office of Research and Development. Washington, D.C.

_____. 1993b. Review Plant Data Submission. February 11, 1993. MRID 424911-01. Douglas Urban of the Ecological Effects Branch, U.S. Environmental Protection Agency. Washington, D.C.

_____. 1995a. Reregistration Eligibility Decision (RED) Diquat Dibromide. Prevention, Pesticides and Toxic Substances. EPA 738-R-95-016. July. U.S. Environmental Protection Agency. Washington D.C.

_____. 1995b. Great Lakes Water Quality Initiative Criteria Documents for the Protection of Wildlife: DDT, Mercury, 2,3,7,8-TCDD, and PCBs. EPA 820/B95/008. March, 1995. Office of Water. U.S. Environmental Protection Agency. Washington D.C.

_____. 1997. Ecological Risk Assessment Guidance for Superfund, Process for Designing and Conducting Ecological Risk Assessments (Interim Final). U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Office of Emergency and Remedial Response. EPA 540/R-97/006. June, 1997.

_____. 1998. Guidelines for Ecological Risk Assessment. EPA/630/R-95/002F, U.S. Environmental Protection Agency. Washington, D.C.

_____. 2000. Ecological Soil Screening Level Guidance. Draft. U.S. Environmental Protection Agency. Office of Emergency and Remedial Response. July 10, 2000.

_____. 2002. Diquat Dibromide: HED Risk Assessment for Tolerance Reassessment Eligibility Document (TRED). U.S Environmental Protection Agency Memo, 3/6/02 from Becky Daiss to Tyler Lane.

_____. 2003. USEPA Pesticide Ecotoxicity Database. Provided by Brian Montague, Office of Pesticide Programs. June 6, 2003.

Westbrooks, R. 1998. Invasive Plants, Changing the Landscape of America: Fact Book. Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW). Washington, DC.

Wong, D., P.B. Dorn, and E.Y. Chai. 1997. Acute Toxicity and Structure-activity Relationships of Nine Alcohol Ethoxylate Surfactants to Fathead Minnow and *Daphnia magna*. Environmental Toxicology and Chemistry 16(9):1970-1976.

APPENDIX A

Summary of Available and Relevant Toxicity Data from Ecological Risk Assessment Literature Review for Diquat

Appendix A

Summary of Available and Relevant Toxicity Data from Ecological Risk Assessment Literature Review for Diquat

Introduction

A literature review and ecological data evaluation was conducted on nine herbicides that are currently being used or are proposed for use by the Bureau of Land Management (BLM) for vegetation management on 261 million acres of public lands in the Western U.S., including Alaska. The information gathered from this evaluation will be included along with other collected data to derive toxicity reference values for use in the ecological risk assessment (ERA; ENSR 2005). The ERA was conducted in conjunction with the Vegetation Treatments Programmatic Ecological Impact Statement (PEIS) for the BLM. Scientific papers were gathered during this process to provide data on acute and chronic toxicity of selected herbicides to the non-target species. The review process included consideration of U.S. Fish and Wildlife Service (USFWS) draft literature search guidance. The nine herbicides that were investigated during this evaluation were as follows:

- Diflufenzopyr
- Diquat
- Fluridone
- Imazapic
- Sulfometuron-methyl
- Bromacil
- Chlorsulfuron
- Diuron
- Tebuthiuron

This review process was carried out in three tiers: Tier I – Literature search and preliminary review to select individual manuscripts; Tier II – Screening to determine whether the manuscript is acceptable; and Tier III – Thorough review to obtain data for possible toxicity reference value (TRV) use. This report provides information for diquat; the other chemicals are discussed in separate reports.

Literature Search Methodology

The literature review process was initiated by conducting a keyword search pertaining to each of the nine chemicals in selected databases. The keyword search for all databases, except for one (Chemical Abstracts/Scifinder Scholar), included the herbicide name but not the commercial name (i.e., some commercial names are common words). The search parameters for Chemical Abstracts consisted of the herbicide name and chemical abstracts service (CAS) registry number. The open literature search was conducted at Colorado State University, Fort Collins, CO. The search period for diquat was from 1970 to 2002. The 12 databases selected and searched were:

- AGRICOLA
- ASFA (Aquatic Sciences and Fisheries Abstracts)
- Biological Sciences
- BIOSIS / Biological Abstracts
- Chemical Abstracts / Scifinder Scholar
- Environmental Science and Pollution Management
- MedLine

- Safety Science and Risk
- Toxline
- Water Resources Abstracts
- Web of Science / Science Citation Index
- Zoological Records

All of the documents obtained in the open literature searches were then evaluated by a Senior Toxicologist to select manuscripts pertaining to the specific objectives of this project (Tier I). Relevant studies were those that were judged, to the extent possible while searching literature databases (i.e., relying on title and abstract, when available), to provide useful data for conducting the ERA. Relevant studies contained the following information at a minimum:

- Acute (mortality vs. survival) or chronic (largely growth or reproduction, although other sublethal data—if available—were also considered potentially relevant) toxicity data for the active ingredient.

- Verifiable numeric endpoint values (e.g., LC_{50}, NOEC) that could be used in the risk characterization process.

- Toxicity data for clinical test species (e.g., mice, rats) and species used for screening non-human impacts (all other mammals, birds, invertebrates, algae, plants).

- Field or mesocosm studies were also included, but only if effects from exposure to the single herbicide in question could be identified and separated from other stressors.

Literature that was excluded as part of this initial literature gathering process included:

- analytical chemistry studies;

- methods papers without specific toxicity data;

- modeling studies that contained no empirically-derived data; and

- reviews or reports that were not primary toxicity data sources (except as a source for obtaining primary literature).

These search criteria enhanced the ability to screen scientific papers for the type of toxicity information needed in the ERA. Hard copies of all manuscripts that met these criteria were then obtained for further evaluation. Once articles were obtained, they were incorporated into a comprehensive management database (EndNote®). There were 243 documents identified from this process and obtained for further consideration. The bibliography list of articles obtained for diquat is included in this report (Appendix A.1).

Literature Review Methodology

A cursory review (Tier II) was performed on each manuscript after a hard copy was obtained. Exclusion and inclusion criteria to determine acceptability for further review were developed prior to the process in conjunction with the BLM. Manuscripts were excluded that dealt only with the following subjects:

- Human health effects
- Effects on microorganisms: (e.g., fungi, bacteria)
- Genotoxic effects (mutagenic, carcinogenic)
- Bioassays on cells of a whole organism (e.g., rat hepatocytes, rat liver S9)
- Effects on target plants (efficacy testing)
- Non-toxic effects (e.g., fate, transport, leaching, analytical methods)

- Mixtures including herbicides other than the nine being reviewed

In addition, manuscripts that solely included data on marine receptors were originally excluded; however, these data were later included because marine ecosystems could be adjacent to application areas on BLM lands.

Inclusion criteria and rating (on a scale of 1 [weak] to 5 [strong]) of issues that were to be emphasized (requiring a subsequent review step) were as follows:

1. Effects on nontarget receptors related to ERA protocol
2. Chronic, sub-lethal, or reproductive effects that may have adverse effects on populations
3. Effects form inerts, degradates, and metabolites
4. Studies with mixtures that include diflufenzopyr and any of the 8 other herbicides (i.e., not containing other herbicides)
5. Indirect effects to food supply or cover

Additional criteria that were used in reviewing papers (reviewers answered 'Yes' or 'No') are listed below:

- Were the corroborating studies described in sufficient detail (i.e., weight of evidence)?
- Did the study have a proper exposure dose, mechanism, and duration?
- Did the test include proper sample size, statistical analysis, and especially statistical endpoints (e.g., NOAEL, EC_{50}) or dose response curves?
- Were proper controls used and were they acceptable?
- Were the data published in a peer-reviewed journal?

Each of the 243 identified papers was scored on the selection criteria listed above, including documentation of the number of test organisms, statistical analysis, proper use, and performance of controls, and the study was classified as either "adequate" on "not adequate".

In Tier III, papers that were found to be acceptable for use were evaluated more thoroughly based on criteria developed with the BLM, and the following information is included as a second review form page for each manuscript (Appendix A.2):

- Author(s).
- Date of publication.
- Title of publication.
- Name of publication.
- Herbicide(s) used in the study.
- Receptor category: 20 g mammal, honey bee, 70 kg herbivore, small bird, large bird, non-target plants (monocot and dicot), warmwater fish, coldwater fish, aquatic invertebrate, aquatic plant, aquatic macrophyte). The specific life history stage was also recorded when available.
- Exposure conditions specifying the formulation, concentration, or amount of active ingredient and medium.
- Effect: Acute or sublethal effect end points of product formulations and breakdown products, and/or their component chemicals, such as: larval and embryonic developmental effects, endocrine disruption, reproductive impairment, changes in behavioral traits such as predator avoidance, feeding/appetite, lethargy or excitement, homing ability, swimming speed, or attraction to or repulsion from the chemicals.
- Toxicity endpoints (e.g., NOAEL, EC_{50}, LC_{50}, or dose response curve).
- Degradates, inerts, if available.
- Ecological conditions of study (e.g., mescosm, static/flow-through, water quality parameters).
- Comments (e.g., mixture effects: additive, synergistic, or antagonistic effect end points of multiple products, other observations).

The Tier II review for diquat was conducted by only one senior toxicologist, while in the subsequent review process (Tier III), two senior toxicologist independently reviewed papers and determined data adequacy. The reviews were then compiled, and the pertinent information was entered into a master spreadsheet documenting

review findings for possible use in TRV derivation. The documents used in this TRV derivation are designated in **bold** in the bibliography (Appendix A.1), and the derivation of TRVs from all available sources is reported in the ERA (ENSR 2005).

Results

There were 125 papers discovered in the review of the open literature for diquat, and of these, 46 were reviewed as part of Tier III. Data from 38 manuscripts were incorporated into the spreadsheet for TRV derivation for diquat (Table 1; Appendix A.3).

TABLE 1

Summary of the Results of the Open Literature Review for Diquat

Total number of papers obtained for diquat	125
Total number of papers accepted for Tier II review	46
Total number of papers used in TRV derivation	38

Information from the open literature review for diquat is contained in the TRV spreadsheet as well (Appendix A.3). The data collected during this review resulted in toxicity information for aquatic plants, crustaceans (amphipods, isopods, ostracods, fairy shrimp, cladocerans, copepods), phytoplankton (green algae, diatoms, euglena), fish (striped bass, smallmouth bass, largemouth bass, walleye, mosquitofish, carp, rainbow trout, brown trout), eel, amphibians (frogs, toads, newts), birds (mallard duck, ringneck pheasant, japanese quail, bobwhite quail), and small mammals (mice and rats). There were multiple studies for some species. Data were available on the chronic toxicity of diquat to several species including mice (Anderson et al. 1976), newts (Cooke 1977), cladocerans and copepods (Draxl et al. 1991), algae (Melendez et al. 1993), and mallard ducks (Sewalk et al. 2001). There were no studies found that examined the effects of degradation products of diquat or mixtures of diquat with any of the other eight herbicides evaluated. Several studies examined the indirect effects of diquat on food supply via changes in alga density (Philips et al. 1992; Melendez et al. 1993), duckweed growth (Peterson et al. 1994; Peterson et al. 1997), and aquatic macrophyte biomass (Cragg and Fry 1984).

References

Anderson, D., D.B. McGregor, and I.F.H. Purchase. 1976. Dominant Lethal Studies with Paraquat and Diquat in Male CD-1 mice. Mutation Research 40:349-358.

Cooke, A.S. 1977. Effects of Field Applications of the Herbicides Diquat and Dichlobenil on Amphibians. Environmental Pollution 12:43-50.

Cragg, B.A., and J.C. Fry. 1984. The Use of Microcosms to Simulate Field Experiments to Determine the Effects of Herbicides on Aquatic Bacteria. Journal of General Microbiology 130:2309-2316.

Draxl, R., K.E. Neugebaur, F.J. Zieris, and W. Huber. 1991. Comparison of the Ecological Effects of Diquat on Laboratory Multi-species and Outdoor Freshwater Systems. Internationale Vereinigung fuer Theoretische und Angewandte Limnologie 24(4):2269-2271.

ENSR. 2005. Diquat Ecological Risk Assessment Final Report. Prepared for the Bureau of Land Management. February 2005.

Melendez, A.L., R.L. Kepner, J.M. Balezon, and J.R. Pratt. 1993. Effects of Diquat on Freshwater Microbial Communities. Archives of Environmental Contamination and Toxicology 25:95-101.Peterson et al. 1994

Peterson, H.G., C. Boutin, K. Freemark, and P.A. Martin. 1997. Toxicity of Hexazinone and Diquat to Green Algae, Diatoms, Cyanobacteria and Duckweed. Aquatic Toxicology 39:111-134.

Philips, E.J., P. Hansen, and T. Velardi. 1992. Effect of the Herbicide Diquat on the Growth of Microalgae and Cyanobacteria. Bulletin of Environmental Contamination and Toxicology 49:750-756.

Sewalk, C.J., G.L. Brewer, and D.J. Hoffman. 2001. Effects of Diquat, An Aquatic Herbicide, on the Development of Mallard Embryos. Journal of Toxicology and Environmental Health, Part A 62:33-45.

APPENDIX A.1

BIBLIOGRAPHY LIST

Appendix A.1. Bibliography List

Anderson, D., D.B. McGregor, and I.F.H. Purchase. 1976. Dominant Lethal Studies with Paraquat and Diquat in Male CD-1 mice. Mutation Research 40:349-358.

Anderson, R.J., and K.V. Prahlad. 1976. The Deleterious Effects of Fungicides and Herbicides on *Xenopus laevis* Embryos. Archives of Environmental Contamination and Toxicology 4:312-323.

Anguelov, A., A. Hvoynev, G. Anguelov, L. Belchev, and C. Christev. 1997. Changes in Protein Content and Activity of Aspartate and Alanine Aminotransferases in Carp (*Cyprinus carpio* L.) After Experimental Treatment with Herbicide Diquat. Veterinarski Arhiv 67(6):253-260.

Bain, M.B., and S.E. Boltz. 1992. Effect of Aquatic Plant Control on the Microdistribution and Population Characteristics of Largemouth Bass. Transactions of the American Fisheries Society 121:94-103.

Bainova, A.I., and V.S. Vulcheva. 1978. Chronic Action of Diquat on Lungs. Doklady Comptes rendus del ‘Académic bulgare des Sciencés 31:1369-1372.

Bartell, S.M., G. Lefebvre, G. Kaminski, M. Carreau, and K.R. Campbell. 1999. An Ecosystem Model for Assessing Ecological Risks in Quebec Rivers, Lakes and Reservoirs. Ecological Modeling 124:43-67.

_____, K.R. Campbell, C.M. Lovelock, S.K. Nair, and J.L. Shaw. 2000. Characterizing Aquatic Ecological Risks from Pesticides Using a Diquat Dibromide Case Study III. Ecological Process Models. Environmental Toxicology and Chemistry 19(5):1441-1453.

Berry, C.R., Jr. 1984. Toxicity of the Herbicides Diquat and Endothall to Goldfish. Environmental Pollution (Series A) 34:251-258.

_____, C.B. Schreck, and S.L. Van Horn. 1975. Aquatic Macroinvertebrate Response to Field Application of the Combined Herbicides Diquat and Endothall. Bulletin of Environmental Contamination and Toxicology 14(3):374-379.

Bimber, D.L., R.W. Boenig, and M.L. Sharma. 1976. Respiratory Stress in Yellow Perch Induced by Subtoxic Concentrations of Diquat. Ohio Journal of Science 76(2):87-89.

_____, and R.A. Mitchell. 1978. Effects of Diquat on Amphibian Embryo Development. Ohio Journal of Science 78(1):50-51.

Birmingham, B.C., and B. Colman. 1983. Potential Phytotoxicity of Diquat Accumulated by Aquatic Plants and Sediments. Water, Air, and Soil Pollution 19:123-131.

Brent, J.A., and B.H. Rumack. 1993. Role of Free Radicals in Toxic Hepatic Injury II. Are Free Radicals the Cause of Toxin-induced Liver Injury? Clinical Toxicology 31(1):173-196.

Bus, J.S., M.M. Preache, C.Z. Cagen, H.S. Posner, B.C. Eliason, C.W. Sharp, and J.E. Gibson. 1975. Fetal Toxicity and Distribution of Paraquat and Diquat in Mice and Rats. Toxicology and Applied Pharmacology 33:450-460.

Campbell, K.R., S.M. Bartell, and J.L. Shaw. 2000. Characterizing Aquatic Ecological Risks from Pesticides Using a Diquat Dibromide Case Study II. Approaches Using Quotients and Distributions. Environmental Toxicology and Chemistry 19(3):760-774.

Cassidy, K., and J.H. Rodgers, Jr. 1989. Response of Hydrilla (*Hydrilla verticillata*) (L.f.) Royle) to Diquat and a model of uptake under nonequilibrium conditions. Environmental Toxicology and Chemistry 8:133-140.

Charles, J.M., M.B. Abou-Donia, and D.B. Menzel. 1978. Absorption of Paraquat and Diquat from the Airways of the Perfused Rat Lung. Toxicology 9: 59-67.

Chernoff, N., R.W. Setzer, D.B. Miller, M.B. Rosen, and J.M. Rogers. 1990. Effects of Chemically Induced Maternal Toxicity on Prenatal Development in the Rat. Teratology 42:651-658.

Chin, Y.N., and K.I. Sudderuddin. 1979. Effect of Methamidophos on the Growth Rate and Esterase Activity of the Common Carp *Cyprinus carpio* L. Environmental Pollution 18:213-220.

Cooke, A.S. 1977. Effects of Field Applications of the Herbicides Diquat and Dichlobenil on Amphibians. Environmental Pollution 12:43-50.

Crabtree, H.C., E.A. Lock, and M.S. Rose. 1977. Effects of Diquat on the Gastrointestinal Tract of Rats. Toxicology and Applied Pharmacology 41:585-595.

Cragg, B.A., and J.C. Fry. 1984. The Use of Microcosms to Simulate Field Experiments to Determine the Effects of Herbicides on Aquatic Bacteria. Journal of General Microbiology 130:2309-2316.

Darvas, B., J. Zdarek, T. Timar, and M.H. Tag El-Din. 1990. Effects of the Bipyridylium Herbicides Diquat Dibromide and Paraquat Dichloride on Growth and Development of *Neobellieria bullata* (Diptera: Sarcophagidae) Larvae. Journal of Economic Entomology 83(6):2175-2180.

de Peyster, A., and W.F. Long. 1993. Fathead Minnow Optomotor Response as a Behaviorial Endpoint in Aquatic Toxicity Testing. Bulletin of Environmental Contamination and Toxicology 51:88-95.

Dial, N.A., and C.A. Bauer Dial. 1983. Letal Effects of Diquat and Paraquat on Developing Frog Embryos and 15-day-old Tadpoles, *Rana pipiens*. Bulletin of Environmental Contamination and Toxicology 38:1006-1011.

Dodson, J.J., and C.I. Mayfield. 1979. Modification of the Rheotropic Response of Rainbow Trout (*Salmo gairdneri*) by Sublethal Doses of the Aquatic Herbicides Diquat and Simazine. Environmental Pollution 18:147-157.

Draxl, R., K.E. Neugebaur, F.J. Zieris, and W. Huber. 1991. Comparison of the Ecological Effects of Diquat on Laboratory Multi-species and Outdoor Freshwater Systems. Internationale Vereinigung fuer Theoretische und Angewandte Limnologie 24(4):2269-2271.

Duvall, R.J., L.W.J. Anderson, and C.R. Goldman. 2001. Pond Enclosure Evaluations of Microbial Products and Chemical Algicides Used in Lake Management. Journal of Aquatic Plant Management 39:99-106.

Fairchild, J.F., D.S. Ruessler, P.S. Haverland, and A.R. Carlson. 1997. Comparative Sensitivity of *Selenastrum capricornatum* and *Lemna minor* to Sixteen Herbicides. Archives of Environmental Contamination and Toxicology 32:353-357.

_____, L.C. Sappington, and D.S. Ruessler. 1999. An Ecological Risk Assessment of the Potential for Herbicide Impacts on Primary Productivity of the Lower Missouri River. Toxic Substances Hydrology Program (USGS) 2:323-330.

Folmar, L.C. 1976. Overt Avoidance Reaction of Rainbow Trout Fry to Nine Herbicides. Bulletin of Environmental Contamination and Toxicology 15(5):509-513.

_____. 1978. Avoidance Chamber Responses of Mayfly Nymphs Exposed to Eight Herbicides. Bulletin of Environmental Contamination and Toxicology 19(3):312-318.

Gaines, T.B., and R.E. Linder. 1986. Acute Toxicity of Pesticides in Adult and Weanling Rats. Fundamental and Applied Toxicology 7:299-308.

Gaivao, I., L.M. Sierra, and M.A. Comendador. 1999. The w/w$^+$ SMART Assay of *Drosophila melanogaster* Detects the Genotoxic Effects of Reactive Oxygen Species Inducing Compounds. Mutation Research 440:139-145.

Gupta, S., R.C. Husser, R.S. Geski, S.E. Welty, and C.V. Smith. 2000. Sex Differences in Diquat-induced Hepatic Necrosis and DNA Fragmentation in Fischer 344 Rats. Toxicological Sciences 54:203-211.

Haag, K.H., and G.R. Buckinham. 1991. Effects of Herbicides and Microbial Insecticides on the Insects of Aquatic Plants. Journal of Aquatic Plant Management 29:55-57.

Halfon, E., S. Galassi, R. Bruggemann, and A. Provini. 1996. Selection of Priority Properties to Assess Environmental Hazard of Pesticides. Chemosphere 33(8):1543-1562.

Heath, R.G., J.W. Spann, E.F. Hill, and J.F. Kreitzer. 1972. Comparative Dietary Toxicities of Pesticides to Birds. U.S. Fish and Wildlife Service. Washington D.C.

Hestand, R.S., and B.E. May. 1972. Effects of a Diquat Plus Cutrine Combination on Invertebrates in Inglis Reservoir. Hyacinth Control Journal 10:40-43.

Hill, E.F., R.G. Heath, J.W. Spann, and J.D. Williams. 1975. Lethal Dietary Toxicities of Environmental Pollutants to Birds. Laurel, MD, Patuxent Wildlife Research Center, U.S. Fish and Wildlife Service.

Hinton, M.J., and A.G. Eversole. 1978. Toxicity of Ten Commonly Used Chemicals to American Eels. Proceedings of the Annual Conference of the Southeast Association of Fish and Wildlife Agencies 32:599-604.

Hong, W., P.G. Meier, and R.A. Deininger. 1988. Determination of Dose-time-response Relationships from Long-term Acute Toxicity Test Data. Environmental Toxicology and Chemistry 7:221-226.

Johnson, C.R., and P.A. Gieke. 1977. The Effects of the Herbicide Diquat on *Gambusia affinis* and Some Associated Fauna in Freshwater Ponds. Proceedings and Papers. Annual Conference California Mosquito Control Association 45:59-60.

Jones, G.M., and J.A. Vale. 2000. Mechanisms of Toxicity, Clinical Features, and Management of Diquat Poisoning: A Review. Clinical Toxicology 38(2):123-128.

Kaya, B., A. Yaniklglu, A. Creus, and R. Marcos. 2000. Genotoxicity Testing of Five Herbicides in the *Drosophila* Wing Spot Test. Mutation Research 465:77-84.

Kevan, S.D., and R.G. Pearson. 1993. Toxicity of Diquat Pulse Exposure to Tropical Freshwater Shrimp (*Caridina nilotica*, Atyidae). Bulletin of Environmental Contamination and Toxicology 51:564-567.

Khan, S.U. 1973. Interaction of Humic Substances with Bipyridylium Herbicides. Canadian Journal of Soil Science 53:199-204.

Kracko, K.M., and R.L. Noble. 1993. Herbicide Inhibition of Grass Carp Feeding on *Hydrilla*. Journal of Aquatic Plant Management 31:273-275.

Krieger, R.I., and P.W. Lee. 1973. Inhibition of In Vivo and In Vitro Epoxidation of Aldrin, and Potentiation of Toxicity of Various Insecticide Chemicals by Diquat in Two Species of Fish. Archives of Environmental Contamination and Toxicology 1(2):112-121.

Kunert, K.J., and A.D. Dodge. 1989. Herbicide-induced Radical Damage and Antioxidative Systems. CRC Press. Boca Raton, Florida.

Lam, H.F., J. Takezawa, B.N. Gupta, and E.W. Vanstee. 1980. A Comparison of the Effects of Paraquat and Diquat on Lung Compliance, Lung Volumes and Single Breath Diffusing Capacity in the Rat. Toxicology 18:111-123.

Langeland, K.A., A.M. Fox, F.B. Laroche, B.B. Martin, D.F. Martin, C.D. Norris, and C. Wang. 1994. Diquat Distribution in Water After Application of Submersed Weeds. Water Resources Bulletin 30(1):93-97.

_____, and J.P. Warner. 1986. Persistence of Diquat, Endothall, and Fluridone in Ponds. Journal of Aquatic Plant Management 24:43-46.

Leahey, J.P., and R.J. Hemingway. 1975. The Metabolism of Diquat in Hens and Residues in Eggs and Tissues. Environmental Quality and Safety (Supplement) 3:157-162.

Leung, T., S.M. Naqvi, and C. Leblanc. 1983. Toxicities of Two Herbicides (Basagran, Diquat) and an Algicide (Cutrine-plus) to Mosquitofish *Gambusia affinis*. Environmental Pollution (Series A) 30:153-160.

Lorz, H.W., S.W. Glenn, R.H. Williams, C.M. Kunkel, L.A. Norris, and B.R. Loper. 1979. Effects of Selected Herbicides on Smolting of Coho Salmon. EPA 600/3-79-071.

Lozano, R.B., and J.R. Pratt. 1994. Interaction of Toxicants and Communities: The Role of Nutrients. Environmental Toxicology and Chemistry 13(3):361-368.

Lugo, A., L.A. Bravo-Inclan, J. Alcocer, M.L. Gaytan, Ma. G. Oliva, Ma. Del R. Sanchez, M. Chavez, and G. Vilaclara. 1998. Effect on the Planktonic Community of the Chemical Program Used to Control Water Hyacinth (*Eichhornia crassipes*) in Guadalupe Dam, Mexico. Aquatic Ecosystem Health and Management 1:333-343.

Ma, J., and W. Liang. 2001. Acute Toxicity of 12 Herbicides to the Green Algae *Chlorella pyrenoidosa* and *Scenedesmus obliquus*. Bulletin of Environmental Contamination and Toxicology 67:347-351.

Manabe, J., and T. Ogata. 1987. Lung Fibrosis Induced by Diquat After Intratracheal Administration. Archives of Toxicology 60:427-431.

May, B.E., R.S. Hestand, and J.M. Van Dyke 1973. Comparative Effects of Diquat Plus Copper Sulfate on Aquatic Organsims. Weed Science 21(3):249-253.

Mayer, F.L., and M.R. Ellersieck. 1986. Manual of Acute Toxicity: Interpretation and Database for 410 Chemicals. USDOL, FWS/Research Publication 160.

Melendez, A.L., R.L. Kepner, J.M. Balezon, and J.R. Pratt. 1993. Effects of Diquat on Freshwater Microbial Communities. Archives of Environmental Contamination and Toxicology 25:95-101.

Morrison, R.J. 1978. The Toxicity to Fish of Diaquat-copper Sulphate Mixtures. Fiji Agricultural Journal 40:105.

Moss, J.L. 1978. Toxicity of Selected Chemicals to the Fairy Shrimp, *Streptocephalus seali*, Under Laboratory and Field Conditions. The Progressive Fish-Culturist 40(4):158-160.

Naqvi, S.M., and R.H. Hawkins. 1989. Responses and LC50 Values for Selected Microcrustaceans Exposed to Spartan, Malathion, Sonar, Weedtrine-d, and Oust Pesticides. Bulletin of Environmental Contamination and Toxicology 43:386-393.

_____, T. Leung, and N.Z. Naqvi. 1980. Toxicities of Paraquat and Diquat Herbicides to Freshwater Copepods (*Diaptomus* sp. and *Eucyclops* sp.). Bulletin of Environmental Contamination and Toxicology 25:918-920.

Narine, D.R., and R.D. Guy. 1982. Binding of Diquat and Paraquat to Humic Acid in Aquatic Environments. Soil Science 133(6):356-363.

Nicholson, S.A., and R.J. Clerman. 1974. Toxicity of Diquat to the Crustacean Amphipod *Hyalella* from Chautauqua Lake. Environmental Letters 7(3):215-227.

Nirei, M., S. Hayasaka, M. Nagata, A. Tamai, and T. Tawara. 1993. Ocular Injury Caused by Preeglox-l, A Herbicide Containing Paraquat, Diquat and Surfactants. Japanese Journal of Ophthalmology 37(1):43-46.

Olaleye, V.F., E.A. Akintunde, O.A. and Akinyemiju. 1993. Effect of a Herbicidal Control of Water Hyacinth (*Eichhornia crassipes* Mart.) on Fish Composition and Abundance in the Kofawei Creek, Ondo State, Nigeria. Journal of Environmental Management 38:85-97.

Paul, E.A., H.A. Simonin, J. Symula, and R.W. Bauer. 1994. The Toxicity of Diquat, Endothall, and Fluridone to the Early Life Stages of Fish. Journal of Freshwater Ecology 9(3):229-239.

Peterson, H.G., C. Boutin, P.A. Martin, K.E. Freemark, N.J. Ruecker, and M.J. Moody. 1994. Aquatic Phyto-toxicity of 23 Pesticides Applied at Expected Environmental Concentrations. Aquatic Toxicology 28:275-292.

_____, _____, K. Freemark, and P.A. Martin. 1997. Toxicity of Hexazinone and Diquat to Green Algae, Diatoms, Cyanobacteria and Duckweed. Aquatic Toxicology 39:111-134.

Petit, V., R. Cabridenc, R.P.J. Swannell, and R.S. Sokhi. 1995. Review of Strategies for Modelling the Environmental Fate of Pesticides Discharged into Riverine Systems. Environment International 21(2):167-176.

Philips, E.J., P. Hansen, and T. Velardi. 1992. Effect of the Herbicide Diquat on the Growth of Microalgae and Cyanobacteria. Bulletin of Environmental Contamination and Toxicology 49:750-756.

Prahlad, K.V., and R.J. Anderson. 1975. Deleterious Changes Induced by the Fungicide Ethylenebis (Dithiocarbamic Acid) Disodium Salt (Nabam) and the Herbicide 1,1-ethylene-2,2-dipyri-dinium Dibromide (Diquat) in *Xenopus laevis* Embryonic Tissues: An Ultrastructural Study. Cytobios 14:63-74.

Pratt, J.R., and R. Barreiro. 1998. Influence of Trophic Status on the Toxic Effects of a Herbicide: A Microcosm Study. Archives of Environmental Contamination and Toxicology 35:404-411.

_____, and N.J. Bowers. 1990. Effect of Sediment on Estimates of Diquat Toxicity in Laboratory Microcosms. Water Research 24(1):51-57.

_____, A.E. Melendez, R. Barreiro, and N.J. Bowers. 1997. Predicting the Ecological Effects of Herbicides. Ecological Applications 7(4):1117-1124.

Reif, D.W., I.L.P. Beales, C.E. Thomas, and S.D. Aust. 1988. Effect of Diquat on the Distribution of Iron in Rat Liver. Toxicology and Applied Pharmacology 93:506-510.

Reinert, K.H. 1989. Environmental Behavior of Aquatic Herbicides in Sediments. Reactions and Movement of Organic Chemicals in Soil. SSSA Special Publication No. 22:335-348. Madison, Wisconsin.

Rikans, L.E., and Y. Cai. 1992. Age-associated Enhancement of Diquat-induced Lipid Peroxidation and Cytotoxicity in Isolated Rat Hepatocytes. The Journal of Pharmacology and Experimental Therapeutics 262(1):271-278.

_____, and _____. 1993. Diquat-induced Oxidative Damage in BCNU-pretreated Hepatocytes of Mature and Old Rats. Toxicology and Applied Pharmacology 118:263-270.

_____, and K.R. Hornbrook. 1997. Age-related Susceptibility to Hepatotoxicants. Environmental Toxicology and Pharmacology 4:339-344.

_____, V. Ardinska, and K.R. Hornbrook. 1997. Age-associated Increase in Ferritin Content of Male Rat Liver: Implication for Diquat-mediated Oxidative Injury. Archives of Biochemistry and Biophysics 344(1):85-93.

Ritter, A. M., J.L. Shaw, W. Martin Williams, and K.Z. Travis. 2000. Characterizing Aquatic Ecological Risks from Pesticides Using a Diquat Dibromide Case Study I. Probabilistic Exposure Estimates. Environmental Toxicology and Chemistry 19(3):749-759.

Robson, T.O. 1969. Developments in the Use of Herbicides for the Control of Aquatic Macrophytes. Water Treatment and Examination 18(4):327-337.

_____, M.C. Fowler, and P.R.F. Barnett. 1976. Effect of Some Herbicides on Freshwater Algae. Pesticide Science 7:391-402.

Ruiz, M.J., L. Lopez-Jaramillo, M.J. Redondo, and G. Font. 1997. Toxicity Assessment of Pesticides Using the Microtox Test: Application to Environmental Samples. Bulletin of Environmental Contamination and Toxicology 59:619-625.

Sahid, I.B., J.E. Lyon, and S.N. Smith. 1981. The Effect of Bipyridyl Herbicides on the Loss of Nutrients from Fungi. New Phytologist 89:401-409.

Salah El-Deen, M.A., and W.A. Rogers. 1992. Acute Toxicity and Some Hematological Hanges in Grass Carp Exposed to Diquat. Journal of Aquatic Animal Health 4:277-280.

_____, and _____. 1993. Changes in Total Protein and Transaminase Activities of Grass Carp Exposed to Diquat. Journal of Aquatic Animal Health 5:280-286.

Salama, A.K., N.M. Bakry, and M.B. Abu-Donia. 1993. A Review Article on Placental Transfer of Pesticides. Journal of Occupational Medicine and Toxicology 2(4):383-389.

Sanders, H.O. 1970. Toxicities of Some Herbicides to Six Species of Freshwater Crustaceans. Journal of Water Pollution Control Federation 42:1544-1550.

Sandy, M S., P. Moldeus, D. Ross, and M.T. Smith. 1987. Cytotoxicity of the Redox Cycling Compound Diquat in Isolated Hepatocytes: Involvement of Hydrogen Peroxide and Transition Metals. Archives of Biochemistry and Biophysics 259(1):29-37.

Schultz, I.R., and W.L. Hayton. 1995. Disposition and Toxicokinetics of Diquat in Channel Catfish. Aquatic Toxicology 33:297-310.

Selypes, A., L. Nagymaitenyi, and G. Berencsi. 1980. Mutagenic and Embryotoxic Effects of Paraquat and Diquat. Bulletin of Environmental Contamination and Toxicology 25:513-517.

Sewalk, C.J., G.L. Brewer, and D.J. Hoffman. 2001. Effects of Diquat, An Aquatic Herbicide, on the Development of Mallard Embryos. Journal of Toxicology and Environmental Health, Part A 62:33-45.

Shah, R.G., J. Lagueux, S. Kajaur, P. Lerallois, P. Ayotle, M. Tremblay, J. Zee, and G.G. Poirier. 1997. Determination of Genotoxicity of the Metabolites of the Pesticides Guthion, Sencor, Lorox, Reglone, Daconil, and Admire by ^{32}P-postlabeling. Molecular and Cellular Biochemistry 169:177-184.

Shaw, J.L., and M.J. Hamer. The Toxicity of Diquat, Endothall, and Fluridone to the Early Life Stages of Fish. Journal of Freshwater Ecology 9(3):229-239.

Simonin, H.A., and J.C. Skea. 1977. Toxicity of Diquat and Cutrine to Fingerling Brown Trout. New York Fish and Game Journal 24(1):37-45.

Simsiman, G.V., and G. Chesters. 1976. Persistence of Diquat in the Aquatic Environment. Water Research 10:105-112.

_____, T.C. Daniel, and G. Chesters. 1976. Diquat and Endothall: Their Fates in the Environment. Residue Reviews 62:131-174.

Smith, C.V. 1987. Effect of BCNU Pretreatment on Diquat-induced Oxidant Stress and Hepatotoxicity. Biochemical and Biophysical Research Communications 144(1):415-421.

_____, H. Hughes, B.H. Lauterburg, and J.R. Mitchell. 1985. Oxidant Stress and Hepatic Necrosis in Rats Treated with Diquat. The Journal of Pharmacology and Experimental Therapeutics 235(1):172-177.

Smith, E.H., and D.T. Logan. 1993. Invertebrate Behavior as an Indicator of Contaminated Water and Sediments. Environmental Toxicology and Risk Assessment. 2nd Volume. American Society for Testing and Materials. Philadelphia, Pennsylvania.

Smith, S.N., J.E. Lyon, and I.B. Sahid. 1976. The Breakdown of Paraquat and Diquat by Soil Fungi. New Phytologist 77:735-740.

Singh, S.P., and N.K. Yadav. 1978. Toxicity of Some Herbicides to Major Carp Fingerlings. Indian Journal of Ecology 5(2):141-147.

St. Laurent, D., C. Blaise, P. MacQuarrie, R. Scroggins, and B. Trottier. 1992. Comparative Assessment of Herbicide Phytotoxicity to *Selenastrum capricornutum* Using Microplate and Flask Bioassay Procedures. Environmental Toxicology and Water Quality 7:35-48.

Suleiman, S.A., and J.B. Stevens. 1987. Bipyridylium Herbicide Toxicity: Effects of Paraquat and Diquat on Isolated Rat Hepatocytes. Journal of Environmental Pathology, Toxicology, and Oncology 7:73-84.

Tooby, T.E. 1975. The Risk to Freshwater Fisheries from the Use of Aquatic Herbicides. Lectures Presented at the Fourth FAO/SIDA Training Course on Aquatic Pollution in Relation to Protection of Living Resources. Malins. FAO/SIDA: 155-167. Lysekil, Sweden.

_____, J. Lucey, and B. Stott. 1980. The Tolerance of Grass Carp, *Ctenopharyngodon idella* Val., to Aquatic Herbicides. Journal of Fish Biology 16:591-597.

Tsokos-Kuhn, J.O. 1988. Lethal Injury by Diquat Redox Cycling in an Isolated Hepatocyte Model. Archives of Biochemistry and Biophysics 265(2):415-424.

Vaishampayan, A. 1985. Mutagenicity of a Bipyridylium Herbicide in an N_2-fixing Cyanobacterium *Nostoc muscorum*. Environment International 10(4):285-290.

Vanholder, R., F. Colardyn, J. de Reuck, M. Praet, N. Lameire, and S. Ringoir. 1981. Diquat Intoxication: Report of Two Cases and Review of the Literature. The American Journal of Medicine 70:1267-1271.

Wellborn, T.L., Jr. 1969. The Toxicity of Nine Therapeutic and Herbicidal Compounds to Striped Bass. The Progressive Fish-Culturist 31(1):27-32.

Whiting, T.L., T. Smyri, J.G. Spearman, and S. Kernatz. 2001. Diquat Poisoning of Dairy Cattle by Topical Application. Canadian Veterinary Journal 42:799-801.

Williams, E.H., E.L. Mather, and S.M. Carter. 1984. Toxicity of the Herbicides Endothall and Diquat to Benthic Crustacea. Bulletin of Environmental Contamination and Toxicology 33:418-422.

Winger, P.V., M.J. Imlay, W.E. McMillan, T.W. Martin, J. Takekawa, and W.W. Johnson. 1984. Field and Laboratory Evaluation of the Influence of Copper-diquat on Apple Snails in Southern Florida. Environmental Toxicology and Chemistry 3:409-424.

Wojeck, G.A., J.F. Price, H.N. Nigg, and J.H. Stamper. 1983. Worker Exposure to Paraquat and Diquat. Archives of Environmental Contamination and Toxicology 12:65-70.

Wong, R.C., and J.B. Stevens. 1986. Bipyridylium Herbicide Toxicity In Vitro: Comparative Study of the Cytotoxicity of Paraquat and Diquat Toward the Pulmonary Alveolar Macrophage. Journal of Toxicology and Environmental Health 18:393-407.

Yazar, O., J.M. Shively, and N.D. Camper. 1975. Effects of Selected Herbicides on Bacterial Populations in Nontreated and Treated Water. Water Resources Bulletin 11(2):294-299.

Yeo, R.R. 1967. Dissipation of Diquat and Paraquat, and Effects on Aquatic Weeds and Fish. Weeds 15:42-46.

_____, and N. Dechoretz. 1977. Acute Toxicity of a Herbicidal Combination of Diquat Plus Copper Ion to Eggs, Alevins, and Fry of Rainbow Trout and Two Aquatic Macroinvertebrates. Hyacinth Control Journal 15:57-60.

APPENDIX A.2

TIER II AND III LITERATURE REVIEW FORMS

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 6-3-03 RJP
Title of Paper/Report:	Toxicity of some herbicides to major carp fingerlings
Author(s)	S. P. Singh & N. K Yadav
Journal/Year/Vol:Pages	J. Ecol / 1978 / 5: 141-147

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	/
Genotoxic effects (mutagenic, carcinogenic)	/
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	/
Effects to target plants (efficacy testing)	/
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	/
Mixtures including non-BLM herbicides	/
Marine receptors	/

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	/
Inerts, degradates, metabolite effects	/
Mixtures of any of the five herbicides	/
Indirect effects (food supply, cover)	/

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	No
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No
Were proper controls used and was control performance acceptable?	No
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Study did not apparently follow appropriate scientific procedures - methods mentioned elsewhere (Oser 1971) - presents results in fish as % mortality - don't calc endpts eg. LC_{50}, NOEC, etc

dequat
duran

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-27-03
Title of Paper/Report:	Determination of genotoxicity of the metabolites of the ....
Author(s)	R. G. Shah et al.
Journal/Year/Vol:Pages	Molecular and Cellular Biochem / 1997 / 168: 177-184

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	Yes
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	Yes
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	/
Mixtures including non-BLM herbicides	/
Marine receptors	/

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	NA
Chronic effects (e.g., reproductive) that may affect populations	/
Inerts, degradates, metabolite effects	/
Mixtures of any of the five herbicides	/
Indirect effects (food supply, cover)	/

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	NA
Was the test of proper exposure dose, mechanism, & duration?	/
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	/
Were proper controls used and was control performance acceptable?	/
Are the data presented in a peer-reviewed journal?	/

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection: diquat	

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-27-03
Title of Paper/Report:	Invertebrate behavior as an indicator of contaminated water and sediment
Author(s)	E.H. Smith and D.T. Logan
Journal/Year/Vol:Pages	Environ. Toxicol and Risk Assess./1993/2nd Ed. ASTM STP 1216. pp 48 -

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including **non-BLM** herbicides	
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	2- behavioral
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Unknown
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	N/A
Were proper controls used and was control performance acceptable?	N/A
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection:	Does not appear to present new data; behavioral data discussed - not appropriate for this study

dc 9/04

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-27-03
Title of Paper/Report:	A review article on placental transfer of pesticides
Author(s)	A. K. Salama et al
Journal/Year/Vol:Pages	J. Occup. Med. Toxicol. / 1993 / 2: 383-387

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	Yes
Effects to microorganisms	\
Genotoxic effects (mutagenic, carcinogenic)	\
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	\
Effects to target plants (efficacy testing)	\
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	\
Mixtures including non-BLM herbicides	\
Marine receptors	\

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	N/O
Additional comments regarding acceptance/rejection:	Review - no new data - deals only with placental transfer

digvat

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	RJW 10/15/03
Title of Paper/Report:	Developments in the use of herbicides for the control of aquatic macrophytes
Author(s)	Robson
Journal/Year/Vol:Pages	Water Treatment & Examination 1969 327-337 18(4)

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	↓
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	NA
Chronic effects (e.g., reproductive) that may affect populations	↓
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	not evaluate
Was the test of proper exposure dose, mechanism, & duration?	↓
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	↓
Were proper controls used and was control performance acceptable?	↓
Are the data presented in a peer-reviewed journal?	↓

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	light review · no new data

Dixon

BLM National Vegetation EIS

Literatnre Review Form

Reviewer/Date:	~~HJN~~ 10/11/03
Title of Paper/Report:	Comparative dietary toxicities of pesticides to birds
Author(s)	~~Heath~~ Heath et al
Journal/Year/Vol:Pages	~~Book~~ Pap 1972 No: 152 1-5 ~~+~~

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	NO
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	↓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	5
Chronic effects (e.g., reproductive) that may affect populations	2
Inerts, degradates, metabolite effects	Na
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	↓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	NO - internal review

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection:	USFW pub mod-high ranking

Task 2: Data Evaluation

Reviewer/Date:	LJW 10/4/03
Partial Title of Paper/Report:	Comparative dietary toxicities of pesticides...

Herbicides tested:	diquat diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: ring-neck pheasants (Phasianus colchicus)	
Test Species:	bobwhites quail (Colinus virginianus) mallard (Anas platyrhynchos) Japanese quail (Coturnix coturnix)		
Life Stage:	2-3 wk old birds		
Duration:	5d exposure to diet / 3 d extra for observation		

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	diet (ad libitum) mixed w/ corn oil or propylene glycol
Test Concentrations (if appropriate):	6 concs spaced geometrically
Test System (e.g., flow-thru, mesocosm, etc.):	

1 rep / conc w/ 6-15 birds depending on availability

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints	diquat in dry diet LC50/EC50	diuron LC50	NOEC/NOAEC	LOEC	Other ( )
Endpoint					
Mortality/Survival CV	715	1730			
Growth CL	333	>5000 (14% mort)			
Reproduction PC	634	>5000 (33% mort @ 4200, repellent @ 5000)			
Embryo/Larval Develop. AP	510	>5000 (30% mort)			

Degradates/Inerts:	
Additional Comments and Observations:	- acclimated to untreated diet - stats mentioned

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	ABN 10/13/03
Title of Paper/Report:	Lethal dietary toxicities of environmental pollutants to birds
Author(s)	Hill et al
Journal/Year/Vol:Pages	USFWS Special Scientific Rpt 1975 #191 : 1-61

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic. carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	Y

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	NA
Chronic effects (e.g., reproductive) that may affect populations	|
Inerts, degradates, metabolite effects	|
Mixtures of any of the five herbicides	|
Indirect effects (food supply, cover)	|

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Not evaluated
Was the test of proper exposure dose, mechanism, & duration?	|
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	|
Were proper controls used and was control performance acceptable?	|
Are the data presented in a peer-reviewed journal?	Y

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection:	SAme data as in Heath 1972

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	RBS 10/17/03
Title of Paper/Report:	The tolerance of grass carp Ctenopharyngodon Della Val., to aquatic herbicides
Author(s)	Tooby, Lucey & Stott
Journal/Year/Vol:Pages	J Fish Biol 1980 16:591-597

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	NO
Effects to microorganisms	↓
Genotoxic effects (mutagenic, carcinogenic)	↓
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	↓
Effects to target plants (efficacy testing)	↓
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	↓
Mixtures including non-BLM herbicides	↓
Marine receptors	↓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	3
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	↓
Indirect effects (food supply, cover)	↓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes n=?
Were proper controls used and was control performance acceptable?	NR
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection:	- Nominal Logs - not sure about replication - acetone conc higher than present day guidelines

low-mod rank

Task 2: Data Evaluation

Reviewer/Date:	RJW 10/17/03
Partial Title of Paper/Report:	The tolerance of grass carp, Ctenopharyngodon...

Herbicides tested:	diuron diquat

20 g Mammal	Honey Bee	70 kg ~~Herbivore~~	Large Bird
Small Bird	Aquatic Invertebrate	~~Warmwater Fish~~	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Grass ca. carp	
Test Species:	Ctenopharyngodon idella		
Life Stage:	9.5 cm 15.8 g	1+yr	
Duration:	5d		

Exposure Conditions	
Formulation:	diuron technical grade (>97%) Aquacide diquat formulation
Concentration/amount of active ingredient:	7/100% 13.5%
Medium (water, food, soil, etc.):	water
Test Concentrations (if appropriate):	geometric series
Test System (e.g., flow-thru, mesocosm, etc.):	40L glass aquaria flow-thru (10 L/h)
	10 fish/aq

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	13°C-diuron	Organic Carbon (D or T):	
pH:	8.1	Ammonia:	
Other ( ):	dechlorinated tap H_2O	Other ( ):	
Other (hard):	270 mg/L	Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50** 96h	**IC( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival diquat	1718 (1510-2757)				
Growth diuron	31 (28-34)				
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	- 1 wk acclimation - fed during study - diuron - solvent control (acetone) - 1000 mg/L - highest conc. - also present 24 & 48h LC_{50}s - NOES?

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-20-03
Title of Paper/Report:	Deleterious changes induced by the fungicide ethylenebis et al.
Author(s)	K.V. Prahlad and R.J. Anderson
Journal/Year/Vol:Pages	Cytobios / 1975 / 14:63-74

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	Histopathology
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Yes - Histo.
Mixtures including non-BLM herbicides	Yes
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Mixture incl. non-BLM herbicide

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-20-02
Title of Paper/Report:	Influence of trophic status on the toxic effects of a herbicide: a microcosm study
Author(s)	J. R. Pratt and R. Barreiro
Journal/Year/Vol:Pages	Arch. Environ. Contam. Toxicol. / 1998 / 35: 404-411

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	Yes
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	3- Microbial communities
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	3- Microbes Fo-Food

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	- Only one dose
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection: digest	

BLM National Vegetation EIS

Literatnre Review Form

Reviewer/Date:	Pillard / 5-20-03
Title of Paper/Report:	Effect of sediment on estimates of diquat toxicity . . . .
Author(s)	J.R. Pratt et al.
Journal/Year/Vol:Pages	Water Research / 1990 / 24: 51-57

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	Yes - but also eff. of sed.
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	1
Effects to target plants (efficacy testing)	1
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Yes - Fate w. Sediment
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	Yes - 3 cell growth
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	3

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	~~Yes~~ / NO
Additional comments regarding acceptance/rejection:	Could be very important regarding the effects of sediment on toxicity - results are to microbial community - No further review PBN

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-20-03 KJN
Title of Paper/Report:	Predicting the ecological effects of herbicides
Author(s)	J. R. Pratt et al.
Journal/Year/Vol:Pages	Ecol. Applications / 1997 / 7: 1117-1124

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	NA
Inerts, degradates, metabolite effects	|
Mixtures of any of the five herbicides	|
Indirect effects (food supply, cover)	|

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	NA
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	|
Were proper controls used and was control performance acceptable?	|
Are the data presented in a peer-reviewed journal?	Yes?

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	No, new toxicity data presented — discusses modeling only

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-26-03
Title of Paper/Report:	Effect of diquat on the distribution of iron in Rat Liver
Author(s)	D.W. Reif et al.
Journal/Year/Vol:Pages	Toxicol. Appl. Pharm. / 1988 / 93: 506-510

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	Yes (via Rat studies)
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	/
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	/
Effects to target plants (efficacy testing)	/
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Yes
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	/
Inerts, degradates, metabolite effects	/
Mixtures of any of the five herbicides	/
Indirect effects (food supply, cover)	/

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	No environ. toxicity.

BLM National Vegetation EIS

Literatnre Review Form

Reviewer/Date:	Pillard / 5-26-03
Title of Paper/Report:	Environ. Behavior of Aquatic Herbicides in Sediments
Author(s)	K. H. Reinert
Journal/Year/Vol:Pages	SSSA Special Pub. No 22 / 1989 / 335-348 Soil Science Society of America

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	/
Genotoxic effects (mutagenic, carcinogenic)	/
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	/
Effects to target plants (efficacy testing)	/
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Yes
Mixtures including non-BLM herbicides	No
Marine receptors	/

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	/
Inerts, degradates, metabolite effects	/
Mixtures of any of the five herbicides	/
Indirect effects (food supply, cover)	/

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	NA
Was the test of proper exposure dose, mechanism, & duration?	/
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	/
Were proper controls used and was control performance acceptable?	/
Are the data presented in a peer-reviewed journal?	/

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Does not present toxicity data; does present info on how Flonidone acts in the presence of sediment digest

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-26-03
Title of Paper/Report:	Age-Associated Increase in Ferritin Content of Male Rat Liver . . . .
Author(s)	L. E. Rikans et al.
Journal/Year/Vol:Pages	ARCH Biochem and Biophysics / 1997 / 344:85-93

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	Yes
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Yes
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Effects of isolated cells only.

BLM National Vegetation EIS

Literatnre Review Form

Reviewer/Date:	Pillard 15-26-03
Title of Paper/Report:	Age-Assoc. Enhancement of diquat-induced lipid peroxidation . . .
Author(s)	L. E. Rikans and Y. Cai
Journal/Year/Vol:Pages	The J. of Pharm. Exp. Therapeutics/ 1992/ 262:271-278

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	Yes (Rat Liver)
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	Yes
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	/
Mixtures including non-BLM herbicides	/
Marine receptors	/

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	/
Inerts, degradates, metabolite effects	/
Mixtures of any of the five herbicides	/
Indirect effects (food supply, cover)	/

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Rat liver study only.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-26-03
Title of Paper/Report:	Diquat-Induced Oxidative Damage in BCNU-Pretreated . . . .
Author(s)	L. E. Rikans and Y. Cai
Journal/Year/Vol:Pages	Toxicol Applied Pharm. / 1993 / 118: 263-270

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	Yes
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Yes
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Effects in isolated cells only.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	P. Pillard / 5-26-03
Title of Paper/Report:	Age-related susceptibility to hepatotoxicants
Author(s)	L. E. Rikans and K. R. Hornbrook
Journal/Year/Vol:Pages	Environ. Toxicol. & Pharm. / 1997 / 4: 339-344

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	Yes
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Yes
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	No original data - summarizes previous isolated cell studies

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard/5-26-03
Title of Paper/Report:	Characterizing aquatic ecological risk from pesticides . . . .
Author(s)	A.M. Ritter et al.
Journal/Year/Vol:Pages	ET+C / 2000 / 19:749-759

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclnsion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	|
Inerts, degradates, metabolite effects	|
Mixtures of any of the five herbicides	|
Indirect effects (food supply, cover)	|

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	N/A
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	|
Were proper controls used and was control performance acceptable?	|
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	~~Yes~~ No
Additional comments regard ng acceptance/reject on:	No new data - presents modeling to evaluate possible environ. exposure

Not put in database - no relevant info

Task 2: Data Evaluation

Reviewer/Date:	MJN 10/1/03
Partial Title of Paper/Report:	Characterizing aquatic ecological risks from pesticides...

Herbicides tested:	

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:			
Life Stage:			
Duration:			

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	
Test Concentrations (if appropriate):	
Test System (e.g., flow-thru, mesocosm, etc.):	

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival					
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	- presents physiochemical properties - fate

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-26-03
Title of Paper/Report:	Effect of some herbicides on freshwater algae
Author(s)	T. O. Robson
Journal/Year/Vol:Pages	Pesticide Sci / 1976 / 7: 391-402

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	Possibly - algae
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	2
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	3 - algal Growth

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Only a few
Was the test of proper exposure dose, mechanism, & duration?	No - 1 dose algae
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No
Were proper controls used and was control performance acceptable?	Unknown
Are the data presented in a peer-reviewed journal?	Unknown

Should evaluation of this paper continue in Task 2?	~~No~~ Yes ~~(field data)~~ / conc level
Additional comments regarding acceptance/rejection:	-Only one dose used in a ~~field~~ lab experiment - No statistical analysis

Task 2: Data Evaluation

Reviewer/Date:	RJN 9/30/03
Partial Title of Paper/Report:	Effect of some herbicides on freshwater algae

Herbicides tested:	diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: algae (filamentous)	
Test Species:	Vaucheria dichotoma		
Life Stage:	20 filaments/chamber	15-30 cm long	
Duration:	3 wks		

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	growth media
Test Concentrations (if appropriate):	2 mg/L
Test System (e.g., flow-thru, mesocosm, etc.):	3L

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival					
Growth					
Reproduction					
Embryo/Larval Develop.					
V. dichotoma	all dead after 1 wk @		2 mg/L		

Degradates/Inerts:	
Additional Comments and Observations:	

BLM National Vegetation EIS

Literatnre Review Form

Reviewer/Date:	Pillard / 5-26-03
Title of Paper/Report:	Toxicity Assessment of Pesticides using the Microtox Test . . . .
Author(s)	M. J Ruiz et al.
Journal/Year/Vol:Pages	Bull. Environ Contam Toxicol / 1997 / 59:619-625

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	Yes
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	Yes X (Microtox)

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	2
Inerts, degradates. metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection: Paper only looks @ Microtox effects - No effects to ~~prokary~~ eukaryotes. Liquat	

BLM National Vegetation EIS

Literatnre Review Form

Reviewer/Date:	Pillard / 5-27-03
Title of Paper/Report:	The effect of bipyridyl herbicides on the loss of nutrients from fungi
Author(s)	I. B. Sahid et al.
Journal/Year/Vol:Pages	New Phytologist / 1981 / 89: 401-409

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	/
Genotoxic effects (mutagenic, carcinogenic)	/
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	/
Effects to target plants (efficacy testing)	/
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Yes
Mixtures including non-BLM herbicides	/
Marine receptors	/

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Dealt with how diquat impacts loss of nutrients in fungi - no toxicity data.

BLM National Vegetation EIS

Literatnre Review Form

Reviewer/Date:	P. Pillard / 5-27-03
Title of Paper/Report:	Acute toxicity and some hematological changes in grass carp exposed to diquat
Author(s)	M.A. Salah El-Deen & W.A. Rogers
Journal/Year/Vol:Pages	J. Aquat. Ani. Health / 1992 / 4:277-280

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Partially - No separate trial reps
Were proper controls used and was control performance acceptable?	No evidence of controls in tox test
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	~~No~~ yes
Additional comments regarding acceptance/rejection:	No evidence of controls in the toxicity test; no replicates (presented 96h LC50 so reviewed) MB

Task 2: Data Evaluation

Reviewer/Date:	RJN 8/20/03
Partial Title of Paper/Report:	Acute toxicity and some hematological ...

Herbicides tested:	diquat dibromide

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	(Warmwater Fish)	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	

Test Species:	Grass carp
Life Stage:	$\bar{x}$=235g ± 10.5 cm length (acclimated to lab for 2 wks)
Duration:	96h acute study / 168h biomarker study

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	35.3% a.i.
Medium (water, food, soil, etc.):	
Test Concentrations (if appropriate):	15, 25, 62, 70, & 117 mg/L - 96h exposure
Test System (e.g., flow-thru, mesocosm, etc.):	static (250L tanks)

Test System Monitoring			
Dissolved Oxygen:	>7.4 mg/L	Conductivity:	
Temperature:	20-22°C	Organic Carbon (D or T):	
pH:	7.0-7.6	Ammonia:	
Other (Alk):	26 mg/L	Other (photoperiod):	16h light : 8h dark
Other (hard):	21 mg/L	Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50 96h IC ( )**		**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival	53.0 mg/L	probit analysis 95%CI		46.02-61.05	
Growth					
Reproduction					
Embryo/Larval Develop.					
increased hemtocrit				168h @ 2 mg/L	
"				48h @ 53 mg/L	

Degradates/Inerts:	
Additional Comments and Observations:	- neither exposure scenario (for hemtocrits) altered hemoglobin conc's for 168hrs - off fed 48h prior to exposure. - mortality <10% during acclimation - measured concs of a.i. (no methods presented) - presents LC50 for other species in RED from other studies (on back) - no control data mentioned in 96h acute study

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-27-03
Title of Paper/Report:	Changes in total protein and transaminase activities ...
Author(s)	M. A. Salah El-Deen + W. A. Rogers
Journal/Year/Vol:Pages	J. Aquat. Anim. Health / 1993 / 5: 280-286

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Yes - Biomarkers
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	|
Inerts, degradates, metabolite effects	|
Mixtures of any of the five herbicides	|
Indirect effects (food supply, cover)	|

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	- No toxicity data - biomarker information

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-26-03
Title of Paper/Report:	Toxicities of some herbicides to Six species of freshwater crustaceans
Author(s)	H. O. Sanders
Journal/Year/Vol:Pages	J. W.P.C.F. / 1970 / 42: 1544-1550

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	No
Was the test of proper exposure dose, mechanism, & duration?	Unknown
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No
Were proper controls used and was control performance acceptable?	Unknown
Are the data presented in a peer-reviewed journal?	Unknown

Should evaluation of this paper continue in Task 2?	No 1425
Additional comments regarding acceptance/rejection:	No reps apparently used (found it in text) diquat data not presented – bioassay methods presented elsewhere (Sanders & Cope 1968 & 1969)

Task 2: Data Evaluation

Reviewer/Date:	KZN 8/21/03
Partial Title of Paper/Report:	Toxicities of some herbicides to six species of freshwater crustaceans

Herbicides tested:	diquat diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	(Aquatic Invertebrate)	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Gammarus fasciatus		
Life Stage:	early instar		
Duration:	≤ 96 h		

Exposure Conditions	
Formulation: technical	(Diuron) & emulsifiable concentrate (diquat)
Concentration/amount of active ingredient:	~~Diuron technical~~
Medium (water, food, soil, etc.): dissolved	in EtOH (< 1 ml/L of H_2O)
Test Concentrations (if appropriate):	4-5 not specified (with appropriate controls
Test System (e.g., flow-thru, mesocosm, etc.):	static 4 L of exposure H_2O

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	15.5°C	Organic Carbon (D or T):	
pH:	7.4	Ammonia:	
Other (TDS):	361 mg/L	Other (hardness):	272 mg/L as $CaCO_3$ = 176 mg/L 96 mg/L
Other (Alk):	260 mg/L	Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50,**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival	1.8 (0.80-5.2) (48h) ? Diuron		mg/L		
~~Growth~~ "	0.7 (0.19-8.2) (96h))				
Reproduction					
Embryo/Larval Develop.					
Mortal	> 100 mg/L	for diquat			

~~Alk~~

Data on scud (diquat & diuron) from a # of bioassays → methods not clearly presented

Degradates/Inerts:	
Additional Comments and Observations:	< 10% mortality 4 d prior to testing - n = 1 (?) with 10 organisms/chamber - 2 h acclimation period in chamber prior to intro of herbicide - prelim tests used to set test concs

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-27-03
Title of Paper/Report:	Cytotoxicity of the redox cycling compound diquat . . . .
Author(s)	M. S. Sandy et al.
Journal/Year/Vol:Pages	Arch. Biochem. and Biophysics / 1987 / 259: 29-37

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	/
Genotoxic effects (mutagenic, carcinogenic)	/
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	Yes
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	/
Mixtures including non-BLM herbicides	/
Marine receptors	/

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Does not address toxicity

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-27-03
Title of Paper/Report:	Disposition and toxicokinetics of diquat in channel catfish
Author(s)	I.R. Schultz et al.
Journal/Year/Vol:Pages	Aquatic Toxicol. / 1995 / 33: 297-310

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Yes - Accumulation
Mixtures including non-BLM herbicides	No
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	No - Not much variation in doses
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Unknown
Were proper controls used and was control performance acceptable?	Unable to determine
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes (considered) no tox data
Additional comments regarding acceptance/rejection:	Does include tissue residue data for diquat. Might be useful in ERA & toxicokinetics

Tissue residue
Toxicokinetics

Task 2: Data Evaluation

Reviewer/Date:	RJN 9/25/08
Partial Title of Paper/Report:	Disposition and toxicokinetics of diquat in channel catfish

Herbicides tested:	diquat (C^{14} labelled)

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:			
Life Stage:			
Duration:	6 d		

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	
Test Concentrations (if appropriate):	5 9 20 Mg/ml
Test System (e.g., flow-thru, mesocosm, etc.):	

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival					
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	- steady state plasma conc (0.6 % exposure H_2O) achieved in 24h - steady state tissue conc reached by 72h - highest tissue conc - trunk kidney (100 x that in plasma) - conc in white muscle was low & similar to plasma levels

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-27-03
Title of Paper/Report:	Mutagenic and embryotoxic effects of Paraquat and diquat
Author(s)	A. Selypes et al.
Journal/Year/Vol:Pages	Bull. Environ. Contam Toxicol / 1980/25:513-517

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No, but mostly mutagenic!
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	4- Effects to embryos
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	No
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	No

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	Contains data on mammalian reproductive effects, which could be useful in an ERA.

Task 2: Data Evaluation

Reviewer/Date:	RJN 9/9/03
Partial Title of Paper/Report:	Mutagenic and embryotoxic effects of paraquat and diquat

Herbicides tested:	diquat

CFLP strain male mice for mutagenic exps.

20 g Mammal 35g	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	

Test Species:	CFLP strain mice
Life Stage:	male - mutagenic exps female - teratogenic exps
Duration:	

Exposure Conditions		
Formulation:	Reglone (20% diquat)	SP 4 total doses in 4 small doses
Concentration/amount of active ingredient:	20% diquat	
Medium (water, food, soil, etc.):	OS & IP	
Test Concentrations (if appropriate):	i.p. 22 mg/kg (i.p. LD_{50}) & 1/3 (7.3 mg/kg) 1/6 (3.6 mg/kg) &	
Test System (e.g., flow-thru, mesocosm, etc.):	o.s. 90.0 mg/kg (1/2 LD_{50})	1/30 of LD_{50} (0.73 mg/kg

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints						
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**	
Mortality/Survival	i.p. LD_{50} 22 mg/kg					
~~Growth~~ Survival	o.s. LD_{50} 180 mg/kg					
Reproduction						
Embryo/Larval Develop.						
Mutagenic i.p.			i.p.	1x 22 mg/kg or	2x 7.3 mg/kg or 2x 3.6 mg/kg or	
" o.s.			o.s.	1x 90 mg/kg		5x 0.73 mg/kg
embryonic					11 mg/kg (i.p.)	
Degradates/Inerts:					2x 2.7 mg/kg (i.p.)	
Additional Comments	+ control organisms used in liver cells of embryos diquat (& paraquat) were not mutagenic + diquat had an embryotoxic effect on bone structure of mice at both concs tested 1x 11 mg/kg i.p. & 4x 2.7 mg/kg i.p.					

Nothing put in database

No stats

Mutagenic is eliminated based on criteria.

Can't tell what is sig'ly diff from control

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-27-03
Title of Paper/Report:	Effects of diquat, an aquatic herbicide, on the development ....
Author(s)	C. J. Sewalk et al
Journal/Year/Vol:Pages	J. Toxicol. Environ. Health, Pt. A / 2001 / 62: 33-45

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	4- embryo exposure
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	

Task 2: Data Evaluation

Reviewer/Date:	RSN / 9/9/05
Partial Title of Paper/Report:	Effects of diquat, an aquatic herbicide, on the ...

Herbicides tested:	diquat dibromide

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird Mallard
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Anas platyrhynchos (mallard)		
Life Stage:	eggs		
Duration:	10 S		

Exposure Conditions	
Formulation:	Diquat Herbicide H/A
Concentration/amount of active ingredient:	448 g/L of diquat bromide salt (240 g cation/L)
Medium (water, food, soil, etc.):	distilled H_2O (n=21)
Test Concentrations (if appropriate):	0.88, 3.5, 7, 14, 56 g/L on either day 4 or ~~21~~
Test System (e.g., flow-thm, mesocosm, etc.):	0.88, 3.5 or 7 g/L exposed on day 24 (n=20) of incubation

Test System Monitoring			
Dissolved Oxygen:	N.R.	Conductivity:	N.R.
Temperature:	37.6° C (incubator)	Organic Carbon (D or T):	N.R.
pH:	N.R.	Ammonia:	N.R.
Other (rel. humidity):	70%	Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival	9.6 g/L	for day 4 exposure	NOEC = 3.5	LOEC = 7.0	
~~Growth~~ mortality	12.6 g/L	for day 21 exposure	→ do did not	produce deformities	
Reproduction					
Embryo/Larval Develop.					
growth (~~day~~ exp)	day 4 exp		14 g/L	56	
Mortality day 21d			3.5	7.0	
Growth day 21d			≥ 7.0	—	

Degradates/Inerts:	
Additional Comments and Observations:	- removed weak/dead embryos on day 3 (candling) - included control group - inital range-finding test done previously - ~~day~~ Many biochemical measurements

BLM National Vegetation EIS

Literatnre Review Form

Reviewer/Date:	Pillard / 5-26-03
Title of Paper/Report:	A Rebuttal to: "The toxicity of diquat, Endothall, and Fluridone...."
Author(s)	J. L. Shaw & M. J. Hamon
Journal/Year/Vol:Pages	J. Freshwater Ecol /(19) 10:303-308

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	NA
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	NA
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	No toxicity data are presented - just a rebuttal

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-27-03
Title of Paper/Report:	Toxicity of diquat and cutrine to fingerling Brown trout
Author(s)	H.A. Simonin and J.C. Skea
Journal/Year/Vol:Pages	NY Fish + Game J. / 1977 / 24:38-45

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes - (TLm)
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	?

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	

Task 2: Data Evaluation

Reviewer/Date:	K. NADDY / 9/9/03
Partial Title of Paper/Report:	Toxicity of diquat to cutrine to fingerling BT

Herbicides tested:	Diquat cutrine (7.1% Cu)

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Brown trout		
Life Stage:	40.3 mm fingerlings		
Duration:	96h		

Exposure Conditions	
Formulation:	35.3% diquat dibromide
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	water (spring water)
Test Concentrations (if appropriate):	
Test System (e.g., flow-thru, mesocosm, etc.):	Static 16L (in 20L glass jars)

Test System Monitoring			
Dissolved Oxygen:	5.6 – 11.2 mg/L	Conductivity:	
Temperature:	18.3°C (65°F)	Organic Carbon (D or T):	
pH:	7.5	Ammonia:	
Other (Alk):	100 mg/L	Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival	96h TL$_m$ of 20.4 mg/L	diquat cation			
~~Growth~~	48h TL$_m$ 22.4 mg/L	"			
~~Reproduction~~	24h TL$_m$ 32.6 mg/L	"			
~~Embryo/Larval Develop~~.		96h survival	NOEC < 5.5 mg/L		

Degradates/Inerts:	
Additional Comments and Observations:	- More water chem data presented in Burdick et al 1954 in refs - fish acclimatized for ≥ 7d prior to testing - unfed 3d prior to use - present control Mortality (< 10%) - n=4 (5 fish/jar, 20/trtmnt) - present all data from acute study @ 24, 48 & 96 h - also did (synergistic) mixture of 2 chemicals - report other endpts of diquat tox (on back)

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Dillard / 6-3-03
Title of Paper/Report:	Persistence of diquat in the aquatic environment
Author(s)	G.V. Simsiman and G. Chesters
Journal/Year/Vol:Pages	Water Res / 1976 / 10: 105-112

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Yes
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	N/A
Chronic effects (e.g., reproductive) that may affect populations	N/A
Inerts, degradates, metabolite effects	|
Mixtures of any of the five herbicides	|
Indirect effects (food supply, cover)	|

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	N/A
Was the test of proper exposure dose, mechanism, & duration?	|
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	|
Were proper controls used and was control performance acceptable?	|
Are the data presented in a peer-reviewed journal?	|

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	No toxicity data

BLM National Vegetation EIS

Literatnre Review Form

Reviewer/Date:	Pillard / 5-26-03 PSN
Title of Paper/Report:	~~Residue~~ Diquat and endothall: Their fates in the environment
Author(s)	G.V. Simsiman et al
Journal/Year/Vol:Pages	Residue Reviews / 1976 / 62: 131-174

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	2
Inerts, degradates, metabolite effects	2
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	N/A
Was the test of proper exposure dose, mechanism, & duration?	|
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	|
Were proper controls used and was control performance acceptable?	↓
Are the data presented in a peer-reviewed journal?	Unknown

Should evaluation of this paper continue in Task 2?	Yes No review paper
Additional comments regarding acceptance/rejection:	Paper is a review, with no new data, however, provides a good summary of fate & effects, & some chronic info. CK on original datas / rpts / manuscripts

b) Fish and aquatic invertebrates

Diquat contamination of the aquatic environment through runoff from treated lands and from direct application to control weed nuisances poses concern regarding its effect on aquatic life. Because of this concern studies have been undertaken to determine the toxicity of diquat not only on fish but also on invertebrates. Invertebrates represent an extremely important link in the food chain.

Table IV shows the acute toxicities of diquat to fish. The median tolerance limit (TL_{50}) appears to be influenced by species, exposure time, and water hardness. Certain species tend to be less tolerant to high diquat concentrations in soft water. LAWRENCE *et al.* (1965) found that the threshold toxicity level for diquat on bluegills, largemouth bass, fathead minnows, channel catfish, and rainbow trout was generally in excess of 10 mg/L of the cation. Also, HILTIBRAN (1967) reported that bluegills tolerated 10 mg/L of diquat during a 12-day exposure. WILSON and BOND (1969) studied the acute toxicities of diquat to 5 insect species and an amphipod species (Table IV). The amphipods were very sensitive to low levels of diquat while insects tolerated very high levels of the herbicide. CROSBY and TUCKER (1966) reported median immobilization concentrations (IC_{50}) of 7.1 mg/L diquat to a Cladoceran species, *Daphnia magna*.

Data indicate that the normal recommended rates of diquat (0.5 to 3.0 mg/L) for aquatic weed control appear to be well below the toxicity level for many species of fish and invertebrates. A weed-control experiment in a reservoir demonstrated that addition of diquat up to 1.0 mg/L did not harm smallmouth bass, green sunfish, mosquitofish, and golden shiner minnows (YEO 1967). Similar results were observed in growth pools treated with 0.5 to 4.0 mg/L diquat except for the death of some mosquitofish. No mortality of fingerlings and adult bluegills occurred in artificial growth ponds treated with 1 and 3 mg/L diquat at various frequencies (GILDERHUS 1967). In a 3-year testing of diquat as an aquatic herbicide, rates as high as 2.5 mg/L showed no toxicity to fish (BLACKBURN and WELDON 1963). Diquat application during the spawning season may prove harmful to fish eggs and fry. JONES (1965) reported that 90% of the fry of largemouth bass, bluegills, and channel catfish survived 3 days of exposure to 1, 4, and 10 mg/L diquat, respectively. A diquat concentration of 1.3 to 2.5 mg/L caused the death of bluegill fry, lake chubsucker, and smallmouth bass within 1 to 4 days of exposure (HILTIBRAN 1967). BEASLEY (1966) detected no toxicity of 1 mg/L diquat to eggs of channel catfish.

Although diquat residues have been detected in fish (BEASLEY 1966, GILDERHUS 1967, CALDERBANK 1968), accumulation in tissues and organs is negligible except in the digestive tract. As mentioned earlier, evidence indicates that the ingested chemical is excreted readily as demonstrated by its disappearance when residue-containing fish were transferred to nontreated water.

Table IV. Acute toxicity of diquat to fish and aquatic invertebrates.

Species	Median tolerance limit (TL_{50}) in mg/L			Reference
	24 hr	48 hr	96 hr	
Fish				
Chinook salmon (*Onchorynchus tshawytscha*)	29.5	28.5	—	Bond *et al.* (1960)
Salmon	—	28.5	—	Bohmont (1967)
Bluegills (*Lepomis macrochirus*)	—	—	35[a]	Gilderhus (1967)
Bluegills	—	19[b]	—	Cope (1966)
Bluegills				
In soft water	91	80	72	Surber & Pickering (1962)
In hard water	410	210	140	Surber & Pickering (1962)
Fathead minnows (*Pimephales promelas*)				
In soft water	> 56 to 140	23 to 26	14	Surber & Pickering (1962)
In hard water	260	220	130	Surber & Pickering (1962)
Largemouth bass (*Micropterus salmoides*)				
In soft water	24	11	7.8	Surber & Pickering (1962)
Striped bass (*Roccus saxatilis*)	—	—	80	Wellborn (1969)
Lake emerald shiners (*Notropis atherinoides*)	15.7 to > 180	11.7 to 86.2	9.1 to 25	Swabey & Schenk (1963)
Rainbow trout (*Salmo gairdneri*)	—	—	11.2[a]	Gilderhus (1967)
Rainbow trout	—	20[b]	—	Cope (1966)
Rainbow trout	—	70	—	Alabaster (1969)
Northern pike (*Esox lucius*)	—	—	16[a]	Gilderhus (1967)
Goldfish (*Carassius auratus*)	—	—	35[a]	Gilderhus (1967)
Walleyes (*Stizostedion vitreum*)	—	—	2.1[a]	Gilderhus (1967)
Aquatic invertebrates				
Amphipod (*Hyalella azeteca*)	0.58	0.12	0.048	Wilson & Bond (1969)
Mayfly (*Callibaetis* sp.)	> 100	37	16.4	Wilson & Bond (1969)
Caddisfly (*Limnephilus* sp.)	> 100	65	33	Wilson & Bond (1969)
Tendipedid	> 100	> 100	> 100	Wilson & Bond (1969)
Damselfly (*Enallagma* sp.)	> 100	> 100	> 100	Wilson & Bond (1969)
Dragonfly (*Libellula* sp.)	> 100	> 100	> 100	Wilson & Bond (1969)
Clam (*Cardium edule*)	—	> 10	—	Portmann & Wilson (1971)
Sand shrimp (*Crangon crangon*)	—	> 10	—	Portmann & Wilson (1971)

[a] Data presented as mean lethal concentration (LC_{50}).
[b] Data presented as mean effective concentration (EC_{50}).
— No data available.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 6-4-03
Title of Paper/Report:	Effect of BCNU pretreatment on diquat-induced oxidant stress and hepatotoxicity
Author(s)	C.V. Smith
Journal/Year/Vol:Pages	Biochem. & Biophys. Res. Commun. / 1987 / 144: 415-421

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Primarily *
Mixtures including non-BLM herbicides	No
Marine receptors	No

*Some acute data

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Study targets effects of a chemical on inhibition of hepatic glutathione reductase

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 6-3-03 KJN 9/11/03
Title of Paper/Report:	Oxidant stress and hepatic necrosis in rats treated with digoxt.
Author(s)	C.V. Smith etal.
Journal/Year/Vol:Pages	J. Pharm. Exper. Therapeutics/1985/ 235: 172–177

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Yes - Hepatic Necrosis *
Mixtures including non-BLM herbicides	No
Marine receptors	No

*Also incl. mortality

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	2 (Liver effects)
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes No
Additional comments regarding acceptance/rejection:	Continue evaluation since an acute endpoint → is presented. data are biochemical alterations so no further review

BLM National Vegetation EIS

Literatnre Review Form

Reviewer/Date:	Pillard / 5-27-03
Title of Paper/Report:	The breakdown of paraquat & diquat by soil Fungi
Author(s)	S. N. Smith et al.
Journal/Year/Vol:Pages	New Phytol. / 1976 / 77: 735-740

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	2 - Fungal Growth
Inerts, degradates, metabolite effects	2 4
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Unknown
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No
Were proper controls used and was control performance acceptable?	Unknown
Are the data presented in a peer-reviewed journal?	Yes?

Should evaluation of this paper continue in Task 2?	| No
Additional comments regarding acceptance/rejection:	Study examines CO_2 production in fungus & equates it to degradation

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 6-5-03
Title of Paper/Report:	Comparative assessment of herbicide phytotoxicity . . . .
Author(s)	D. St-Laurent et al.
Journal/Year/Vol:Pages	Environ. Toxicol. & Wat. Qual / 1992 / 7: 35-48

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	Yes *
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

* S. capricornutum, a std. test species

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	2
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	4 - algae

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	

Task 2: Data Evaluation

Reviewer/Date:	RZ- NABD7 9/11/03
Partial Title of Paper/Report:	Comparative Assessment of herbicide phytotox to S.c. ...

Herbicides tested:	diquat dibromide & others (not relevant)

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Algae	
Test Species:	Selenastrum capricornutum		
Life Stage:	4-7 d old cells used for biomass inoculations		
Duration:			

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	stock in milliQ 15 mg/L
Medium (water, food, soil, etc.):	0.625X algal assay procedure medium
Test Concentrations (if appropriate):	n=3
Test System (e.g., flow-thru, mesocosm, etc.):	static · 40 ml in 125 ml Erlenmeyer flask

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	24 ± 2°C	Organic Carbon (D or T):	
pH:		mmonia:	
Other (light):	73 ± 9 $\mu E \cdot m^{-2} \cdot s^{-1}$	Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival					
Growth	34.2 (25.0-43.6)				
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	- comparison betw 2 methods - only interested in EPA method - isolate to ensure purity regularly. - extra care for glassware cleaning discussed - 6 control reps - conc' measured conc - can't not sure if results based on nominal or measured

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 6-5-03
Title of Paper/Report:	Bipyridylium herbicide toxicity: effects of Paraquat and diquat on isolated rat hepatocytes
Author(s)	S. A. Suleiman and J. B. Stevens
Journal/Year/Vol:Pages	J. Environ. Pathology, Toxicol., and Oncology / 1987 / 7: 73-84

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	I
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	Yes
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Yes
Mixtures including non-BLM herbicides	NO
Marine receptors	NO

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection:	Toxicity (dye uptake, loss of cell respiration, etc) to isolated hepatocytes only

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 6-5-03
Title of Paper/Report:	The risk to freshwater fisheries from the use of aquatic herbicides
Author(s)	T. E. Tooby
Journal/Year/Vol:Pages	In: Lectures fr. Training Course / 1975 /

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No	
Are corroborating studies described?	N/A	
Was the test of proper exposure dose, mechanism, & duration?		
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?		
Were proper controls used and was control performance acceptable?		
Are the data presented in a peer-reviewed journal?	No	

Should evaluation of this paper continue in Task 2?	~~Yes~~ No
Additional comments regarding acceptance/rejection:	This is a review paper. It does have acute data for diquat, but it is from Wilson & Bond 1969. Enough primary data should be available.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 6-5-03
Title of Paper/Report:	Lethal injury by diquat redox cycling in an isolated hepatocyte model
Author(s)	J. O. Tsokos-Kuhn
Journal/Year/Vol:Pages	Arch. Biochem. Biophysics / 1988 / 265: 415-424

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	/
Genotoxic effects (mutagenic, carcinogenic)	/
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	Yes
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	/
Mixtures including non-BLM herbicides	/
Marine receptors	/

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Study on isolated cells only.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 6-5-03
Title of Paper/Report:	Mutagenicity of a bipyridylium herbicide in an N_2-fixing cyanobacterium
Author(s)	A. Vaishampayan et al.
Journal/Year/Vol:Pages	Environ. Internat. / 1983 / 10: 285-290

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	Yes
Genotoxic effects (mutagenic, carcinogenic)	Yes
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	/
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	/
Mixtures including non-BLM herbicides	/
Marine receptors	/

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	/
Inerts, degradates, metabolite effects	/
Mixtures of any of the five herbicides	/
Indirect effects (food supply, cover)	/

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Deals only with mutagenicity in a blue-green bacterium

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilliod / 6-5-03
Title of Paper/Report:	Digoxin Intoxication Report of two cases and review of the literature
Author(s)	R. VanHolden et al.
Journal/Year/Vol:Pages	The Amer. J. Med / 1981 / 70: 1267-1271

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	Yes
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	/
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	/
Effects to target plants (efficacy testing)	/
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	/
Mixtures including non-BLM herbicides	/
Marine receptors	/

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	N/A
Chronic effects (e.g., reproductive) that may affect populations	/
Inerts, degradates, metabolite effects	/
Mixtures of any of the five herbicides	/
Indirect effects (food supply, cover)	/

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	N/A
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	/
Were proper controls used and was control performance acceptable?	/
Are the data presented in a peer-reviewed journal?	/

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Human Health only

BLM National Vegetation EIS

Literatnre Review Form

Reviewer/Date:	RJN 10/22/03
Title of Paper/Report:	The toxicity of nine therapeutic and herbicidal compounds to striped bass
Author(s)	Wellborn
Journal/Year/Vol:Pages	The Progressive Fish Culturist ~~##~~ 1969 January 27-32

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	↓
Genotoxic effects (mutagenic, carcinogenic)	↓
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	↓
Effects to target plants (efficacy testing)	↓
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	↓
Mixtures including non-BLM herbicides	↓
Marine receptors	↓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	~~1~~ 3
Chronic effects (e.g., reproductive) that may affect populations	↓
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	↓
Indirect effects (food supply, cover)	↓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	~~yes~~ NR
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection:	– No measured LOAC – ~~Art~~ low - mod rank

Task 2: Data Evaluation

Reviewer/Date:	ASN 10/22/03
Partial Title of Paper/Report:	The toxicity of nine therapeutic and herbicidal ...

Herbicides tested:	diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	striped bass
Test Species:	Roccus saxatilis		
Life Stage:	fingerlings avg wt = 2.7g avg length = 60 mm		
Duration:	96h		

Exposure Conditions	
Formulation:	commercial formulation
Concentration/amount of active ingredient:	3.78 lbs salt/gal : 2 lbs diquat cation
Medium (water, food, soil, etc.):	dechlorinated tap water
Test Concentrations (if appropriate):	5-6 conc
Test System (e.g., flow-thru, mesocosm, etc.):	55L glass aquaria 40L sol'n

10 fish / aquaria n=3 - 2 controls

Test System Monitoring			
Dissolved Oxygen:	7.8 mg/L	Conductivity:	
Temperature:	21°C	Organic Carbon (D or T):	
pH:	8.2	Ammonia:	
Other (hard):	35 mg/L	Other ( ):	
Other (Alk):	64	Other ( ):	

Biological and Statistical Endpoints (96h)					
Endpoint	LC50/EC50	IC (LC) 1%	NOEC/NOAEC	LOEC	Other ( )
Mortality/Survival	20 mg/L	70			
Growth CI	(24-28)				
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	- acclimated for 1 wk prior to testing - stats described - results as commercial formulation - results also at 24 & 48h

Conversion: diquat bromide salt → diquat cation

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 6-10-03
Title of Paper/Report:	Diquat poisoning of dairy cattle by topical application
Author(s)	T. L. Whiting
Journal/Year/Vol:Pages	Canadian Veterinary J. / 2001 / 42: 799-801

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	Yes *
Marine receptors	NO

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	NO
Was the test of proper exposure dose, mechanism, & duration?	|
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	|
Were proper controls used and was control performance acceptable?	|
Are the data presented in a peer-reviewed journal?	Yes ?

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection:	* Accidental application of diquat mail to cows when mixed w insecticide - no dose data.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 6-18-93
Title of Paper/Report:	Toxicity of two herbicides endothall and diquat to benthic crustacea
Author(s)	E. H. Williams et al.
Journal/Year/Vol:Pages	Bull. Environ. Contam. Toxicol / 1984 / 33: 419-422

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	/
Genotoxic effects (mutagenic, carcinogenic)	/
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	/
Effects to target plants (efficacy testing)	/
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	/
Mixtures including non-BLM herbicides	/
Marine receptors	/

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	/
Inerts, degradates, metabolite effects	/
Mixtures of any of the five herbicides	/
Indirect effects (food supply, cover)	/

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	No

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	Proper replicates & controls used.

Task 2: Data Evaluation

Reviewer/Date:	Rami Naddy 8/19/03
Partial Title of Paper/Report:	Toxicity of the herbicide endothall and diquat to benthic crustacea

Herbicides tested:	diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	(Aquatic Invertebrate)	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Hyalella azteca (Scud)	Asellus communis (Sow) – isopod	
Life Stage:	2 1 mm (passed thru 1 mm sieve)	field collected	
Duration:	5d		

Exposure Conditions	
Formulation: diquat dibromide	
Concentration/amount of active ingredient:	0, 1, 3, 10 mg/L / 35.3% a.i.
Medium (water, food, soil, etc.):	water
Test Concentrations (if appropriate):	0, 1, 3, & 10 mg/L
Test System (e.g., flow-thru, mesocosm, etc.):	flow thru 12 L/d, turnover rate of 2.0/d

Test System Monitoring			
Dissolved Oxygen:	10 mg/L	Conductivity:	265-290 µmhos/cm
Temperature:	17°C	Organic Carbon (D or T):	
pH:	6.5 - 7.3	Ammonia:	
Other (light:dark): photoperiod	11:13hr light:dark	Other ( ):	
Other ( ):		Other ( ):	4 reps/conc

Biological and Statistical Endpoints				
Endpoint	**LC50/EC50(48h) IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
(Mortality)/Survival	3.4 for H.a.			20% mortality to A.c. in high treatment
Growth				
Reproduction				
Embryo/Larval Develop.				
control mortality < 10%				
10 amphipods per chamber, 2 or 3 isopods per chamber				

Degradates/Inerts:	
Additional Comments and Observations:	Wilson & Bond 1969 96h tolerance limit of diquat to H. azteca 0.048 mg/l other info in discussion presented as well

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 6-18-03
Title of Paper/Report:	Field and laboratory evaluation of the influence of copper-diquat . . . .
Author(s)	P. V. Wingen et al.
Journal/Year/Vol:Pages	ET&C / 1998 / 3: 409-424

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	/
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	/
Effects to target plants (efficacy testing)	/
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	/
Mixtures including non-BLM herbicides	/ - See Comments
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	? - Not clearly explained
Were proper controls used and was control performance acceptable?	? - Not clearly explained
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection: Most data on copper or copper/diquat combos	

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland/6-22-03
Title of Paper/Report:	Worker exposure to paraquat + diquat
Author(s)	G.A. Wojeck et al.
Journal/Year/Vol:Pages	Arch. Environ. Contam. Toxicol/1983/12:65-70

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	Yes
Effects to microorganisms	NO
Genotoxic effects (mutagenic, carcinogenic)	/
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	/
Effects to target plants (efficacy testing)	/
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	/
Mixtures including non-BLM herbicides	/
Marine receptors	/

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	/
Inerts, degradates, metabolite effects	/
Mixtures of any of the five herbicides	/
Indirect effects (food supply, cover)	/

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	N/A
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection:	Human health, incidental exposure only - generally an indication of no residue.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 6-22-03
Title of Paper/Report:	Bipyridylium herbicide toxicity in vitro: comparative study of the . . . .
Author(s)	R.C. Wong & J.B. Stevens
Journal/Year/Vol:Pages	J. Toxicol. Environ. Health / 1986 / 18:393-407

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	Yes
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	|
Chronic effects (e.g., reproductive) that may affect populations	|
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	|

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	N/A
Was the test of proper exposure dose, mechanism, & duration?	|
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	|
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Isolated Rat cells only.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 6-22-03
Title of Paper/Report:	Effects of selected herbicides on bacterial populations. . .
Author(s)	O. Yazan et al.
Journal/Year/Vol:Pages	Wat. Res. Bull / 1975 / 11: 294 - 299

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	Yes
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	No
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No (No reps)
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Bacteria only; true reps apparently not used; no stats

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 6-22-03
Title of Paper/Report:	Dissipation of diquat & paraquat, and effects on aquatic weeds and fish
Author(s)	R. R. Yeo
Journal/Year/Vol:Pages	Unknown / Unknown / Unknown: 42-46 Weeds 1967 15

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	|
Inerts, degradates, metabolite effects	|
Mixtures of any of the five herbicides	|
Indirect effects (food supply, cover)	|

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	No
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No
Were proper controls used and was control performance acceptable?	No
Are the data presented in a peer-reviewed journal?	Unknown

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection: Proper experimental setup apparently not conducted Mesocosm studies with tox data	

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 6-22-03
Title of Paper/Report:	Acute toxicity of a herbicidal combination of diquat plus copper ion . . . .
Author(s)	R. R. Yoo and N. Dechoretz
Journal/Year/Vol:Pages	Unknown Journal / Unknown Year / Unknown Hyacinth Control Journal 15? ~~57~~: 57-60 p

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	NO
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	Yes
Marine receptors	NO

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	|
Inerts, degradates, metabolite effects	|
Mixtures of any of the five herbicides	|
Indirect effects (food supply, cover)	|

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	N/A
Was the test of proper exposure dose, mechanism, & duration?	|
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	|
Were proper controls used and was control performance acceptable?	|
Are the data presented in a peer-reviewed journal?	Unknown

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection:	Evaluates a mixture only

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-10-03
Title of Paper/Report:	Avoidance chamber responses of mayfly Nymphs. . . .
Author(s)	L. C. Folman
Journal/Year/Vol:Pages	Bull. Environ. Contam Toxic. / 1978 / 19: 312-318

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	3 - Avoidance
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	Not sure
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No
Were proper controls used and was control performance acceptable?	- No Control> No
Are the data presented in a peer-reviewed journal?	No

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection: digital	

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-10-02
Title of Paper/Report:	Acute toxicity of pesticides in adult and weanling rats
Author(s)	T. B. Gaines & R. E. Linder
Journal/Year/Vol:Pages	Fund. & Appl. Toxicol. / 1986 / 7:299-308

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes (LD50
Were proper controls used and was control performance acceptable?	Could not determine
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	

Task 2: Data Evaluation

Reviewer/Date:	Pillard / 7-22-03
Partial Title of Paper/Report:	Acute toxicity of pesticides in adult . . .

Herbicides tested:	diquat bromacil diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	(Other:) Sherman - strain rat	
Test Species:	Rat		
Life Stage:	≥ 90 days (adult tests); 4-6 wks (weanlings)		

Exposure Conditions	
Formulation:	9,10-Dihydro-8a,10a-diazonia phenanthrene dibromide monohydrate
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	Water / oil CAS 638562-2
Test Concentrations (if appropriate):	Multiple doses used, but not presented
Test System (e.g., flow-thru, mesocosm, etc.):	Oral dosing or dermal dosing

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
PpH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

LD50

Biological and Statistical Endpoints					
Endpoint	~~LC50/EC50~~	IC ( )	NOEC/NOAEC	LOEC	Other ( )
Adult ♂ Mortality/Survival Oral	~~27 (26-29) mg/kg~~		147 (138+ 155 mg/kg)		
Adult ♀ ~~Growth~~ Surv. Oral	121 (108 - 136 mg/kg)				
Adult ♂ ~~Reproduction~~ Surv. Dermal	433 (344 - 568)				
Embryo/Larval Develop.					
diuron Adult ♂	1258	adult ♂	791	bromacil	
♀	1182	♀	641		
		weanling ♂	1737		

Degradates/Inerts:	
Additional Comments and Observations:	Oral application as dissolved in water or peanut oil. Diquat in water was used for dermal application.

new 10/8/03 JSN — See Table 2 p 304 for data on bromacil & diuron dermal for both ♂ + ♀ > 2500 mg/kg

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-11-03
Title of Paper/Report:	The w/w SMART assay of Drosophila melanogaster --- .
Author(s)	I. Gaivão et al
Journal/Year/Vol:Pages	Mutation Research / 1999 / 440: 139-145

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	Yes
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Mutation only

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-11-03
Title of Paper/Report:	Sex Differences in Diquat-Induced Hepatic Necrosis & . . .
Author(s)	S. Gupta et al.
Journal/Year/Vol:Pages	Toxicological Sciences / 2000 / 54: 203-211

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	Yes? - using Rats
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Hepatic damage
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Paper only describes a study looking a hepatic damage in rats.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-11-03
Title of Paper/Report:	Effects of herbicides & microbial insecticides on the .....
Author(s)	K. H. Haag & G. R. Buckingham
Journal/Year/Vol:Pages	J. Aquat Plant Manage / 1991 / 29: 55-57

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	|
Inerts, degradates, metabolite effects	|
Mixtures of any of the five herbicides	|
Indirect effects (food supply, cover)	|

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes - 5 reps
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	Mean % mortality in various trmts tested for significance using Students t-test

Task 2: Data Evaluation

Reviewer/Date:	Pillard/ 7-23-03
Partial Title of Paper/Report:	Effects of herbicides and microbial . . .

Herbicides tested:	Diquat*/Fluridone

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	(Aquatic Invertebrate)	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Bagous affinis (weevil); Hydrellia pakistanae (Diptera)		
Life Stage:	B. affinis (adult); H. pakistanae (larva)		
Duration:			

Fluridone	**Exposure Conditions**
Formulation:	1-methyl-3-phenyl-5-[3-(trifluoromethyl) phenyl]-4(1H)-pyridinone
Concentration/amount of active ingredient:	4 lbs Active/gallon
Medium (water, food, soil, etc.):	Water
Test Concentrations (if appropriate):	1.8 L/ha or 3.6 L/ha (4.6 & 9.2 ppm)
Test System (e.g., flow-thru, mesocosm, etc.):	Static?

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival B. affinis			9.2 ppm		
~~Growth~~ Mortality H. pakistanae				4.6 ppm[a]	
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	*Diquat was combined with chelated copper; data are therefore excluded. [a] Death of H. pakistanae may be associated with loss of habitat (hydrilla leaf death) & not direct toxicity.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	~~Halfon~~ Pillard / 5-11-03
Title of Paper/Report:	Selection of Priority Properties to assess environmental . . . .
Author(s)	E. Halfon et al.
Journal/Year/Vol:Pages	Chemosphere / 1996 / 33 : 1543-1562

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	NA
Inerts, degradates, metabolite effects	|
Mixtures of any of the five herbicides	|
Indirect effects (food supply, cover)	|

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	NA
Was the test of proper exposure dose, mechanism, & duration?	|
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	|
Were proper controls used and was control performance acceptable?	|
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Modeling – no new data

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-11-03
Title of Paper/Report:	Effects of a diquat plus cutrine combination on . . .
Author(s)	R.S. Hestand and B.E. May
Journal/Year/Vol:Pages	Hyacinth Control J. / 1972 / 10:40-43

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	Yes
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	Yes - 5
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No
Were proper controls used and was control performance acceptable?	No
Are the data presented in a peer-reviewed journal?	No

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-11-03
Title of Paper/Report:	Toxicity of ten commonly used chemicals to American eels
Author(s)	M. J. Hinton + A. G. Eversole
Journal/Year/Vol:Pages	Proc. Annual Conf. SE Assoc. of Fish and Wildlife Agencies / 1978 / 32: 579-604.

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes (LC50 only)
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Unknown

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	LC50 data should be representative

Task 2: Data Evaluation

Reviewer/Date:	Pillard / 7-23-03
Partial Title of Paper/Report:	Toxicity of ten commonly used . . .

Herbicides tested:	Diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:			
Life Stage:			
Duration:			

Exposure Conditions	
Formulation:	6,7-dihydrodipyrido [1,2-a:2',1'-c] pyrazinediium dibromide
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	Water
Test Concentrations (if appropriate): (mg/L)	0.25, 30.35, 40, 45, 50, 65
Test System (e.g., flow-thru, mesocosm, etc.):	3 L of water - unknown system

Test System Monitoring			
Dissolved Oxygen:	> 40% saturation	Conductivity:	
Temperature:	22° C	Organic Carbon (D or T):	
pH:		Ammonia:	
Other (hardness):	40-48 mg/L $CaCO_3$	Other ( ):	
Other (Alkalinity):	30-35 mg/L $CaCO_3$	Other ( ):	

	96-H **Biological and Statistical Endpoints**				
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival	30.72 (26.85 - 34.43) mg/L				
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-11-03
Title of Paper/Report:	Determination of a Dose-Time-Response Relationships . . .
Author(s)	W-H. Hong et al.
Journal/Year/Vol:Pages	ET&C / 1988 / 7 : 221-226

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Modelling Only
Mixtures including non-BLM herbicides	No
Marine receptors	NO

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	2 - Models Toxicity
Inerts, degradates, metabolite effects	~~NA~~ 1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	NA
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	|
Were proper controls used and was control performance acceptable?	|
Are the data presented in a peer-reviewed journal?	1

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Does not present new data - Modelling only Dajet

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-11-03
Title of Paper/Report:	The effects of the herbicide diquat on Gambusia affini
Author(s)	C. R. Johnson & P. A. Gieke
Journal/Year/Vol:Pages	Proceed & Papers: Annual Conf. Calif. Mosquito Control Assoc. / 1977 / 59-60

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	No - only 1 nom. dose
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	No

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	42% mortality of G. affinis at 12% mortality of ♀ after 48 hr. @ a treatment conc. of .5ppm (nominal), but no analytical chemistry or statistics.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-11-03
Title of Paper/Report:	Mechanisms of Toxicity, Clinical Features, and Management...
Author(s)	G.M. Jones & J.A. Vale
Journal/Year/Vol:Pages	Clinical Toxicology / 2000 / 38:123-128

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	Yes
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	\
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	\
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Yes
Mixtures including non-BLM herbicides	\
Marine receptors	\

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection: - Human health - Toxicity mechanisms only	

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-12-03
Title of Paper/Report:	Genotoxicity testing of five herbicides in the. . . .
Author(s)	B. Kaya et al
Journal/Year/Vol:Pages	Mutation Research / 2000 / 465: 77-84

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	Yes
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Mutagenic effects only diquat

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-12-03
Title of Paper/Report:	Toxicity of diquat pulse exposure to tropical . . . .
Author(s)	S. D. Kevan & R. G. Pearson
Journal/Year/Vol:Pages	Bull Environ. Contam Toxic/1993/564-567

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e. g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	

Task 2: Data Evaluation

Reviewer/Date:	Pillard
Partial Title of Paper/Report:	Toxicity of diquat pulse exposure . . .

Herbicides tested:	Diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	(Aquatic Invertebrate)	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Caridina nilotica		
Life Stage:	Adult		
Duration:	2-h exposure followed by 15 min. in clean water		

Exposure Conditions	
Formulation:	Dig. Dibromide Monohy., ICI Australia Operations
Concentration/amount of active ingredient:	Active Constit: 200g/L Dig. Dibromide Monohydrate
Medium (water, food, soil, etc.):	Water
Test Concentrations (if appropriate): Nominal	62.5, 125, 250, 500 mg Active Constit/Liter
Test System (e.g., flow-thru, mesocosm, etc.):	Static

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	0.200 mS/cm
Temperature:	23.4 ± 0.5°C	Organic Carbon (D or T):	
pH:	7.6	Ammonia:	0.014 mg/L
Other (Turbidity):	1.6	Other (Chloride):	29.8 mg/L
Other (TSS):	<0.5	Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival Test 1	241.7 (178.6-327.2 mg/L)				
~~Growth~~ Survival Test 2	200.4 (154.8-259.3 mg/L)				
~~Reproduction~~ Surv. Test 3	185.9 (146.4-236.8 mg/L)				
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	Measured concn: Test(1): 59.8, 136, 275, 318 mg/L Test 2: 54.4, 113, 265, 389 Test 3: 57.7, 122, 231, ~~69~~ 465 mg/L

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-11-03
Title of Paper/Report:	Interaction of humic substances with bipyridylium herbicides
Author(s)	S. U. Khan
Journal/Year/Vol:Pages	Can. J. Soil Sci / 1973 / 53: 199-204

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Yes
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	No toxicity data. dquit

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-12-03
Title of Paper/Report:	Herbicide inhibition of grass carp - Feeding on Hydrilla
Author(s)	K.M. Kracko & R.L. Noble
Journal/Year/Vol:Pages	J. Aquat. Plant Managm / 1993 / 31: 273-275

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	3 - Feeding rates
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	2

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	No
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	

Task 2: Data Evaluation

Reviewer/Date:	Pillard / 7-24-03
Partial Title of Paper/Report:	Herbicide inhibition of grass carp feeding. . .

Herbicides tested:	Diquat ; Fluridone

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	(Warmwater Fish)	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Ctenopharyngodon idella (Triploid)		
Life Stage:	200-300 mm in length		
Duration:	Microcosms w sediment (Fluridone) + w/o sediment (Diquat)		

Exposure Conditions	
Formulation:	Sonar 5P®
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	Food - Hydrilla
Test Concentrations (if appropriate):	Plants treated w 2 ppm Diquat + 90 ug/L Active Ingred Fluri.
Test System (e.g., flow-thru, mesocosm, etc.):	

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	24°C (Air)	Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival					
Growth					
Reproduction					
Embryo/Larval Develop.					
Reduced Food consumpt	- Diquat			2 ppm	Diquat - Mean.
" " "	- Fluridone			90 ug/L	Fluri - Active Ing

Degradates/Inerts:	
Additional Comments and Observations:	This test indicates that these application rates will reduce consumption of the plant by grass carp. Actual concns in the plants or fish were not measured.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-12-03
Title of Paper/Report:	Inhibition of In vivo and in vitro epoxidation . . .
Author(s)	R. I. Kreiger and P. W. Lee
Journal/Year/Vol:Pages	Arch. Environ. Contam. Toxicol / 1973 / 1: 112-121

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Yes
Mixtures including non-BLM herbicides	Yes
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Interaction of digest on other herbicides only

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-12-03
Title of Paper/Report:	Herbicide-induced radical damage and antioxidative systems . . .
Author(s)	K. J. Kunert and A. D. Dodge
Journal/Year/Vol:Pages (Book)	Target Sites of Herbicide Action / 1989 / Chap. 3 p 45-63

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	Sort of
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	NA
Chronic effects (e.g., reproductive) that may affect populations	|
Inerts, degradates, metabolite effects	|
Mixtures of any of the five herbicides	|
Indirect effects (food supply, cover)	|

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	NA
Was the test of proper exposure dose, mechanism, & duration?	|
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	|
Were proper controls used and was control performance acceptable?	|
Are the data presented in a peer-reviewed journal?	|

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection: A chapter describing mechanisms for toxicity - no new data	dquat

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-13-03
Title of Paper/Report:	A comparison of the effects of paraquat + diquat . . . .
Author(s)	H. F. Lam et al.
Journal/Year/Vol:Pages	Toxicology / 1980 / 18 : 111-123

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No (Rats)
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Yes
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	3 - Body weight
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes - for this study
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	

Task 2: Data Evaluation

Reviewer/Date:	Pillard
Partial Title of Paper/Report:	A comparison of the effects of paraquat . . .

Herbicides tested:	Diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Sprague-Dawley Rats	
Test Species:			
Life Stage:	6-8 weeks old		
Duration:	72 hours		

Exposure Conditions	
Formulation:	Not Given
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	Intratracheal or intraperitoneal
Test Concentrations (if appropriate):	27 mg/kg (i.p.), 0.5 mg/kg (i.t.)
Test System (e.g., flow-thru, mesocosm, etc.):	One-time dose

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival					
Growth				27 mg/kg IP	
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	Appeared to be a decrease in body wt. as soon as 12 hr after treatment. Greatest diff. was seen 72 h after treatment.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-13-03
Title of Paper/Report:	Diquat distribution in water after application to submersed weeds
Author(s)	K.A. Langeland etal.
Journal/Year/Vol:Pages	Wat. Res. Bull / 1994 / 30: 93-97

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	NO
Effects to microorganisms	/
Genotoxic effects (mutagenic, carcinogenic)	/
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	/
Effects to target plants (efficacy testing)	/
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Fate - Yes
Mixtures including non-BLM herbicides	NO
Marine receptors	NO

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	No toxicity data - Fate data only

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard 5-12-03
Title of Paper/Report:	Persistence of diquat, endothall, and Fluridone in ponds
Author(s)	K.A Langeland and J.P. Warner
Journal/Year/Vol:Pages	J. Aquat. Plant Manage./1986/24:43-46

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Yes
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	1
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	NA
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	NA
Were proper controls used and was control performance acceptable?	NA
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection: data only.	No toxicity data - persistance

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-12-03
Title of Paper/Report:	The metabolism of digoxin in hens and residues in eggs and tissues
Author(s)	J.P. Leahey & R.J. Hemingway
Journal/Year/Vol:Pages	Environ. Qual. & Safety Supplement / 1975 / 3:157-162

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	"
Genotoxic effects (mutagenic, carcinogenic)	"
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	"
Effects to target plants (efficacy testing)	"
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Tissue Residue only
Mixtures including non-BLM herbicides	"
Marine receptors	"

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	2(?) Tissue residue
Inerts, degradates, metabolite effects	4
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	No
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	NA
Were proper controls used and was control performance acceptable?	Not apparent
Are the data presented in a peer-reviewed journal?	Yes?

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	Good for possible use in risk assessment

Tissue residues
&
metabolites

Task 2: Data Evaluation

Reviewer/Date:	Pillard
Partial Title of Paper/Report:	The metabolism of diquat in hens . . .

Herbicides tested:	Diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Hen & eggs	
Test Species:	Chicken (hen)		
Life Stage:	Adult / Embryo		
Duration:	4-5 ug/g (2 hens) & 0.4-0.5 ug/g (Hen 3)		

Exposure Conditions	
Formulation:	1,1'-^{14}C-ethylene 2,2'-bipyridylium bromide
Concentration/amount of active ingredient:	29 mCi/mM - Radiochemical Centre, Amst.
Medium (water, food, soil, etc.):	Oral doses. ^{14}C-Diquat
Test Concentrations (if appropriate):	
Test System (e.g., flow-thru, mesocosm, etc.):	

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival					
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	Two metabolites were found in faeces.
Additional Comments and Observations:	(1) Purified to >99.7% purity - Residues, no toxicity data

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-13-03
Title of Paper/Report:	Toxicities of two herbicides (Basagran, Diquat) and an . . . .
Author(s)	Tat-Sing Leung et al.
Journal/Year/Vol:Pages	Environ. Pollut. / 1983 / 30: 153-160

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	Yes - 4 (LC_{10})
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	

Task 2: Data Evaluation

Reviewer/Date:	Pilland / 7-31-03
Partial Title of Paper/Report:	Toxicities of two herbicides . . .

Herbicides tested:	Diquat

20 g Mammal	Honey Bee	~~70 kg Herbivore~~	Large Bird
Small Bird	Aquatic Invertebrate	(Warmwater Fish)	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Mosquitofish (Gambusia affinis)		
Life Stage:	Not given		
Duration:	96 h		

Exposure Conditions	
Formulation:	Technical Grade Diquat (Ortho-Chevron)
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	Water
Test Concentrations (if appropriate):	0-1500 ppm
Test System (e.g., flow-thru, mesocosm, etc.):	Not Given

Test System Monitoring			
Dissolved Oxygen:	8.0 ppm	Conductivity:	
Temperature:	20°C	Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**(LC50/EC50)**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival 96-h	2.89 (3.9-3.29)	ppm			
~~Growth~~ Surv. 24-h	723 (772-820)	ppm			
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	Three reps, good control performance. No indication that concentrations were analytically verified.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-13-03
Title of Paper/Report:	Effects of Selected herbicides on Smolting of Coho Salmon
Author(s)	H. W. Lorz et al.
Journal/Year/Vol:Pages	EPA-600/3-79-071/ 1979/ 102 p

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	No - EPA Report *

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	* EPA report was probably reviewed before it was published

Table 21 (pp 56-57) has large # of refs

Task 2: Data Evaluation

Reviewer/Date:	RSW 10/6/03
Partial Title of Paper/Report:	Effects of selected herbicides ...

Herbicides tested:	diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Coho salmon (Oncorhynchus Kisutch)		
Life Stage:	yearling (12-17 mo old)		
Duration:	96 h & 12-15 d		

Exposure Conditions	
Formulation:	Ortho diquat dibromide
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	water
Test Concentrations (if appropriate):	5 concs
Test System (e.g., flow-thru, mesocosm, etc.):	static fiberglass (0.61 m dia) tanks flow through (1.5 d) → 85-20 of 120L exchanged 1x/d (static renew) n=2 (10 fish/tank) (2 to 22)

Test System Monitoring			
Dissolved Oxygen:	> 8.5 mg/L	Conductivity:	
Temperature:	10°C 9-12.3°C	Organic Carbon (D or T):	
pH:	7.03	Ammonia:	< 0.10 mg/L
Other (hard/alk):	70-83 mg/L	Other ( ):	
Other (alkalinity):	100 85-93 mg/L	Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival 96h	30 mg/L				
Growth 144 h	19 mg/L				
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments	- analytical measurements confirmed (weekly composites) - acclimation ≥ 7 d prior to testing - histological examination of fish. - effect of diquat on downstream migration - see p 56 & 57 for other data - seawater challenge

Stats used to generate LC50s or determine diffs from control assume (or not) ... variate → then ...

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-13-03
Title of Paper/Report:	Interaction of toxicants and communities: The role of nutrients
Author(s)	R. Barreiro Lozano and J.R. Pratt
Journal/Year/Vol:Pages	ET&C / 1994 / 13: 361-368

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	/
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	/
Effects to target plants (efficacy testing)	/
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	/
Mixtures including non-BLM herbicides	Yes interaction w/ nut
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	Yes-4- Chl a concn.
Inerts, degradates, metabolite effects	/
Mixtures of any of the five herbicides	/
Indirect effects (food supply, cover)	3- Food/algae

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Controls used - Perf. not elaborated
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	~~Yes~~ NO
Additional comments regarding acceptance/rejection:	Microcosm study → Microbial communities → Did not use

Task 2: Data Evaluation

Reviewer/Date:	RJW 10/6/03
Partial Title of Paper/Report:	Interaction of toxicants...

Herbicides tested:	diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:			
Life Stage:			

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	
Test Concentrations (if appropriate):	
Test System (e.g., flow-thru, mesocosm, etc.):	

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
PpH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival					
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	endpts are Chl A, protein levels, enzymatic responses alkaline phosphatase activity (APA) & electron-transport-system activity (ETSA) not very useful for this review (?)

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-13-03 RJN
Title of Paper/Report:	Effect on the planktonic community of the chemical program...
Author(s)	A. Lugo et al.
Journal/Year/Vol:Pages	Aquat. Ecosyst. Health Manage. / 1998 / 1: 333-343

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No (Zooplankton)
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	/
Effects to target plants (efficacy testing)	/ water hyacinth
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	/
Mixtures including non-BLM herbicides	/
Marine receptors	/

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	Yes - 3 (Meas. populations)
Inerts, degradates, metabolite effects	/
Mixtures of any of the five herbicides	/
Indirect effects (food supply, cover)	4

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	No
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No
Were proper controls used and was control performance acceptable?	No
Are the data presented in a peer-reviewed journal?	~~Yes~~ Unknown

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Improper controls used. - Unsure of 'real' concentration of herbicide. in situ study digest

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-19-03
Title of Paper/Report:	Lung fibrosis induced by diquat after intratracheal administration
Author(s)	J. Manabe & T. Ogata
Journal/Year/Vol:Pages	Arch. of Toxicol. / 1987 / 60:427-431

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	Yes (via rats)
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	Yes
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	/
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	/
Mixtures including non-BLM herbicides	/
Marine receptors	/

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	/
Chronic effects (e.g., reproductive) that may affect populations	/
Inerts, degradates, metabolite effects	/
Mixtures of any of the five herbicides	/
Indirect effects (food supply, cover)	/

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	/
Are the data presented in a peer-reviewed journal?	/

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Non ecological toxicity.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-20-03
Title of Paper/Report:	Comparative effects of diquat plus copper sulfate on aquatic organisms
Author(s)	B. E. May, R. S. Hostand + J. M. Van Dyke
Journal/Year/Vol:Pages	Weed Sci. / 1973 / 21: 249 - 253

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	Yes
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates. metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection: copper sulfate	comb. of herbicides (diquat + in situ study

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-17-03
Title of Paper/Report:	Manual of acute toxicity: interpretation and data base for 410 chemicals . . .
Author(s)	F.L. Mayer, & M.R. Ellersieck
Journal/Year/Vol:Pages	US DOI, FWS/1986/ Res. Publ. 160

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	|
Inerts, degradates, metabolite effects	|
Mixtures of any of the five herbicides	|
Indirect effects (food supply, cover)	|

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	NA
Was the test of proper exposure dose, mechanism, & duration?	|
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	|
Were proper controls used and was control performance acceptable?	| NR. followed ASTM guidelines
Are the data presented in a peer-reviewed journal?	No

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection: Data base pub - Summarizes many studies	

Task 2: Data Evaluation

Reviewer/Date:	LJN 10/6/03
Partial Title of Paper/Report:	Manual of acute toxic interpretation and...

Herbicides tested:	diquat fluridone diuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	various		
Life Stage:	varies		
Duration:	48 - 96h		

Exposure Conditions	
Formulation: diquat 35.3%	Summary of many studies
Concentration/amount of active ingredient:	fluridone (98% tech + 41% liquid)
Medium (water, food, soil, etc.):	water
Test Concentrations (if appropriate):	NR
Test System (e.g., flow-thru, mesocosm, etc.):	static / static renewal / flow through

Test System Monitoring			
Dissolved Oxygen:	various in ug/l	Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival	2800 - 9500 µg/L	Bluegill	Diuron		
Growth	115,000 - 498,000 µg/L		Diquat		
Reproduction					
Embryo/Larval Develop.			Diquat 18	LC50s	p 179
			fluridone 24	"	p 245
			diuron 48	LC50s	p 182

Degradates/Inerts:	
Additional Comments and Observations:	also list 24 & 48h data for some studies

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	~~EFF~~ Pillard / 5-20-03
Title of Paper/Report:	Effects of diquat on freshwater microbial communities
Author(s)	A. L. Melendez et al.
Journal/Year/Vol:Pages	Arch. Environ. Cont. Toxicol / 1993 / 25: 95-101

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	Yes
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	/
Effects to target plants (efficacy testing)	/
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	/
Mixtures including non-BLM herbicides	/
Marine receptors	/

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	4 (algal populations)
Inerts, degradates, metabolite effects	/
Mixtures of any of the five herbicides	/
Indirect effects (food supply, cover)	3 - algae

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	micro- ~~meso~~cosm study; includes effects to algae, diatoms, protists

Task 2: Data Evaluation

Reviewer/Date:	RSN 10/6/03
Partial Title of Paper/Report:	

Herbicides tested:	diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	microorganism assemblage
Test Species:	various green algae, diatoms		did not identify spc
Life Stage:			allowed to colonize for 25c
Duration:	21-d post-treatment		

Exposure Conditions	
Formulation:	Diquat H/A
Concentration/amount of active ingredient:	35.3% a.i.
Medium (water, food, soil, etc.):	₱ water (7L)
Test Concentrations (if appropriate):	5 conc + Ctrl (0, 0.3, 1, 3, 10 & 30 mg/L)
Test System (e.g., flow-thru, mesocosm, etc.):	~~Aquatic~~ microcosm static 35 x 25 x 15 cm PE tanks

n=3 5 pts (1 L) | microcosm

Test System Monitoring			
Dissolved Oxygen:	NR.	Conductivity:	
Temperature:	22.4°C (18.9 - 27.5°C)	Organic Carbon (D or T):	
pH:	9.1	Ammonia:	
Other (light):	5000 lux	Other (hard):	39 mg/L
Other (photo period):	12h light : 12h dark	Other (alk):	37 mg/L

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival					
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	- Measured diquat concs. after 14d post exposure to 10 & 30 mg/L nt - some algal sp. bloomed - good for insitu analysis

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-13-03
Title of Paper/Report:	The toxicity to Fish of diquat - copper sulphate mixtures
Author(s)	R.J. Morrison
Journal/Year/Vol:Pages	Fish. Aquat. J. / 1978 / 40:105

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	No Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No
Were proper controls used and was control performance acceptable?	No
Are the data presented in a peer-reviewed journal?	No

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillad /5-20-03
Title of Paper/Report:	Toxicity of selected chemicals to the fairy shrimp . . . .
Author(s)	J. L. Moss
Journal/Year/Vol:Pages	The Progressive Fish-Culturist / 1978 / 40: 158-160

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	No
Was the test of proper exposure dose, mechanism, & duration?	No
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No
Were proper controls used and was control performance acceptable?	No
Are the data presented in a peer-reviewed journal?	No

Should evaluation of this paper continue in Task 2?	~~No~~ Yes
Additional comments regarding acceptance/rejection:	Statistical analysis = plotting linear regression of time against arcsin transformation of % mortality 6D Control mortality @ 18%.

Task 2: Data Evaluation

Reviewer/Date:	KJN 10/6/03
Partial Title of Paper/Report:	Toxicity of selected chemicals to the ...

Herbicides tested:	Diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	fairy shrimp (Streptocephalus sealii)		
Life Stage:	Adult		
Duration:	48h		

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	35.3 ?. a.i.
Medium (water, food, soil, etc.):	
Test Concentrations (if appropriate):	
Test System (e.g., flow-thru, mesocosm, etc.):	glass gallon jars

n=3 25 organisms/chamber

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	24±1 °C	Organic Carbon (D or T):	
pH:	8.5	Ammonia:	
Other (hard):	120 mg/L	Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival	>2.0 mg/L		2.0 mg/L		
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	control mortality > 10% (18.1% @ 48h)

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-20-03
Title of Paper/Report:	Responses and LC_{50} values for selected microcrustaceans . . .
Author(s)	S. M. Naqvi and R. H. Hawkins
Journal/Year/Vol:Pages	Bull. Environ. Contam. Toxicol / 1989 / 43: 386-393

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	NO
Effects to microorganisms	Yes (Multicellular Crust.)
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	\
Effects to target plants (efficacy testing)	\
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	\
Mixtures including non-BLM herbicides	\
Marine receptors	\

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	(
Indirect effects (food supply, cover)	4 - Zooplankton

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No reps - LC_{50}'s
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	No

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	

Task 2: Data Evaluation

Reviewer/Date:	RJH 10/5/03
Partial Title of Paper/Report:	Responses and LC50 values for ...

Herbicides tested:	Hurricane (Sonar®)
	diquat dibromide (Weedtrine DP) oust (sulfometuron methyl)

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte) (D. polymorphus sp)	Other:	
Test Species:	copepod (Eucyclops sp) cladocerans (Alonella sp) ostracod (Cypria sp)		
Life Stage:			
Duration:	48 h		

100-150 organisms/jar n=3	**Exposure Conditions**
Formulation:	
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	
Test Concentrations (if appropriate):	Sonar 1.0 - 25 mg/L / diquat 12 - 100 mg/L/ oust 100-2 mg/L
Test System (e.g., flow-thru, mesocosm, etc.):	3.8 L jars w/ 3 L soln

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		mmonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints (Sonar / oust / diquat)					
Endpoint	**LC50/EC50**	**IC50**	**NOEC/NOAEC**	**~~LOEC~~**	**Other ( )**
~~Mortality/Survival~~ Eucy	8.0 mg/L	1320 mg/L		~~<10.0~~	46.6 mg/L
Growth Alga	13.0	802		<10.0	
Reproduction Cypria	13.0	2241		13.8 mg/L	
Embryo/Larval Develop.					?
Diaptomus	12.0	1315		<10.0	

Degradates/Inerts:	
Additional Comments and Observations:	- Mortality rates of controls acceptable for acclimation & testing - organisms acclimated 96h prior to testing - no solvents used for mixing - field collected organisms

BLM National Vegetation EIS

Literatnre Review Form

Reviewer/Date:	Pillard / 5-20-07
Title of Paper/Report:	Toxicities of paraquat + diquat herbicides to freshwater . . . .
Author(s)	S. M. Naqvi et al
Journal/Year/Vol:Pages	Bull. Environ. Contam Toxicol / 1980 / 25: 918-920

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	/
Genotoxic effects (mutagenic, carcinogenic)	/
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	/
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	/
Marine receptors	/

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	/
Inerts, degradates, metabolite effects	/
Mixtures of any of the five herbicides	/
Indirect effects (food supply, cover)	/

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes (LC 50)
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	NO

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	

Task 2: Data Evaluation

Reviewer/Date:	MBN 10/5/03
Partial Title of Paper/Report:	Toxicities of paraquat & diquat herb...

Herbicides tested:	diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte),	Other: Zooplankton	
Test Species:	Copepod (Diaptomus sp & E. cyclops)		
Life Stage:	comprised 90% of population ↓10% of pop.		
Duration:	48 h		

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	water
Test Concentrations (if appropriate):	0, 5, 10, 20, 30, 50, 60, 70, 90, 100, 120, 140 mg/L
Test System (e.g., flow-thru, mesocosm, etc.):	

n=3 Test System Monitoring			
Dissolved Oxygen:	5.62 ~~6.3~~ mg/L	Conductivity:	
Temperature:	18°20-22°C	Organic Carbon (D or T):	
pH:	6.5-7.0	Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

48 h Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival	19 (12-28) mg/L				
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	~~field~~ collected organism acclimated to lab for 96 h prior to testing - also report 24 h values + do not discuss effect on individual sp. genera - do not discuss measured values - not sure of what were? - stock soins prepared fresh each time - static renewal? - cols's aerated continuously

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-20-03
Title of Paper/Report:	Binding of diquat and paraquat to humic acid in aquatic environments.
Author(s)	D. R. Marinus and R. D. Goy
Journal/Year/Vol:Pages	Soil Science / 1982 / 133; 356 - 363

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms		
Genotoxic effects (mutagenic, carcinogenic)		
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)		
Effects to target plants (efficacy testing)		
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Yes
Mixtures including non-BLM herbicides	No
Marine receptors	NO

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	N/A
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?		
Were proper controls used and was control performance acceptable?	↓
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	No Tox data

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-20-03
Title of Paper/Report:	Toxicity of diquat to the crustacean amphipod . . . .
Author(s)	S. A. Nicholson and R. J. Clerman
Journal/Year/Vol:Pages	Environ. Letters / 1974 / 7:215-227

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	3 (Hyalella is food for some fish)

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	TLm is given
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Unknown

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	~~Need to acquire missing~~

low rank

Task 2: Data Evaluation

Reviewer/Date:	AJN 10/5/03
Partial Title of Paper/Report:	Toxicity of diquat to the crustacean amphipod ...

Herbicides tested:	ai diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Hyalella Hyalella sp. (likely H. azteca) subsample		
Life Stage:			
Duration:	(108 h → control survival problems) 48-h data - ok		

Exposure Conditions	
Formulation:	ortho commercial product
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	water
Test Concentrations (if appropriate):	0.30 - 4.02 mg/L (cation)
Test System (e.g., flow-thru, mesocosm, etc.):	600 ml beakers

10 Hyalella / beaker

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	20° C	Organic Carbon (D or T):	
pH:	7.06 - 8.90	Ammonia:	
Other (Alk):	44.4 - 55.7	Other (Hrd):	7.7 mg/L
Other (Ca):	17.6 - 26.5 mg/L	Other (light:dark):	12h : 12h

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival	24h TL_{50} = 1.26 mg/L	(0.67 mg/L cation)			LC 7 lake water
Growth			≥ 1.00 @ 48h		
Reproduction			(4 mg/L @ 48h in tap water		
Embryo/Larval Develop.					
			No statistical interp (AJN)		

Degradates/Inerts:	
Additional Comments and Observations:	Poor survival in controls @ 108hrs (60%) (92% @ 24h), & 92% @ 48h

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-20-03
Title of Paper/Report:	Ocular injury caused by preoglox-4, a herbicide containing
Author(s)	M. Mirei et al.
Journal/Year/Vol:Pages	Jpn. J. opthalmol / 1993 / 37: 43-46

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	Yes
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	human impacts only

BLM National Vegetation EIS

Literatnre Review Form

Reviewer/Date:	Pillard / 5-20-03
Title of Paper/Report:	Effect of a herbicidal control of water hyacinth. . . .
Author(s)	V. F. Olaleye and E. A. Akintunde
Journal/Year/Vol:Pages	J. Environ. Manage/ 1993 / 38 : 85-97

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	2 - In situ studies
Inerts, degradates, metabolite effects	|
Mixtures of any of the five herbicides	|
Indirect effects (food supply, cover)	|

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	?
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes - Little stats data
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes ?

Should evaluation of this paper continue in Task 2?	~~Yes~~ Yes NO
Additional comments regarding acceptance/rejection:	in situ study results only deal w/ fish (ie. numbers pre & post spraying) digital RS

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard /5-20-03
Title of Paper/Report:	The toxicity of diquat, endothall, and fluridone to the . . . .
Author(s)	E.A. Paul et al.
Journal/Year/Vol:Pages	J. Freash. Ecol. / 1994 / 9: 229-

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	|
Mixtures of any of the five herbicides	|
Indirect effects (food supply, cover)	|

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Controls not mentioned
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	

Task 2: Data Evaluation

Reviewer/Date:	RBN 10/3/03
Partial Title of Paper/Report:	The toxicity of diquat, endothall, and fluridone ...

Herbicides tested:	diquat fluridone

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	(Warmwater Fish)	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: smallmouth bass (M. dolomieu)	
Test Species:	Walleyes (Stizostedion vitreum) largemouth bass (Micropterus salmo		
Life Stage:	Walleye 3 age groups 1) 8-10 d posthatch 2) 41-43d posthatch 3) 84-86 d pH		
Duration:	96 h		

Exposure Conditions	
Formulation:	commercial formulations Diquat HA (Valent) / Sonar
Concentration/amount of active ingredient:	240g diquat cation / L / 479 g fluridone / L
Medium (water, food, soil, etc.):	
Test Concentrations (if appropriate):	
Test System (e.g., flow-thru, mesocosm, etc.):	Static non-renewal 2L glass w/ 1.5L soln

n=3, 84-d Walleye n=2 — 84-d Walleye 20L jars w/ 16L soln

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	~~15.6°C ± 0.5°C~~	Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

see back for info

96 h mg/L — Biological and Statistical Endpoints — 96 h

Endpoint	LC50/EC50	~~IC ( )~~	NOEC/NOAEC	LOEC	Other ( )	
~~Mortality/Survival~~	0.75		0.48	0.93	Walleye 8-10 d	diquat
~~Growth~~	1.5		0.90	1.9	" 41-43 d	
Reproduction	4.9		2.6	4.4	" 84-86 d	
~~Embryo/Larval Develop.~~	3.9		1.6	3.4	SMB	
	4.9		1.8	3.6	LMB	
	1.8		0.78	1.2	Walleye 8-12 d	fluridone
	7.6		4.5	6.2	SMB 4-8	
Degradates/Inerts:	13		9.6	12	LMB 10-14	

Additional Comments and Observations:	- analytical confirmed at beginning & end of each exp. - present analytical methods - ½ life study (photolysis/hydrolysis of diquat) - no appreciable decrease over 4-8 - also present 24, 48 & 72 h values (LC50s & NOEC/LOECs)

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-20-03
Title of Paper/Report:	Toxicity of hoxazinone and diquat to green algae, ...
Author(s)	H. G Peterson et al.
Journal/Year/Vol:Pages	Aquat. Toxicol / 1997 / 39: 111-134

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	1 (some microcosm)
Genotoxic effects (mutagenic, carcinogenic)	/
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	/
Effects to target plants (efficacy testing)	/
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	Yes - 3 - Plant Growth
Inerts, degradates, metabolite effects	/
Mixtures of any of the five herbicides	/
Indirect effects (food supply, cover)	3- Plant

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes - but minimal
Were proper controls used and was control performance acceptable?	Unknown
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	- other data presented in discussion - see p 129

Task 2: Data Evaluation

Reviewer/Date:	RJN 10/3/03
Partial Title of Paper/Report:	Toxicity of hexazinone and diquat to green algae, diatoms...

Herbicides tested:	diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	~~Aquatic Plant (Macrophyte)~~	Other: algae / diatoms / cyanobacteria	not presented here
Test Species:	diatom: Nitzschia Cyclotella meneghiana algae: Scenedesmus quadricauda Selenastrum capricornutum		Lemna minor
Life Stage:	L.m. 3 mature leaves / plant		
Duration:	7d L. minor	Algae 6h preincubation w/ pest, 16h incubation w/ pest	

Exposure Conditions	
Formulation:	technical
Concentration/amount of active ingredient:	25% diquat ion ; (Table 2)
Medium (water, food, soil, etc.):	ASTM Type I & culture Lemna only
Test Concentrations (if appropriate):	EC07 0.5% 5% 50% 100% 0.73 mg/L → 0.367 mg/L 3.67, 36.7, 367, 733 µg/l
Test System (e.g., flow-thru, mesocosm, etc.):	algae 7ml borosilicate glass Microplates - L.m.

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	25°C / 15°C for diatoms	Organic Carbon (D or T):	
pH:		Ammonia:	
Other (light):	75 ~~µE~~ µmol m^{-2} s^{-1}	Other ( ):	
Other (photoperiod):	24h light	Other ( ):	

algae n = 3 / repeated 2x L.m. n=3-84

Biological and Statistical Endpoints						
Endpoint	**LC50/EC50** (mg/L)	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**	
Mortality/Survival	C.m. 97					
Growth	Nitz sp. 65					
Reproduction	Sq 652					
Embryo/Larval Develop.	Sc 492					
	L.m. 4					

Degradates/Inerts:	
Additional Comments and Observations:	- fraction of measured concentrations, i.e. Concentrations measured - endpts algae: ^{14}C uptake - inhibition of L.minor: increase in leaf #

- other data in discussion (on back) refs

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-20-03
Title of Paper/Report:	Aquatic phyto-toxicity of 25 pesticides applied at expected . . . .
Author(s)	H. G. Peterson et al.
Journal/Year/Vol:Pages	Aquat. Toxicol. / ~~23~~ 1994 / 28 : 275-292

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	3- Plant Growth
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	3 - Algae, duckweed

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Not presented
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	-only test 1 conc - Est environ. conc.

Task 2: Data Evaluation

Reviewer/Date:	ASN 10/3/03
Partial Title of Paper/Report:	Aquatic phyto-toxicity of 23 pesticides applied at expected...
Herbicides tested:	~~Sulfometuron-methyl~~ ~~Sulfometuron methyl~~ metsulfuron-methyl (oust) tebuthiuron diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	~~Aquatic Invertebrate~~	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: diatoms algae & cyanobacteria	not incluc
Test Species:	diatoms: Cyclotella meneghiana Nitzschia sp. algae: Scenedesmus quadricauda Selenastrum capricornutum		Lemna minor (duck wee
Life Stage:	L. minor (3 mature leaves / plant)		
Duration:	7-d (L. minor)	72h algae	6h incubation w/ pesticide 16h incubation w/ 14C

Exposure Conditions	
Formulation:	technical / analytical grade
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	
Test Concentrations (if appropriate):	3 µg/L Oust / 0.733 mg/L diquat / 5.867 mg/L teb
Test System (e.g., flow-thru, mesocosm, etc.):	algae test tube 7ml / L. minor 12ml Microplat

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other (reps):	n=3 algae n=4 duckw	Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	~~LC50/EC50~~	IC ( )	NOEC/NOAEC	LOEC	~~Other~~ ( )
Mortality/Survival	Species	% Inhibition		% Inhibition (tebuthiuron)	
Growth	S. capri	27 *	3 Oust	~~Chl~~ C.M.	98% *
Reproduction	L. minor	63 *	30 Oust	N.sp	99% *
Embryo/Larval Develop.	C. m.	99 *		S.q.	90 *
	N. sp	100 *		S.c.	100 *
	S.q.	53 * Oust diquat		L.m.	100 *
	S.c.	69 *			
	L.m.	100 *			

Degradates/Inerts:	
Additional Comments and Observations:	~~one~~ ~~was uptake of herbicides at est. environ. conc.~~ one conc (EEC) was tested - compared to control - endpts Algae: uptake of ^{14}C L.minor: increase in # leaves

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-20-03
Title of Paper/Report:	Review of strategies for modeling the environmental fate . . .
Author(s)	V. Petit et al.
Journal/Year/Vol:Pages	Environ. International / 1995 / 21: 167-176

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Yes
Mixtures including non-BLM herbicides	No
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection: Digest	No new toxicity data - modeling only

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-20-03
Title of Paper/Report:	Effect of the herbicide diquat on the growth of . . . .
Author(s)	E. J. Phlips et al.
Journal/Year/Vol:Pages	Bull. Environ. Contam Toxicol / 1992 / 49: 750-756

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	Yes
Genotoxic effects (mutagenic, carcinogenic)	/
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	/
Effects to target plants (efficacy testing)	/
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	/
Mixtures including non-BLM herbicides	/
Marine receptors	/

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	4- Cell Growth
Inerts, degradates, metabolite effects	/
Mixtures of any of the five herbicides	/
Indirect effects (food supply, cover)	3- Algae

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes - EC_{50}
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection: Deals with Algae only, but may play a role in an ERA.	

Task 2: Data Evaluation

Reviewer/Date:	KJN 10/3/03
Partial Title of Paper/Report:	Effect of the herbicide diquat on the growth of microalgae...

Herbicides tested:	diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	algae? diatoms... Navicula sp. euglenoa (Euglena gracilis) Chlorella vulgaris Selenastrum capricornutum Ictonema costatum		
Life Stage:			
Duration:	10-d test only 3- & 7-d data presented		

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	400 ml culture media modified Hoaglands
Test Concentrations (if appropriate): n=3	0, 12, 23, 46, 92, 184, 368, 735, 1,470, 2,940 µg
Test System (e.g., flow-thru, mesocosm, etc.):	

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	25°C	Organic Carbon (D or T):	
pH:	7.0	Ammonia:	
Other (light):	100 µmol photons m⁻² s⁻¹	Other ( ):	
Other ( ):		Other (T):	

IC 25 = 25% of inhibition IC 100 results de for cell density

Biological and Statistical Endpoints						
Endpoint		~~LC50~~/~~EC50~~	~~IC 20~~/IC 10	~~NOEC~~/NOAEC	~~LOEC~~	Other ( )
~~Mortality~~/Survival	CV	307	<92	154	—	
Growth	SC	47	<24	32	75?	
Reproduction						
~~Embryo~~/Larval Develop.		EC50	~3-d growth			
	CV	>2940				
	SC	22 (12-77)				

Degradates/Inerts:	
Additional Comments and Observations:	endpts: cell #, chlorophyll also report ~~E~~EC0, ~~E~~C 25, ~~E~~C100 for three days of exposure

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 8 May 2003
Title of Paper/Report:	Dominant lethal studies with Paraquat & Diquat in male CD-1 Mice
Author(s)	D. Anderson et al.
Journal/Year/Vol:Pages	Mutation Research / 1976 / 40 : 349-358

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No (Incl. Mutagenicc)
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reporductive) that may affect populations	5 (fertility)
Inerts, degradates, metabolite effects	~~No~~ 1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	Discusses fertility & implantation success which has a direct impact on Population.

Task 2: Data Evaluation

Reviewer/Date:	Pillard
Partial Title of Paper/Report:	Dominant lethal studies with. . . .

Herbicides tested:	Diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	CD-1 Mice, Mus musculus?		
Life Stage:	8- 12 weeks old		
Duration:	5 oral doses (1 dose/day); obs. for 3 weeks		

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	28.6% (w/v)
Medium (water, food, soil, etc.):	Oral doses
Test Concentrations (if appropriate): 0.01,	0.10 1.0 ~~0.0~~ mg/kg body wt
Test System (e.g., flow-thru, mesocosm, etc.):	Oral doses

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival - Early deaths of pups, females			1.0 mg/kg		
Growth					
Reproduction					
Embryo/Larval Develop.					
Mating Success			1.0 mg/kg		
Pregnancy Success			1.0 mg/kg		

Degradates/Inerts:	
Additional Comments and Observations:	No sign. deleterious effects up to 1.0 mg/kg

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 6 May 2003
Title of Paper/Report:	The deleterious effects of fungicides and herbicides on Xenopus laevis embryos
Author(s)	R. J. Anderson and K. V. Prahlad
Journal/Year/Vol:Pages	Arch of Environ. Contam. Toxicol / 1976 / 4: 312-323

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reporductive) that may affect populations	3
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	No
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No (No indication of reps.)
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Perhaps
Additional comments regarding acceptance/rejection:	

Task 2: Data Evaluation

Reviewer/Date:	Pillard 6/30/03
Partial Title of Paper/Report:	The deleterious effects of . . .

Herbicides tested:	diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Amphibian	
Test Species:	Xenopus laevis		
Life Stage:	< 24 h embryos		
Duration:	5 days		

Exposure Conditions	
Formulation:	Technical grade
Concentration/amount of active ingredient:	~~0.5~~
Medium (water, food, soil, etc.):	Water
Test Concentrations (if appropriate):	0.5, 0.75, 1.0, 1.25, 1.5, 2.0 ppm
Test System (e.g., flow-thru, mesocosm, etc.):	Static?

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival			=0.5 ppm (1)	0.75 ppm (1)	
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	(1) Concentrations are based on visual examination of figures. No stats apparently run. Could calculate an LC50 from data.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Fillard / 7 May 2003
Title of Paper/Report:	Changes in protein content and activity of aspartate - - - .
Author(s)	A. Anguelov et al
Journal/Year/Vol:Pages	Veterinarski Arhiv / 1997 / 67: 253-260

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reporductive) that may affect populations	2
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	No
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No
Were proper controls used and was control performance acceptable?	No
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Unable to determine if replicates were used or if a control was included. No chronic effects

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 8 May 2003
Title of Paper/Report:	Effect of Aquatic Plant control on the Microdistribution . . .
Author(s)	M. B. Bain + S. E. Boltz
Journal/Year/Vol:Pages	Trans. Amer. Fish. Soc./1992/121:94-103

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	Yes
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates. metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Application included diquat + Komeen (copper ethylene diamine complex).

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-8-03
Title of Paper/Report:	Chronic action of diquat on lungs
Author(s)	A.I. Bainova & V.S. Vulchova
Journal/Year/Vol:Pages	Comptes rendus de l'Académie bulgare des Sciences / 1978 / 31: 1369 – 1372

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	Yes ?
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Unable to determine
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Unable to determine
Were proper controls used and was control performance acceptable?	Unable to determine
Are the data presented in a peer-reviewed journal?	Unknown

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-8-03
Title of Paper/Report:	An ecosystem model for assessing ecological risks in Quebec rivers, lakes, & reservoirs
Author(s)	S. M. Bartell et al.
Journal/Year/Vol:Pages	Ecological Modeling / 1999 / 124: 43-67

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reporductive) that may affect populations	3 (Modeling only)
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	NA
Was the test of proper exposure dose, mechanism, & duration?	NA
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	NA
Were proper controls used and was control performance acceptable?	NA
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Possibly
Additional comments regarding acceptance/rejection:	This presents a modeling approach for translating laboratory test results to the field- may have some application for discuss.

Task 2: Data Evaluation

Reviewer/Date:	Dillard
Partial Title of Paper/Report:	An ecosystem model for assessing. . .

Herbicides tested:	

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:			
Life Stage:			
Duration:			

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	
Test Concentrations (if appropriate):	
Test System (e.g., flow-thru, mesocosm, etc.):	

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival					
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	No specific concns. or values given – risk calculations on a hypothetical ecosystem

BLM National Vegetation EIS

Literature Review Form overall Rating - 1

Reviewer/Date:	Pillard / 8 May 2003
Title of Paper/Report:	Characterizing aquatic ecological risks from pesticides . . .
Author(s)	S.M. Bartell et al
Journal/Year/Vol:Pages	Environ. Toxicol Chem / 2000 / 19: 1441-1453

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	Yes - 5
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	NA
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	NA
Were proper controls used and was control performance acceptable?	NA
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Perhaps
Additional comments regarding acceptance/rejection:	- Discusses ERA models - does predict effects.

Task 2: Data Evaluation

Reviewer/Date:	Pillard
Partial Title of Paper/Report:	Characterizing Aquatic Ecologic. Risks . . .

Herbicides tested:	Diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:			
Life Stage:			
Duration:			

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	
Test Concentrations (if appropriate):	
Test System (e.g., flow-thru, mesocosm, etc.):	

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival					
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	No new data - Modeling only

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 8 May 2003
Title of Paper/Report:	Toxicity of Herbicides Diquat & Endothall to Goldfish
Author(s)	C. R. Berry Jr
Journal/Year/Vol:Pages	Environ. Pollut. / 1984 / 34:251-258

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	2 - Behavior
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	No. Few concentrations
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Controls not adequately described
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection: Results not described in staff. detail - control information lacking	

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / May 8, 2003
Title of Paper/Report:	Aquatic Macroinvertebrate Response to Field....
Author(s)	C. R. Berry Jr. et al.
Journal/Year/Vol:Pages	Bull. Environ. Contam / 1975 / 14: 374-379

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	?
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	Yes
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	No

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Mixture of diquat & endothall was used.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-8-03
Title of Paper/Report:	Respiratory stress in yellow perch induced by subtoxic concentrations of diquat
Author(s)	D. L. Bimbon et al.
Journal/Year/Vol:Pages	Ohio J Sci / 1976 / 76:87 - 89

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1 - Resp. Stress - Highly Invasive
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Resp. not given - No
Were proper controls used and was control performance acceptable?	Yes - Unknown
Are the data presented in a peer-reviewed journal?	Unknown

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection:	Highly invasive procedure - respiratory stress not necessarily connected to population effects

BLM National Vegetation EIS

Literature Review Form Rating: 2 **Page 1 of 2**

Reviewer/Date:	Pillard / May 8, 2003
Title of Paper/Report:	Effects of diquat on amphibian embryo development
Author(s)	D.L. Bimber & R.A. Mitchell
Journal/Year/Vol:Pages	Ohio J. of Sci. / 1978 / 78: 50-51

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	Yes - 4
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	No
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes (No standard)
Are the data presented in a peer-reviewed journal?	Unknown

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	Stats not described. Diffs in post-hatch survival w/ diquat noted but not stated to be sig. GD

Task 2: Data Evaluation

Reviewer/Date:	Dillard
Partial Title of Paper/Report:	Effects of diquat on amphibian...

Herbicides tested:	Diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Amphibian	
Test Species:	Rana Pipiens		
Life Stage:	Eggs		

Exposure Conditions	
Formulation: No comm. product	1:1'-ethylene-2:2'-dipyridylium dibromide
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	Water
Test Concentrations (if appropriate):	100 ppm (assume as presented)
Test System (e.g., flow-thru, mesocosm, etc.):	Static

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
PpH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival					
Growth					
Reproduction (Egg)	survival @	14 days post exposure)		100ppm	
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	

BLM National Vegetation EIS

Literature Review Form Rating: 2

Reviewer/Date:	Pilland / 5-9-03
Title of Paper/Report:	Potential phytotoxicity of diquat accumulated by aquatic plants and sediments
Author(s)	B. C. Birmingham & B. Colman
Journal/Year/Vol:Pages	Water, Air, & Soil Pollution / 1983 / 19: 123-131

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No (Incl. Microorg.)
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	?
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	3 (Plant Growth)
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	2

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	- Unclear
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	Some details lacking but Further review is warranted.

No description of stats in methods. Sig. diffs using GD

Task 2: Data Evaluation

Reviewer/Date:	Pillard
Partial Title of Paper/Report:	Potential phytotoxicity of diquat....

Herbicides tested:	Diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Phytoplankton	
Test Species:	Chlorella vulgaris, Navicula pellicolosa, Anabaena flos-aquae, Anacystis nidulans, Lemna sp.		
Life Stage:	Algal cells / Fronds		
Duration:	Variable	Cladophora sp, Spirogyra sp., Myriophyllum spicatum	

	Exposure Conditions
Formulation:	Reglone A - Chipman Chemicals, Ltd.
Concentration/amount of active ingredient:	200g/L
Medium (water, food, soil, etc.):	Water
Test Concentrations (if appropriate):	0.03 - 3mg active Ingred/L
Test System (e.g., flow-thru, mesocosm, etc.):	Static in Flasks

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival					
~~Growth~~ Chl a - Chlorella vulgaris, nidulans			3ppm		
~~Reproduction~~ Chl a - Anacystis			<0.03ppm	0.03ppm	
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	Also examined the residual toxicity of diquat taken up in sediment

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-9-03
Title of Paper/Report:	Role of Free Radicals in toxic injury II: Are free - - - - -
Author(s)	J. A. Brent + B. H. Rumack
Journal/Year/Vol:Pages	Clinical Toxicology / 1993 / 31: 173-196

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	Yes
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	Some
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	Appears to
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	
Inerts, degradates, metabolite effects	
Mixtures of any of the five herbicides	
Indirect effects (food supply, cover)	

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	Not appropriate. — no environ. effects.

BLM National Vegetation EIS

Literature Review Form Rating: 2

Reviewer/Date:	Pilland / 5-8-03
Title of Paper/Report:	Fetal toxicity and distribution of Paraquat and Diquat in Mice and Rats
Author(s)	J. S. Bus et al.
Journal/Year/Vol:Pages	Toxicol. & Applied Pharmac. / 1975 / 33: 450-460

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	5 (Fetal reabsorption)
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Unclear- Not describ. well
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	Diffs noted (and notable) but no stats run GD

Task 2: Data Evaluation

Reviewer/Date:	Pillard
Partial Title of Paper/Report:	Fetal toxicity and distribution . . . .

Herbicides tested:	Diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Nulliparous ~~Swiss-Webster mice~~ + Sprague-Dawley ~~mice~~ rats		
Life Stage:	Fetuses		

Exposure Conditions	
Formulation:	diquat dibromide
Concentration/amount of active ingredient:	/
Medium (water, food, soil, etc.):	Intra-venous
Test Concentrations (if appropriate):	15 mg/kg
Test System (e.g., flow-thru, mesocosm, etc.):	IV to pregnant rats

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
PpH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival				~~15 mg/kg IV~~	
Growth					
Reproduction				15mg/kg IV	
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	⑧ The dose appeared to decrease the # of viable Fetuses, but no statistics were apparently run.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-(0-0)
Title of Paper/Report:	Characterizing Aquatic Ecolog. Risks From Pesticides . . . .
Author(s)	K. R. Campbell, S. M. Bartell, J. L. Shaw.
Journal/Year/Vol:Pages	ET & C / 2000 / 19: 760-774

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	↓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	Yes - 4
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	- Summarizes data
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	N/A
Were proper controls used and was control performance acceptable?	N/A
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	This paper summarizes a substantial amount of data - may want to get primary research literature.

A 2¼ page table for fish - toxic values for diquat
A 3¼ page table of TV for invert & diquat

Task 2: Data Evaluation

Reviewer/Date:	L.A. NADDY /7/12/03
Partial Title of Paper/Report:	Characterizing 'aquatic ecological risks from pest...

Herbicides tested:	diquat dibromide

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Several		
Life Stage:	several		
Duration:	24-96h		

Exposure Conditions	
Formulation:	
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	water
Test Concentrations (if appropriate):	NA - review article
Test System (e.g., flow-thru, mesocosm, etc.):	?

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival					
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	Table 1 has ~160 LC_{50} values for diff species, stages from other lit Do we have to lit?

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-10-03
Title of Paper/Report:	Response of Hydrilla (Hydrilla verticillata) to diquat . . . .
Author(s)	K. Cassidy & J. H. Rodgers
Journal/Year/Vol:Pages	Environ. Tox. Chem / 1989 / 8 : 133-140

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	Yes ?
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	- Discusses primarily uptake, WQ conditions - tissue burden.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-10-03
Title of Paper/Report:	Absorption of paraquat + diquat from the airways of a perfused rat lung
Author(s)	J. M. Charles et al.
Journal/Year/Vol:Pages	Toxicology / 1978 / 9: 59-67

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	Yes (vitamins)
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	Sort of
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	Yes
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No.
Additional comments regarding acceptance/rejection:	

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-10-03
Title of Paper/Report:	Effects of chemically induced maternal toxicity on prenatal Devel. in the Rat
Author(s)	L N. Chernoff et al
Journal/Year/Vol:Pages	Teratology / 1980 / 42: 651-658

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No (Rats)
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	Yes - 4 (WE)
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes, but minimal
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	? - Sample size not clear
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	

Task 2: Data Evaluation

Reviewer/Date:	NADDY 7/12/03 /Pillard 7/18/03
Partial Title of Paper/Report:	Effects of chemically induced maternal tox ... Chernoff et al. 1990

Herbicides tested:	diquat 2,4-Dichlorophenoxyacetic acid 2,4,5-Trichlorophenol

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Rat	
Test Species:	Sprague-Dawley strain		
Life Stage:			
Duration:			

Exposure Conditions	
Formulation:	diquat dibromide monohydrate From
Concentration/amount of active ingredient:	49.1% ration. Chevron Chem. Co.
Medium (water, food, soil, etc.):	Oral gavage
Test Concentrations (if appropriate):	LD50 was highest; actual concn. not given For
Test System (e.g., flow-thru, mesocosm, etc.):	Oral gavage range Finding studies 65 mg/kg/day - Reviewed study

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival			≥ 65 mg/kg/d	> 65 mg/kg/d	
Growth					
Reproduction - Fetal	toxicity		65 mg/kg/d	> 65	
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	A dose of 65 mg/kg/d did not cause an increase in Fetal toxicity. There were signif. changes in organ wts, but these changes didn't affect survival, or reproductive success.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-10-03
Title of Paper/Report:	Effect of Methamidophos on the growth rate .....
Author(s)	Y.K. Chin & K.I. Sudderuddin
Journal/Year/Vol:Pages	Environ. Pollut / 1979 / 18: 213-220

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	\
Genotoxic effects (mutagenic, carcinogenic)	\
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	\
Effects to target plants (efficacy testing)	\
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	\
Mixtures including non-BLM herbicides	\
Marine receptors	\

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	\
Inerts, degradates, metabolite effects	\
Mixtures of any of the five herbicides	\
Indirect effects (food supply, cover)	\

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	

Task 2: Data Evaluation

Reviewer/Date:	Pillard / 7-9-03
Partial Title of Paper/Report:	Effect of methamidophos on the ....

Herbicides tested:	Diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	(Warmwater Fish)	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Carp- Cyprinus carpio		
Life Stage:	Fingerlings 6-9 wks old (9 for diquat)		
Duration:	4 days		

Exposure Conditions	
Formulation:	Not given
Concentration/amount of active ingredient:	0.02% - LC_{50}s based on active Ingred.
Medium (water, food, soil, etc.):	Water
Test Concentrations (if appropriate):	Not given
Test System (e.g., flow-thru, mesocosm, etc.):	Not given

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	29 ± 3°C	Organic Carbon (D or T):	
pH:	7 ± 0.1	Ammonia:	
Other (hardness):	22 mg/L $CaCO_3$	Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	~~EC~~ (95% Limits)	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival	50.28	13.29 - 190.18			
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-10-03
Title of Paper/Report:	Effects of field applications of the herbicides diquat ..... on amphibians
Author(s)	A. S. Cooke
Journal/Year/Vol:Pages	Environ. Pollut / 1977 / 12: 43 – 50

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	✓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	Yes – 4
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	5

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	Field study – increased food supply

hypothesis testing used but test type(s) not described 6D

Task 2: Data Evaluation

Reviewer/Date:	Tillard / 7-9-03
Partial Title of Paper/Report:	Effects of field applications of the. . .

Herbicides tested:	Diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Amphibian	
Test Species:	Rana temporaria; B. fo bufo; Triturus vulgaris (newt)		
Life Stage: Tadpoles	Frogs: 8.5-9.8 mm stages III-V; Toads: 7-7.5mm, stages II-III		
Duration:	32 days Note: Length is snout to anus.		

Exposure Conditions	
Formulation:	Not given
Concentration/amount of active ingredient:	Not Given
Medium (water, food, soil, etc.):	Water
Test Concentrations (if appropriate):	Sprayed w 1.0 mg/L diquat
Test System (e.g., flow-thru, mesocosm, etc.):	Mesocosm in ponds

Test System Monitoring			
Dissolved Oxygen:	4-12 mg/L	Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival			1 mg/L	> 1 mg/L	
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	Diquat @ a measured concn. of 1 mg/L had no effect on tadpoles. However, as macrophytes died, algae grew at a faster rate, providing more food for the tadpoles

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-10-03
Title of Paper/Report:	Effects of digest on the gastro intestinal Tracts of Rats
Author(s)	H.C. Crabtree et al.
Journal/Year/Vol:Pages	~~IT~~ Toxicol. & Appl. Pharm / 1977 / 41:585-595

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No ~~Yes~~ (via rats)
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	2
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	LD50s not recalculated for these studies but mortality described

Task 2: Data Evaluation

Reviewer/Date:	NADDY / 7/12/03 Dillard
Partial Title of Paper/Report:	Effects of diquat on the gastrointestinal tract of rats

Herbicides tested:	diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Rat	
Test Species:	Rats (male) Alderley Park (Wistar-derived)		
Life Stage:	150-200 g		
Duration:	8 wks ± Changes in H_2O content		

Exposure Conditions	
Formulation: crystalline diquat dichloride	Subcut. inject. / oral admin - stomach tube
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	SC / PO (Water - oral Ingest or Subcut.)
Test Concentrations (if appropriate):	900 μmol/kg (PO) ; 90 μmol/kg (sc)
Test System (e.g., flow-thru, mesocosm, etc.):	

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	LD50 **EC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival 14-d	900 μmol/kg (PO) ; 90 μmol/kg (sc)				
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	other endpts focused on water content / distended abdomens in various tissues Animals were exposed to LD50 doses, which were based on previous studies

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-10-03
Title of Paper/Report:	The use of Microcosms to simulate Field experiments.....
Author(s)	B.A. Cragg & J.C. Fry
Journal/Year/Vol:Pages	J. Gen. Microbiology / 1984/130: 2307-2316

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	Yes - Primary
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	Maybe - Elodea
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes - maybe
Additional comments regarding acceptance/rejection:	Microcosm study - effects to bacteria, but also Elodea.

Task 2: Data Evaluation

Reviewer/Date:	Pillard / 7-11-03
Partial Title of Paper/Report:	The use of microcosms to Simulate....

Herbicides tested:	Diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Elodea canadensis		
Life Stage:			
Duration:			

Exposure Conditions	
Formulation:	Reglone 40 ICI
Concentration/amount of active ingredient:	1 mg/L in the Microcosms
Medium (water, food, soil, etc.):	Water
Test Concentrations (if appropriate):	1 mg/L → don't think it was (think was)
Test System (e.g., flow-thru, mesocosm etc.):	Microcosm - Flow thru

Test System Monitoring			
Dissolved Oxygen:	as low as 1 mg/L	Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other (Alkalinity):	≈ 60 - 160 mg/L $CaCO_3$	Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival				1 mg/L	
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-10-03
Title of Paper/Report:	Effects of the bipyridylium herbicides diquat dibromide ....
Author(s)	B. Darvas et al.
Journal/Year/Vol:Pages	J. Econ. Entomology / 1990 / 83: 2175-2180

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	3 (metamorphosis)
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No-Stat Results not given
Were proper controls used and was control performance acceptable?	Yes ?
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-10-03
Title of Paper/Report:	Fathead Minnow Optomotor Response as a behavioral - - -
Author(s)	A. de Peyster & W.F. Long
Journal/Year/Vol:Pages	Bull. Environ. Contam. Toxicol. / 51:88-95 / 1993

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	NO
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Unknown
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes, but NOAEL not reported
Were proper controls used and was control performance acceptable?	Unknown
Are the data presented in a peer-reviewed journal?	Yes ?

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-10-03
Title of Paper/Report:	Lethal Effects of Diquat and Paraquat on Developing . . .
Author(s)	N. A. Dial and C. A. Baver Dial
Journal/Year/Vol:Pages	Bull Environ. Contam Toxicol / 1987/38: 1006-1011

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	|
Inerts, degradates, metabolite effects	|
Mixtures of any of the five herbicides	|
Indirect effects (food supply, cover)	|

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	~~Yes~~ No

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	

Task 2: Data Evaluation

Reviewer/Date:	Pilland / 7-11-02
Partial Title of Paper/Report:	Lethal effects of diquat and . . .

Herbicides tested:	Diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Amphibians	
Test Species:	Rana pipiens		
Life Stage:	Early gastrula and 15 days old		
Duration:	Up to 16 days		

Exposure Conditions	
Formulation:	Not given - commercial source
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	Water
Test Concentrations (if appropriate):	0, 2.0, 5.0, 10.0 mg/L
Test System (e.g., flow-thru, mesocosm, etc.):	Static-renewal (renewed every other day)

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival (Gastrula stage)			2 mg/L	5 mg/L	@ 13 days
~~Growth~~ Survival (15 days old)			10 mg/L		@ 16 days
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	No effects on survival @ 10 mg/L diquat

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-10-03
Title of Paper/Report:	Modification of the Rheotropic response of rainbow trout....
Author(s)	J. J. Dodson & C. I. Mayfield
Journal/Year/Vol:Pages	Environ. Pollut / 1979 / 18: 147 - 157

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	2 - 'swimming' response
Inerts, degradates, metabolite effects	|
Mixtures of any of the five herbicides	|
Indirect effects (food supply, cover)	|

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	Tissue residues

Task 2: Data Evaluation

Reviewer/Date:	Pillard / 7-11-03
Partial Title of Paper/Report:	Modification of the rheotropic . . . .

Herbicides tested:	Diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	(Coldwater Fish)
Non-Target Plants	Aquatic Plant (Macrophyte)	Other:	
Test Species:	Rainbow trout (Salmo gairdneri)*		
Life Stage:	1-year old		
Duration:	24 hours		

Exposure Conditions	
Formulation:	Technical grade diquat; Reglone A (278 g/litre diquat
Concentration/amount of active ingredient:	278 g/L diquat dibromide (dibromide)
Medium (water, food, soil, etc.):	Water. (Chipman
Test Concentrations (if appropriate):	lowest Field Appl rate (Chemicals, Ltd.
Test System (e.g., flow-thru, mesocosm, etc.):	Static highest appl. rate +
0, 0.5, 1.5, 5.0 ppm	5 times Field Applic. rate

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	15°C	Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival					
Growth					
Reproduction					
Embryo/Larval Develop.					
Swimming Speed				0.5 ppm diquat	

Degradates/Inerts:	
Additional Comments and Observations:	*Now known as Oncorhynchus mykiss.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-10-03
Title of Paper/Report:	Comparison of the ecological effects of diquat on - - - - .
Author(s)	R. Draxl et al.
Journal/Year/Vol:Pages	Verh. Intern. Verein. Limnol / 1991 / 24: 2269-2271

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	4 Yes (zooplankton)
Inerts, degradates, metabolite effects	No - 1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	3- zooplankton

No statistical analysis but substantial effects seen

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	No
Was the test of proper exposure dose, mechanism, & duration?	-Maybe
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Outdoor FW system → No - No reps; lab tests carried out in duplicate
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Unknown

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	- Discusses effects on zooplankton, a food animal for fish.

Task 2: Data Evaluation

Reviewer/Date:	Pillard / 7-11-03
Partial Title of Paper/Report:	Comparison of the ecological effects . . . .

Herbicides tested:	Diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Zooplankton	
Test Species:			
Life Stage:			

Exposure Conditions	
Formulation:	Diquat (Natl. Physical Lab Teddington, UK)
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	Water
Test Concentrations (if appropriate):	1.0 mg/L & 0.3 mg/L (measured)
Test System (e.g., flow-thru, mesocosm, etc.):	Microcosm - static? & Laboratory tanks

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
PpH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival					
Growth					
Reproduction					
Embryo/Larval Develop.					
Population of Zooplankton				0.3mg/L	

Degradates/Inerts:	
Additional Comments and Observations:	0.3 mg/L appeared to have a substantial adverse effect on zooplankton density. However, no statistical analysis was completed.

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-10-03
Title of Paper/Report:	Pond enclosure evaluations of microbial products & chemical - - - -
Author(s)	R. J. Duvall, L. W. J. Anderson, C. R. Goldman
Journal/Year/Vol:Pages	J. Aquat. Plant Manage. / 2001 / 39: 99-106

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	Yes
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	No
Mixtures including non-BLM herbicides	No
Marine receptors	No

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	1
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	- Microbial effects only

BLM National Vegetation EIS

Literature Review Form Rating : 3

Reviewer/Date:	Pillard / 5-10-03
Title of Paper/Report:	Comparative sensitivity of Selenastrum capricornutum and Lemna minor....
Author(s)	JF Fairchild et al.
Journal/Year/Vol:Pages	Arch. Environ. Contam. Toxicol. / 1997 / 32: 353-357

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	4
Inerts, degradates, metabolite effects	|
Mixtures of any of the five herbicides	|
Indirect effects (food supply, cover)	4 - Lemna / Selenast

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Yes
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	

Task 2: Data Evaluation

Reviewer/Date:	Pillard/
Partial Title of Paper/Report:	Comparative Sensitivity of Selenastrum. . .

Herbicides tested:	Diquat chlorsulfuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Alga - Selenastrum	
Test Species:	Lemna minor; Selenastrum capricornutum		
Life Stage:	cells / fronds (L. minor).		

Duration: 96h

Exposure Conditions	
Formulation:	~~Not Given~~ 1,1'ethylene-2,2'dipyridylium
Concentration/amount of active ingredient:	Not Given dibromide
Medium (water, food, soil, etc.):	Water
Test Concentrations (if appropriate):	
Test System (e.g., flow-thru, mesocosm, etc.):	Static

n=3

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	25°C	Organic Carbon (D or T):	
PpH:		Ammonia:	
Other (light intensity):	400 fc	Other ( ):	
Other (photoperiod):	16:8 hr L:D	Other ( ):	

96-hr Biological and Statistical Endpoints

Endpoint	LC50/EC50	IC ( )	NOEC/NOAEC	LOEC	Other ( )
diquat ~~Mortality/Survival~~ Selen.	80 (64-95)		44	88	ug/L
~~Growth~~ Lemna	18 (7-28)		<11	11	ug/L
~~Reproduction~~					
~~Embryo/Larval Develop.~~					
chlorsul S.c.	135 (109-161)		<19	19	ug/L
L.m.	0.07 (0.5-0.9)		0.4	0.7	ug/L

Degradates/Inerts:	
Additional Comments and Observations:	

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pilland / 5-10-03
Title of Paper/Report:	An Ecological Risk Assessment of the Potential . . .
Author(s)	J. F. Fairchild, L. C. Sappington, D. S. Ruessler
Journal/Year/Vol:Pages	USGS Report / 1999 / Wat-Res. Invest. Rpt 99-4018B

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	Yes
Inerts, degradates, metabolite effects	|
Mixtures of any of the five herbicides	|
Indirect effects (food supply, cover)	|

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	N/A
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	|
Were proper controls used and was control performance acceptable?	|
Are the data presented in a peer-reviewed journal?	|

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection: Review document - cites primary data	

Diquat data is directly from Fairchild et al. 1997 (already in database)

Task 2: Data Evaluation

Reviewer/Date:	Pillard
Partial Title of Paper/Report:	An ecological risk assessment of tho...

Herbicides tested:	Diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte) Lemna	Other: Selenastrum	
Test Species:	Lemna & Selenastrum		
Life Stage:			
Duration:			

Exposure Conditions	
Formulation:	Not Given
Concentration/amount of active ingredient:	Not Given
Medium (water, food, soil, etc.):	Water
Test Concentrations (if appropriate):	Not Given
Test System (e.g., flow-thru, mesocosm, etc.):	Not Given

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other ( ):		Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
~~Mortality/Survival~~ Lemna	18 mg/L				
~~Growth~~ Selenastrum	80 mg/L				
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	Review article - contains good characterization information (e.g., K_{oc}) for several herbicides. Also apparently contains original data as well. See original paper by Fairchild et al 1997

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-10-03
Title of Paper/Report:	Overt avoidance reaction of rainbow trout fry to nine herbicides.
Author(s)	L. C. Folmar
Journal/Year/Vol:Pages	Bull. Environ. Contam Toxicol / 1976/15: 509-514

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	NO
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	2- Avoidance
Inerts, degradates, metabolite effects	|
Mixtures of any of the five herbicides	|
Indirect effects (food supply, cover)	|

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	No
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	No
Were proper controls used and was control performance acceptable?	No
Are the data presented in a peer-reviewed journal?	No

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection: Legal	

APPENDIX A.3

SPREADSHEET OF TOXICITY DATA FOR DIQUAT TRV

Formulation	% purity/ai	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product)[1]		Toxicity Value (ai)[1]	Units	Chemical Analysis Done/ Reported	Lab	Study Number	Report Number	Data Source[2]	EPA Reviewer	Date Reviewed	Used for TRV derivation
1:1'ethylene-2:2'-dipyridylium dibromide[3]		amphibian	Northern leopard frog	*Rana pipiens*	0-21 d	Static Renewal	Water	fertilization or 21 d	21 d	Post-hatch survival	LOEC		100	NR	mg/L	No/No				Bimber & Mitchell. 1978. Ohio J. of Sci. 78: 50-51.			Yes
6,7-dihydrodipyrido[1,2-a:2',1'-c]pyrazinediium		**amphibian**	**Northern leopard frog**	***Rana pipiens***	**early gastrula**	**Static-renewal**	**Water**	**16 d**	**16 d**	**Mortality**	**NOEC**		**2**	**NR**	**mg/L**	**No/No**				**Dial & Bauer Dial**			**Yes**
6,7-dihydrodipyrido[1,2-a:2',1'-c]pyrazinediium		**amphibian**	**Northern leopard frog**	***Rana pipiens***	**early gastrula**	**Static-renewal**	**Water**	**16 d**	**16 d**	**Mortality**	**LOEC[5]**		**5**	**NR**	**mg/L**	**No/No**				**Dial & Bauer Dial. 1987. Bull. Environ. Contam. Toxicol. 38: 1006-1011.**			**Yes**
6,7-dihydrodipyrido[1,2-a:2',1'-c]pyrazinediium		amphibian	Northern leopard frog	*Rana pipiens*	tadpole - 15 d	Static-renewal	Water	16 d	16 d	Mortality	NOEC		10	NR	mg/L	No/No				Dial & Bauer Dial. 1987. Bull. Environ. Contam. Toxicol. 38: 1006-1011.			Yes
6,7-dihydrodipyrido[1,2-a:2',1'-c]pyrazinediium		amphibian	Northern leopard frog	*Rana pipiens*	tadpole - 15 d	Static-renewal	Water	16 d	16 d	Mortality	LOEC	>	10	NR	mg/L	No/No				Dial & Bauer Dial. 1987. Bull. Environ. Contam. Toxicol. 38: 1006-1011.			Yes
Diquat		amphibian	frog	*Rana temporaria*	8.5-9.5 mm	Mesocosm[4]	Water	Sprayed on Day 0	32 d	Mortality/ Development	NOEC		1	NR	mg/L	Yes/Yes				Cooke. 1977. Environ. Poll. 12: 43-50.			Yes
Diquat		amphibian	frog	*Rana temporaria*	8.5-9.5 mm	Mesocosm	Water	Sprayed on Day 0	32 d	Mortality/ Development	LOEC	>	1	NR	mg/L	Yes/Yes				Cooke. 1977. Environ. Poll. 12: 43-50.			Yes
Diquat		amphibian	toad	*Bufo bufo*	7-7.5 mm	Mesocosm[4]	Water	Sprayed on Day 0	32 d	Mortality/ Development	NOEC		1	NR	mg/L	Yes/Yes				Cooke. 1977. Environ. Poll. 12: 43-50.			Yes
Diquat		amphibian	toad	*Bufo bufo*	7-7.5 mm	Mesocosm	Water	Sprayed on Day 0	32 d	Mortality/ Development	LOEC	>	1	NR	mg/L	Yes/Yes				Cooke. 1977. Environ. Poll. 12: 43-50.			Yes
Diquat		amphibian	smooth newt	*Triturus vulgaris*	all	Mesocosm[4]	Water	Unknown	15 m	Population number	LOEC	>	1	NR	mg/L	Yes/Yes				Cooke. 1977. Environ. Poll. 12: 43-50.			Yes
Diquat		aquatic invertebrate	cladocerans and copepods		All & nauplii	Microcosm[6]	Water	8 weeks	8 w	Zooplankton density	LOEC[7]		0.18	NR	mg/L	Yes/Yes				Draxl et al. 1991. Verh. Internat. Verein. Limnol. 1991. 24: 2269-2271.			Yes
Diquat		aquatic invertebrate	cladocerans and copepods		All & nauplii	Flow-thru?[6]	Water	8 weeks	8 w	Zooplankton density	LOEC[7]		0.24	NR	mg/L	Yes/Yes				Draxl et al. 1991. Verh. Internat. Verein. Limnol. 1991. 24: 2269-2271.			Yes
Diquat		aquatic invertebrate	copepod[11]		unknown	Static	Water	24 hr	24 hr	Mortality	LC_{50}		74	NR	mg/L	No/No				Naqvi et al. 1980. Bull. Environ. Contam. Toxicol. 25: 918-920.			Yes
Diquat		aquatic invertebrate	copepod[11]		unknown	Static	Water	48 hr	48 hr	Mortality	LC_{50}		19	NR	mg/L	No/No				Naqvi et al. 1980. Bull. Environ. Contam. Toxicol. 25: 918-920.			Yes
Diquat dibromide monohydrate		aquatic invertebrate	shrimp	*Caridina nilotica*	1.5 cm	Static	Water	2 hr	2.25 hr	Mortality	LC_{50}		NR	NR		Yes/Yes				Kevan & Pearson. 1993. Bull. Environ. Contam. Toxicl. 51: 564-567.			Yes
Diquat dibromide[14]	35.3	aquatic invertebrate	amphipod	*Hyalella azteca*	< 1 mm	Flowthru	Water[15]	5 d	5 d	Mortality	LC_{50}[16]		3.4	NR	mg/L	No/No				Williams et al. 1984. Bull. Environ. Contam. Toxicol. 33: 418-422.			Yes
Diquat dibromide[14]	35.3	aquatic invertebrate	isopod	*Asellus communis*	< 1 mm	Flowtbru	Water[15]	5 d	5 d	Mortality	LC_{50}[17]	>	10	NR	mg/L	No/No				Williams et al. 1984. Bull. Environ. Contam. Toxicol. 33: 418-422.			Yes
Ortho commercial	53.5	aquatic invertebrate	amphipod	*Hyallela spp*	unknown	Static	Water[12]	24 hr	24 hr	Mortality	TL_{50}[13]	>	1.26	NR	mg/L	No/No				Nicholson & Clerman. 1974. Environmental Letters. 7: 215-227.			Yes
Weedtrine-D	8.53[10]	aquatic invertebrate	calanoid copepod	*Diaptomus spp*	unknown	Static	Water	48 hr	48 hr	Mortality	LC_{50}		10	NR	mg/L	No/No				Naqvi & Hawkins. 1989. Bull. Environ. Contam. Toxicol. 43: 386-393.			Yes
Weedtrine-D	8.53[10]	aquatic invertebrate	copepod	*Eucyclops spp*	unknown	Static	Water	48 hr	48 hr	Mortality	LC_{50}		46.6	NR	mg/L	No/No				Naqvi & Hawkins. 1989. Bull. Environ. Contam. Toxicol. 43: 386-393.			Yes
Weedtrine-D	8.53[10]	aquatic invertebrate	cladoceran	*Alonella spp*	unknown	Static	Water	48 hr	48 hr	Mortality	LC_{50}	<	10	NR	mg/L	No/No				Naqvi & Hawkins. 1989. Bull. Environ. Contam. Toxicol. 43: 386-393.			Yes
Weedtrine-D	8.53[10]	aquatic invertebrate	ostracod	*Cypria spp*	unknown	Static	Water	48 hr	48 hr	Mortality	LC_{50}		13.8	NR	mg/L	No/No				Naqvi & Hawkins. 1989. Bull. Environ. Contam. Toxicol. 43: 386-393.			Yes
Diquat	35.3	aquatic invertebrate	scud	*Gammarus fasciatus*	mature	Static	Water	96 hr	96 hr[8]	Mortality	LC_{50}	>	100	NR	mg/L	Unknown/ No	FWS	MRID 40094602	FWS Res. Pub 160	Mayer & Ellersieck. 1986.[9]	Johnson & Finley	1980	Yes
Diquat	35.3	aquatic invertebrate	apple snail		1 wk	Static	Water	96 hr	96 hr	Mortality	LC_{50}		1.8	NR	mg/L	Unknown/ No	FWS	MRID 40098001	FWS Res. Pub 160	Mayer & Ellersieck. 1986.[9]	Mayer & Ellersieck	1986	Yes

Formulation	% purity/ai	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product)[1]	Toxicity Value (ai)[1]	Units	Chemical Analysis Done/ Reported	Lab	Study Number	Report Number	Data Source[2]	EPA Reviewer	Date Reviewed	Used for TRV derivation
Diquat	**35.3**	**aquatic invertebrate**	**fairy shrimp**	***Streptocephalus seali***	**adult**	**Static**	**Water**	**48 hr**	**48 hr**	**Mortality**	**NOEC**	**> 2**	**NR**	mg/L	**No/No**				**Moss. 1978. Progressive Fish Culturist. 40: 158-160.**			**Yes**
emulsifiable concentrate		aquatic invertebrate	scud	*Gammarus fasciatus*	early instar	Static	Water	48 hr	48 hr	Mortality	TL_{50}[13]	> 100	> NR	mg/L	No/No				Sanders. 1970. Water Pollution Control Fed. 42: 1544-1550.			Yes
Diquat	41.4	aquatic invertebrate	cladoceran	*Daphnia magna*		life cycle	Water				MATC	0.044	NR	mg/L			MRID 00115862		In USEPA 1995.			
Diquat	47	aquatic invertebrate	cladoceran	*Daphnia magna*	1st instar	Static	Water	48 hr	48 hr	Mortality	EC_{50}	1.17	NR	mg/L		CCC	MRID 00115576		1978. In USEPA 2003.	C. Lewis	1985	Yes
Diquat	35	aquatic invertebrate	cladoceran	*Daphnia magna*	1st instar	Static	Water	48 hr	48 hr	Mortality	EC_{50}	0.77	NR	mg/L		CCC	MRID 00235179		1978. In USEPA 2003.	D. McLane	1979	Yes
Diquat	technical grade	aquatic invertebrate	cladoceran	*Daphnia magna*	1st instar	Static	Water		26 hr	Mortality	EC_{50}	7.1	NR	mg/L		REF	MRID 00090862		1966. In USEPA 2003.	T. O'Brien	1978	Yes
Diquat	41.4	aquatic invertebrate	cladoceran	*Daphnia magna*	1st instar	Flow through	Water		21 d		LOEC	0.17	NR	mg/L		SBI	MRID 40380702		1987. In USEPA 2003.	C. Lewis	1990	Yes
Diquat	41.4	aquatic invertebrate	cladoceran	*Daphnia magna*	1st instar	Flow through	Water		21 d		NOEC	< 0.17	NR	mg/L		SBI	MRID 40380702		1987. In USEPA 2003.	C. Lewis	1990	Yes
Diquat		**aquatic invertebrate**	**amphipod**	***Hyallela spp***		**Static**	**Water**		**48 hr**		**EC_{50}**	**0.14**	**NR**	**mg/L**		**REF**	**MRID 00115862**		**1974. In USEPA 2003.**	**C. Lewis**	**1985**	**Yes**
1,1'ethylene-2,2'-bipyridyldiylium ion		aquatic plant	algae	*Vaucheria dichotoma*	cells	Static	Water	7 d	7 d	Mortality	100% mortality	2	NR	mg/L	No/No				Robson et al. 1976. Pesticide Science. 7: 391-402.			Yes
Diquat		aquatic plant	elodea	*Elodea canadensis*	plant	Flow-thru?[6]	Water	8	8 w[21]	Mortality	LOEC	NR	0.24	mg ai/L	Yes/Yes				Draxl et al. 1991. Verh. Internat. Verein. Limnol. 1991. 24: 2269-2271.			Yes
Diquat dibromide	technical grade	aquatic plant	Green algae	*Selenastrum capricornutum*	4-7 d-old cells	Static	Water	96 hr	96 hr	Growth	EC^{50}	34.2	NR	mg/L	No/No				St-Laurent et al. 1992. Environ. Toxicol. Water Qual. 7: 35-48.			Yes
Reglone 40, ICI		aquatic plant	elodea	*Elodea canadensis*	plant	Microcosm	Water	20-30 d	20-30 d	Biomass	LOEC	1	NR	mg/L	No/No				Cragg & Fry. 1984. J. General Microbiology. 130: 2309-2316.			Yes
Reglone A		aquatic plant	Green algae	*Chlorella vulgaris*	cells	Static	Water	2-7 d	2-7 d	Chl A	NOEC	NR	> 3	mg ai/L	No/No				Birmingham & Colman. 1983. Water Air Soil Pollut. 19: 123-131.			Yes
Reglone A		aquatic plant	diatom	*Navicula pelliculosa*	cells	Static	Water[18]	2-7 d	2-7 d	Chl A	NOEC	NR	0.3	mg ai/L	No/No				Birmingham & Colman. 1983. Water Air Soil Pollut. 19: 123-131.			Yes
Reglone A		aquatic plant	diatom	*Navicula pelliculosa*	cells	Static	Water	2-7 d	2-7 d	Chl A	LOEC	NR	3	mg ai/L	No/No				Birmingham & Colman. 1983. Water Air Soil Pollut. 19: 123-131.			Yes
Reglone A		aquatic plant	duckweed	*Lemna sp.*	plant	Static	Sediment[19]	see Comment[19]	4 d	Chl A	NOEC[20]	NR	3.3	mg ai/L	Yes/No				Birmingham & Colman. 1983. Water Air Soil Pollut. 19: 123-131.			Yes
Reglone A		aquatic plant	duckweed	*Lemna sp.*	plant	Static	Sediment[19]	see Comment[19]	4 d	Chl A	LOEC[20]	NR	33.4	mg ai/L	Yes/No				Birmingham & Colman. 1983. Water Air Soil Pollut. 19: 123-131.			Yes
Diquat	technical grade; 25%	aquatic plant	diatom	*Cyclotella meneghiana*	cells	Static	Water	22 hr	22 hr	^{14}C uptake	EC_{50}[20]	NR	92	ug ai/L	Yes/No				Peterson et al. 1997. Aquatic Toxicol. 39: 111-134.			Yes
Diquat	technical grade; 25%	aquatic plant	diatom	*Nitzschia spp*	cells	Static	Water	22 hr	22 hr	^{14}C uptake	EC_{50}[20]	NR	65	ug ai/L	Yes/No				Peterson et al. 1997. Aquatic Toxicol. 39: 111-134.			Yes
Diquat	technical grade; 25%	aquatic plant	Green algae	*Scenedesmus quadricauda*	cells	Static	Water	22 hr	22 hr	^{14}C uptake	EC_{50}[20]	NR	652	ug ai/L	Yes/No				Peterson et al. 1997. Aquatic Toxicol. 39: 111-134.			Yes
Diquat	technical grade; 25%	aquatic plant	Green algae	*Selenastrum capricornutum*	cells	Static	Water	22 hr	22 hr	^{14}C uptake	EC_{50}[20]	NR	492	ug ai/L	Yes/No				Peterson et al. 1997. Aquatic Toxicol. 39: 111-134.			Yes
Diquat	technical grade; 25%	aquatic plant	duckweed	*Lemna minor*	plant	Static	Water	7 d	7 d	Frond growth	EC_{50}[20]	NR	4	ug ai/L	Yes/No				Peterson et al. 1997. Aquatic Toxicol. 39: 111-134.			Yes
Valent Diquat H/A	35.3	aquatic plant	algal community		various	Static	Water	Single application	21 d post	Total algal cell density	MATC[22]	5.5	NR	mg/L	Yes/Yes				Melendez et al. 1993. Arch. Environ. Contam. Toxicol. 25: 95-101.			Yes
Diquat	technical grade	aquatic plant	duckweed	*Lemna minor*	fronds	Static	Water	96 hr	96 hr	Growth	EC_{50}	18	NR	ug/L	No/No				Fairchild et al. 1997. Arch. Environ. Contam. Toxicol. 32: 353-357.			Yes
Diquat	technical grade	aquatic plant	duckweed	*Lemna minor*	fronds	Static	Water	96 hr	96 hr	Growth	NOEC	< 11	NR	ug/L	No/No				Fairchild et al. 1997. Arch. Environ. Contam. Toxicol. 32: 353-357.			Yes
Diquat	technical grade	aquatic plant	duckweed	*Lemna minor*	fronds	Static	Water	96 hr	96 hr	Growth	LOEC	11	NR	ug/L	No/No				Fairchild et al. 1997. Arch. Environ. Contam. Toxicol. 32: 353-357.			Yes
Diquat	technical grade	aquatic plant	Green algae	*Selenastrum capricornutum*	cells	Static	Water	96 hr	96 hr	Growth	EC_{50}	80	NR	ug/L	No/No				Fairchild et al. 1997. Arch. Environ. Contam. Toxicol. 32: 353-357.			Yes

Formulation	% purity/ai	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Du ation	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) [1]	Toxicity Value (ai) [1]		Units	Chemical Analysis Done/ Reported	Lab	Study Number	Report Number	Data Source[2]	EPA Reviewer	Date Reviewed	Used for TRV derivation
Diquat	technical grade	aquatic plant	Green algae	*Selenastrum capricornutum*	cells	Static	Water	96 hr	96 hr	Growth	NOEC	44	NR		ug/L	No/No				Fairchild et al. 1997. Arch. Environ. Contam. Toxicol. 32: 353-357.			Yes
Diquat	technical grade	aquatic plant	Green algae	*Selenastrum capricornutum*	cells	Static	Water	96 hr	96 hr	Growth	LOEC	88	NR		ug/L	No/No				Fairchild et al. 1997. Arch. Environ. Contam. Toxicol. 32: 353-357.			Yes
Diquat		aquatic plant	Green algae	*Chlorella vulgaris*	cells	Static	Water	7 d	7 d	Cell density	IC_0	NR	<	92	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Green algae	*Chlorella vulgaris*	cells	Static	Water	7 d	7 d	Cell density	IC_{25}	NR		154	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Green algae	*Chlorella vulgaris*	cells	Static	Water	7 d	7 d	Cell density	IC_{50}	NR		307	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Green algae	*Selenastrum capricornutum*	cells	Static	Water	7 d	7 d	Cell density	IC_0	NR	<	24	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Green algae	*Selenastrum capricornutum*	cells	Static	Water	7 d	7 d	Cell density	IC_{25}	NR		32	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Green algae	*Selenastrum capricornutum*	cells	Static	Water	7 d	7 d	Cell density	IC_{50}	NR		47	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Green algae	*Selenastrum capricornutum*	cells	Static	Water	7 d	7 d	Cell density	IC_{100}	NR	>	759	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	diatom	*Navicula spp*	cells	Static	Water	7 d	7 d	Cell density	IC_0	NR	<	93	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	diatom	*Navicula spp*	cells	Static	Water	7 d	7 d	Cell density	IC_{25}	NR		107	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	diatom	*Navicula spp*	cells	Static	Water	7 d	7 d	Cell density	IC_{50}	NR		127	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	diatom	*Navicula spp*	cells	Static	Water	7 d	7 d	Cell density	IC_{100}	NR	>	368	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Green algae	*Euglena gracilis*	cells	Static	Water	7 d	7 d	Cell density	IC_0	NR	<	735	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Green algae	*Euglena gracilis*	cells	Static	Water	7 d	7 d	Cell density	IC_{25}	NR		1531	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Green algae	*Euglena gracilis*	cells	Static	Water	7 d	7 d	Cell density	IC_{50}	NR	>	2940	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	cryptomonad	*Cryptomonas ozolini*	cells	Static	Water	7 d	7 d	Cell density	IC_0	NR	<	12	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	cryptomonad	*Cryptomonas ozolini*	cells	Static	Water	7 d	7 d	Cell density	IC_{25}	NR		38	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	cryptomonad	*Cryptomonas ozolini*	cells	Static	Water	7 d	7 d	Cell density	IC_{50}	NR		75	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	cryptomonad	*Cryptomonas ozolini*	cells	Static	Water	7 d	7 d	Cell density	IC_{100}	NR	>	175	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Crysophyte	*Ochromonas danica*	cells	Static	Water	7 d	7 d	Cell density	IC_0	NR	<	23	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Crysophyte	*Ochromonas danica*	cells	Static	Water	7 d	7 d	Cell density	IC_{25}	NR		67	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Crysophyte	*Ochromonas danica*	cells	Static	Water	7 d	7 d	Cell density	IC_{50}	NR		124	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Crysophyte	*Ochromonas danica*	cells	Static	Water	7 d	7 d	Cell density	IC_{100}	NR	>	368	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Green algae	*Chlorella vulgaris*	cells	Static	Water	3 d	3 d	Cell density	IC_0	NR	<	735	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Green algae	*Chlorella vulgaris*	cells	Static	Water	3 d	3 d	Cell density	IC_{25}	NR		1200	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Green algae	*Chlorella vulgaris*	cells	Static	Water	3 d	3 d	Cell density	IC_{50}	NR	>	2940	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Green algae	*Selenastrum capricornutum*	cells	Static	Water	3 d	3 d	Cell density	IC_0	NR	<	24	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Green algae	*Selenastrum capricornutum*	cells	Static	Water	3 d	3 d	Cell density	IC_{25}	NR		44	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes

Formulation	% purity/ai	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) [1]	Toxicity Value (ai) [1]	Units	Chemical Analysis Done/ Reported	Lab	Study Number	Report Number	Data Source [2]	EPA Reviewer	Date Reviewed	Used for TRV derivation
Diquat		aquatic plant	Green algae	*Selenastrum capricornutum*	cells	Static	Water	3 d	3 d	Cell density	IC_{50}	NR	96	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Green algae	*Selenastrum capricornutum*	cells	Static	Water	3 d	3 d	Cell density	IC_{100}	NR	> 1472	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Green algae	*Euglena gracilis*	cells	Static	Water	3 d	3 d	Cell density	IC_0	NR	< 735	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Green algae	*Euglena gracilis*	cells	Static	Water	3 d	3 d	Cell density	IC_{25}	NR	1259	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Green algae	*Euglena gracilis*	cells	Static	Water	3 d	3 d	Cell density	IC_{50}	NR	> 2940	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Crysophyte	*Ochromonas danica*	cells	Static	Water	3 d	3 d	Cell density	IC_0	NR	< 12	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Crysophyte	*Ochromonas danica*	cells	Static	Water	3 d	3 d	Cell density	IC_{25}	NR	65	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Crysophyte	*Ochromonas danica*	cells	Static	Water	3 d	3 d	Cell density	IC_{50}	NR	136	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat		aquatic plant	Crysophyte	*Ochromonas danica*	cells	Static	Water	3 d	3 d	Cell density	IC_{100}	NR	> 368	ug ai/L	No/No[23]				Philips et al. 1992. Bull. Environ. Contam. Toxicol. 49: 750-756.			Yes
Diquat	technical or analytical	aquatic plant	diatom	*Cyclotella meneghiana*	cells	Static	Water	22 hr	22 hr	^{14}C uptake	99% inhibition at EEC (733 ug/L)*	NR			No/No				Peterson et al. 1997. Aquatic Toxicol. 39: 111-134.			Yes
Diquat	technical or analytical	aquatic plant	diatom	*Nitzschia spp*	cells	Static	Water	22 hr	22 hr	^{14}C uptake	100% inhibition at EEC (733	NR			No/No				Peterson et al. 1997. Aquatic Toxicol. 39: 111-134.			Yes
Diquat	technical or analytical	aquatic plant	Green algae	*Scenedesmus quadricauda*	cells	Static	Water	22 hr	22 hr	^{14}C uptake	53% inhibition at EEC (733 ug/L)*	NR			No/No				Peterson et al. 1997. Aquatic Toxicol. 39: 111-134.			Yes
Diquat	technical or analytical	aquatic plant	Green algae	*Selenastrum capricornutum*	cells	Static	Water	22 hr	22 hr	^{14}C uptake	69% inhibition at EEC (733 ug/L)*	NR			No/No				Peterson et al. 1997. Aquatic Toxicol. 39: 111-134.			Yes
Diquat	technical or analytical	aquatic plant	duckweed	*Lemna minor*	plant	Static	Water	7 d	7 d	Frond growth	100% inhibition at EEC (733	NR			No/No				Peterson et al. 1997. Aquatic Toxicol. 39: 111-134.			Yes
Diquat	40	aquatic plant	algae	*Chlorococcum sp.*		Static	Water		10 d		EC^{50}	200	NR	mg/L		EPA	MRID 40228401		1986. In USEPA 2003.	F.L. Mayer	1986	Yes
Diquat	**35.3**	**aquatic plant**	**giant duckweed**	***Spirodela punctata***		**Static**	**Water**		**14 d**	**root zone**	**EC^{50}**	**0.00075**	**NR**	**mg/L**		**CCC**	**MRID 41883002**		**1990. In USEPA 1995, 2003.**	**M. Davy**	**1994**	**Yes**
Diquat	26.8	aquatic plant	Green algae	*Selenastrum capricornutum*		Static	Water	96 hr	96 hr		EC^{50}	9.4	NR	ug/L		ICI	MRID 43532703		1988. In USEPA 2003.	KBN	1988	Yes
Diquat	26.8	aquatic plant	Green algae	*Selenastrum capricornutum*		Static	Water	96 hr	96 hr		NOEL	6.8	NR	ug/L		ICI	MRID 43532703		1988. In USEPA 2003.	KBN	1988	Yes
Diquat	37	bird	bobwhite quail	*Colinus virginianus*	2-3 w	Acute dietary	Diet	5 d	8 d[24]	Survival	LC_{50}	2932	NR	ppm[25]	No/No	FWS	MRID 00022923	Wildlife No 152	Heath et al. 1972. Special Scientific Report. 152: 1-57.	Hill, E.F. et al	1985	Yes
Diquat	37	bird	Japanese quail	*Coturnix coturnix*	2-3 w	Acute dietary	Diet	5 d	8 d[24]	Survival	LC_{50}	1346	NR	ppm[25]	No/No	FWS	MRID 00022923	Wildlife No 152	Heath et al. 1972. Special Scientific Report. 152: 1-57.	Hill, E.F. et al	1985	Yes
Diquat	37	bird	Ring-necked pheasant	*Phasianus colchicus*	2-3 w	Acute dietary	Diet	5 d	8 d[24]	Survival	LC_{50}	3742	NR	ppm[25]	No/No	FWS	MRID 00022923	Wildlife No 152	Heath et al. 1972. Special Scientific Report. 152: 1-57.	Hill, E.F. et al	1985	Yes
Diquat	37	bird	Mallard duck	*Anas platyrhynchos*	2-3 w	Acute dietary	Diet	5 d	8 d[24]	Survival	LC_{50}[27]	> 5000	> NR	ppm[25]	No/No	FWS	MRID 00022923	Wildlife No 152	Heath et al. 1972. Special Scientific Report. 152: 1-57.	Hill, E.F. et al	1985	Yes
Diquat	37	bird	Mallard duck	*Anas platyrhynchos*	2-3 w	Acute dietary	Diet	5 d	8 d[24]	Survival	NOAEL	< 2500	< NR	ppm[25]	No/No	FWS	MRID 00022923	Wildlife No 152	Heath et al. 1972. Special Scientific Report. 152: 1-57.	Hill, E.F. et al	1985	Yes
Diquat	35.3	bird	bobwhite quail	*Colinus virginianus*	ErlyLf	Repro & Fert Test	Diet	1-generation		Reprod/ Develop	LOAEL	< 100	< NR	ppm		Wildlife International	MRID 00119988		1982. In USEPA 1995, 2003.	C. Lewis	1985	Yes
Diquat	30	bird	Mallard duck	*Anas platyrhynchos*		Acute oral	oral			Mortality	LD_{50}	NR	89.6	mg ai/kg		Wildlife International	MRID 00106559		In USEPA 1995.			Yes
Diquat	37	bird	bobwhite quail	*Colinus virginianus*		Acute dietary	Diet			Survival	LC_{50}	NR	575	ppm ai					In USEPA 1995.			Yes
Diquat	30	bird	Mallard duck	*Anas platyrhynchos*		Acute dietary	Diet			Survival	LC_{70}	NR	980	ppm ai					In USEPA 1995.			Yes
Diquat	**37**	**bird**	**Japanese quail**	***Coturnix coturnix***		**Acute dietary**	**Diet**			**Survival**	**LC_{50}**	**NR**	**264**	**ppm ai**			**MRID 00034769, MRID 00116565**		**In USEPA 1995.**			**Yes**

Formulation	% purity/ai	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) [1]		Toxicity Value (ai) [1]	Units	Chemical Analysis Done/ Reported	Lab	Study Number	Report Number	Data Source [2]	EPA Reviewer	Date Reviewed	Used for TRV derivation
Diquat	**37**	bird	Ring-necked pheasant	***Phasianus colchicus***		**Acute dietary**	**Diet**			**Survival**	**LC_{50}**	**NR**		**734**	**ppm ai**			**MRID 00034769, MRID 00116565**		**In USEPA 1995.**			**Yes**
Diquat	35.3	bird	bobwhite quail	*Colinus virginianus*		Acute dietary	Diet			Survival	LC_{50}	NR		106	ppm ai					In USEPA 1995.			Yes
Diquat	**35.3**	bird	bobwhite quail	***Colinus virginianus***		**Repro & Fert Test**	**Diet**			**Reprod/ Develop**	**NOEL**	**NR**	**>**	**19.6**	**ppm ai**			**MRID 00119988**		**In USEPA 1995.**			**Yes**
Diquat	**35.3**	bird	**Mallard duck**	***Anas platyrhynchos***	**ErlyLf**	**Repro & Fert Test**	**Diet**	**1-generation**		**Reprod/ Develop**	**NOEL**	**NR**		**5**	**ppm ai**		**Wildlife International**	**MRID 00114230**		**1982. In USEPA 1995.**	**C. Lewis**	**1985**	**Yes**
Diquat	35.3	bird	Mallard duck	*Anas platyrhynchos*	ErlyLf	Repro & Fert Test	Diet	1-generation		Reprod/ Develop	LOEL	NR		25	ppm ai		Wildlife International	MRID 00114230		1982. In USEPA 1995, 2003.	C. Lewis	1985	Yes
Diquat	30	bird	Mallard duck	*Anas platyrhynchos*	3-4 months	Acute oral	Oral	14 d		Mortality	LD_{50}	564		NR	mg/kg		DWR	MRID 00160000		1984. In USEPA 1995, 2003.	Hudson, R.H. et al	1985	Yes
Diquat	45	bird	Mallard duck	*Anas platyrhynchos*		Acute oral	Oral	14 d		Mortality	LD_{50}	60.6		NR	mg/kg		Wildlife International	MRID 00106559		1982. In USEPA 1995, 2003.	C. Lewis	1985	Yes
Diquat	35.3	bird	bobwhite quail	*Colinus virginianus*	ErlyLf	Repro & Fert Test	Diet	1-generation		Reprod/ Develop	NOEL	5		NR	ppm		Wildlife International	MRID 00119988		1982. In USEPA 1995, 2003.	C. Lewis	1985	Yes
Diquat HA	240 g/L[28]	bird	Mallard duck	*Anas platyrhynchos*	Day 4 of incubation	Topical	Water	10 s	14 d	Mortality	LC_{50}	NR		19.5	g ai/L	No/No				Sewalk et al. 2001. J. Toxicol. Environ. Health Pt. A. 62: 33-45.			Yes
Diquat HA	240 g/L[28]	bird	Mallard duck	*Anas platyrhynchos*	Day 4 of incubation	Topical	Water	10 s	To hatch	Mortality	LC_{50}	NR		9.6	g ai/L	No/No				Sewalk et al. 2001. J. Toxicol. Environ. Health Pt. A. 62: 33-45.			Yes
Diquat HA	240 g/L[28]	bird	Mallard duck	*Anas platyrhynchos*	Day 4 of incubation	Topical	Water	10 s	To hatch	Mortality	LOEC	NR		7.0	g ai/L	No/No				Sewalk et al. 2001. J. Toxicol. Environ. Health Pt. A. 62: 33-45.			Yes
Diquat HA	240 g/L[28]	bird	Mallard duck	*Anas platyrhynchos*	Day 4 of incubation	Topical	Water	10 s	To hatch	Mortality	NOEC	NR		3.5	g ai/L	No/No				Sewalk et al. 2001. J. Toxicol. Environ. Health Pt. A. 62: 33-45.			Yes
Diquat HA	240 g/L[28]	bird	Mallard duck	*Anas platyrhynchos*	Day 4 of incubation	Topical	Water	10 s	To hatch	Weight	LOEC	NR		56	g ai/L	No/No				Sewalk et al. 2001. J. Toxicol. Environ. Health Pt. A. 62: 33-45.			Yes
Diquat HA	240 g/L[28]	bird	Mallard duck	*Anas platyrhynchos*	Day 4 of incubation	Topical	Water	10 s	To hatch	Weight	NOEC	NR		14	g ai/L	No/No				Sewalk et al. 2001. J. Toxicol. Environ. Health Pt. A. 62: 33-45.			Yes
Diquat HA	240 g/L[28]	bird	Mallard duck	*Anas platyrhynchos*	Day 21 of incubation	Topical	Water	10 s	To hatch	Mortality	LC_{50}	NR		12.6	g ai/L	No/No				Sewalk et al. 2001. J. Toxicol. Environ. Health Pt. A. 62: 33-45.			Yes
Diquat HA	240 g/L[28]	bird	Mallard duck	*Anas platyrhynchos*	Day 21 of incubation	Topical	Water	10 s	To hatch	Mortality	LOEC	NR		7.0	g ai/L	No/No				Sewalk et al. 2001. J. Toxicol. Environ. Health Pt. A. 62: 33-45.			Yes
Diquat HA	240 g/L[28]	bird	Mallard duck	*Anas platyrhynchos*	Day 21 of incubation	Topical	Water	10 s	To hatch	Mortality	NOEC	NR		3.5	g ai/L	No/No				Sewalk et al. 2001. J. Toxicol. Environ. Health Pt. A. 62: 33-45.			Yes
Diquat HA	240 g/L[28]	bird	Mallard duck	*Anas platyrhynchos*	Day 21 of incubation	Topical	Water	10 s	To hatch	Growth	NOEC	NR	>	7.0	g ai/L	No/No				Sewalk et al. 2001. J. Toxicol. Environ. Health Pt. A. 62: 33-45.			Yes
6,7-dihydrodipyrido (1,2-a:2',1'-c) pyrazinediium ion		fish	Coho salmon	*Oncorhynchus kisutch*	12-17 mo - smolt	Static-Renewal	Water	96 hr	96 hr	Mortality	LC_{50}[32]	30		NR	mg/L	Yes/No		EPA-600/3-79-071		Lorz et al. 1979.			Yes
6,7-dihydrodipyrido (1,2-a:2',1'-c) pyrazinediium ion		fish	Coho salmon	*Oncorhynchus kisutch*	12-17 mo - smolt	Static-Renewal	Water	96 hr	96 hr	Mortality	LC_{50}[32]	19		NR	mg/L	Yes/Yes		EPA-600/3-79-071		Lorz et al. 1979.			Yes
6,7-dihydrodipyrido (1,2-a:2',1'-c) pyrazinediium ion		fish	Coho salmon	*Oncorhynchus kisutch*	12-17 mo - smolt	Static-Renewal	Water	96 hr	96 hr + release	Downstream Migration	NOEC*	<	0.5		NR	mg/L	Yes/No		EPA-600/3-79-071		Lorz et al. 1979.			Yes
6,7-dihydrodipyrido (1,2-a:2',1'-c) pyrazinediium ion		fish	Coho salmon	*Oncorhynchus kisutch*	12-17 mo - smolt	Static-Renewal	Water	96 hr	96 hr + release	Downstream Migration	LOEC[20]		0.5		NR	mg/L	Yes/No		EPA-600/3-79-071		Lorz et al. 1979.			Yes
6,7-dihydrodipyrido (1,2-a:2',1'-c) pyrazinediium ion		fish	Coho salmon	*Oncorhynchus kisutch*	12-17 mo - smolt	Flow-thru	Water	285 hr	285 hr + release	Downstream Migration	NOEC[20]		0.5		NR	mg/L	Yes/No		EPA-600/3-79-071		Lorz et al. 1979.			Yes
6,7-dihydrodipyrido (1,2-a:2',1'-c) pyrazinediium ion		fish	Coho salmon	*Oncorhynchus kisutch*	12-17 mo - smolt	Flow-thru	Water	285 hr	285 hr + release	Downstream Migration	LOEC[20]		1		NR	mg/L	Yes/No		EPA-600/3-79-071		Lorz et al. 1979.			Yes
6,7-dihydrodipyrido (1,2-a:2',1'-c) pyrazinediium ion		fish	Coho salmon	*Oncorhynchus kisutch*	12-17 mo - smolt	Flow-thru	Water	12 d	12 d	Condition Factor	NOEC[20]		3		NR	mg/L	Yes/No		EPA-600/3-79-071		Lorz et al. 1979.			Yes

Formulation	% purity/ai	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product)[1]	Toxicity Value (ai)[1]	Units	Chemical Analysis Done/ Reported	Lab	Study Number	Report Number	Data Source[2]	EPA Reviewer	Date Reviewed	Used for TRV derivation
6,7-dihydrodipyrido [1,2-a: 2',1'-c] pyrazinediium dibromide		fish	American eel	*Anguilla rostrata*	glass eel stage	Static	Water	96 hr	96 hr	Mortality	LC_{50}	NR	NR	mg ai/L	No/No				Hinton & Eversole. 1978. Proc. Ann. Conf. SE Assoc. Fish & Wildl. Agencies. 32: 599-604.			Yes
Diquat		fish	Grass carp	*Ctenopharyngodon idella*	adult	Static	Food/ Hydrilla[31]	NA	5 d	Food consumption	LOEC	2	NR	mg/L	No/No				Kracko & Noble. 1993. J. Aquat. Plant Management. 31: 273-275.			Yes
Diquat	35.3 [10]	fish	brown trout	*Salmo trutta*	40.3 mm fingerling	Static	Water	96 hr	96 hr	Mortality	TLm^{35}	NR	20.4	mg ai/L	No/No				Simonin & Skea. 1977. NY Fish & Game Journal. 24: 38-45.			No
Diquat	35.3 [10]	fish	brown trout	*Salmo trutta*	40.3 mm fingerling	Static	Water	96 hr	96 hr	Mortality	$NOEC^{35}$	NR	< 5.5	mg ai/L	No/No				Simonin & Skea. 1977. NY Fish & Game Journal. 24: 38-45.			No
Diquat	35.3 [10]	fish	brown trout	*Salmo trutta*	40.3 mm fingerling	Static	Water	48 hr	48 hr	Mortality	TLm^{35}	NR	22.4	mg ai/L	No/No				Simonin & Skea. 1977. NY Fish & Game Journal. 24: 38-45.			No
Diquat	41	**fish**	**Fathead minnow**	***Pimephales promelas***	**early life**	**Flow through**	**Water**		**34 d**		**NOEC**	**0.58**	**NR**	**mg/L**		**SBI**	**MRID 40380703**		**1987. In USEPA 2003.**	**C. Lewis**	**1990**	**Yes**
Diquat	40	fish	Longnose killifish	*Fundulus similis*	juvenile	Static	Water		48 hr	Mortality	LC_{50}	> 40	> NR	mg/L		EPA	MRID 40228401		1986. In USEPA 2003.	F.L. Mayer	1986	Yes
Diquat	19.6	fish	Striped bass	*Morone saxatilis*	fingerling	Static	Water		96 hr	Mortality	LC_{50}	43.2	NR	mg/L		REF	MRID 00028002		1969. In USEPA 2003.	C. Lewis	1985	Yes
Diquat HA	240 g/L	fish	Walleye	*Stizostedion vitreum*	8-10 d	Static	Water	96 hr	96 hr[34]	Mortality	LOAEC	NR	> 0.93	mg ai/L	Yes/No				Paul et al. 1994. J. Freshwater Ecology. 9: 229-239.			Yes
Diquat HA	240 g/L	fish	Walleye	*Stizostedion vitreum*	8-10 d	Static	Water	96 hr	96 hr[34]	Mortality	NOAEC	NR	> 0.48	mg ai/L	Yes/No				Paul et al. 1994. J. Freshwater Ecology. 9: 229-239.			Yes
Diquat	35.3	fish	Rainbow trout	*Oncorhynchus mykiss*	fingerling	Static	Water	96 hr	96 hr	Mortality	LC_{50}	> 100	> NR	mg/L	Unknown/No	EPA	MRID 40098001	FWS Res. Pub 160	Mayer & Ellersieck. 1986. In USEPA 2003.	Mayer & Ellersieck	1986	Yes
Diquat	35.3	fish	goldfish	*Carassius auratus*	fingerling	Static	Water	24 hr	24 hr	Mortality	LC_{50}	> 100	> NR	mg/L	Unknown/No	FWS	MRID 40098001	FWS Res. Pub 160	Mayer & Ellersieck. 1986. In USEPA 2003.	Mayer & Ellersieck	1986	Yes
Diquat	35.3	fish	black bullhead	*Ameiurus melas*	0.8 g	Static	Water	96 hr	96 hr[8]	Mortality	LC_{50}	170	NR	mg/L	Unknown/No	FWS	MRID 40094602	FWS Res. Pub 160	Mayer & Ellersieck. 1986. In USEPA 2003.	Johnson & Finley	1985	Yes
Diquat	35.3	fish	black bullhead	*Ameiurus melas*	0.8 g	Static	Water	96 hr	96 hr[8]	Mortality	LC_{50}	24.6	NR	mg/L	Unknown/No	FWS	MRID 40098001	FWS Res. Pub 160	Mayer & Ellersieck. 1986. In USEPA 2003.	Mayer & Ellersieck	1986	Yes
Diquat	35.3	fish	bluegill sunfish	*Lepomis macrochirus*	1.1-1.3 g	Static	Water	96 hr	96 hr[8]	Mortality	LC50[33]	115	NR	mg/L	Unknown/No	FWS	MRID 40098001	FWS Res. Pub 160	Mayer & Ellersieck. 1986. In USEPA 2003.	Mayer & Ellersieck	1986	Yes
Diquat	35.3	fish	bluegill sunfish	*Lepomis macrochirus*	1.1 g	Static	Water	96 hr	96 hr[8]	Mortality	LC_{50}	508	NR	mg/L	Unknown/No			FWS Res. Pub 160	Mayer & Ellersieck. 1986.			Yes
Diquat	35.3	fish	bluegill sunfish	*Lepomis macrochirus*	1.1 g	Static	Water	96 hr	96 hr[8]	Mortality	LC_{50}	870	NR	mg/L	Unknown/No			FWS Res. Pub 160	Mayer & Ellersieck. 1986.			Yes
Diquat	35.3	fish	Yellow perch	*Perca flavescens*	0.6 g	Static	Water	96 hr	96 hr[8]	Mortality	LC_{50}	60	NR	mg/L	Unknown/No	FWS	MRID 40094602	FWS Res. Pub 160	Mayer & Ellersieck. 1986. In USEPA 2003.	Johnson & Finley	1985	Yes
Diquat	35.3	fish	Yellow perch	*Perca flavescens*	0.6 g	Static	Water	96 hr	96 hr[8]	Mortality	LC_{50}	23.5	NR	mg/L	Unknown/No	FWS	MRID 40098001	FWS Res. Pub 160	Mayer & Ellersieck. 1986. In USEPA 2003.	Mayer & Ellersieck	1986	Yes
Diquat HA	**240 g/L**	**fish**	**Walleye**	***Stizostedion vitreum***	**8-10 d**	**Static**	**Water**	**96 hr**	**96 hr[34]**	**Mortality**	**LC_{50}**	**NR**	**0.75**	**mg ai/L**	**Yes/No**				**Paul et al. 1994. J. Freshwater Ecology. 9: 229-239.**			**Yes**
Diquat HA	240 g/L	fish	Walleye	*Stizostedion vitreum*	41-43 d	Static	Water	96 hr	96 hr[34]	Mortality	LC_{50}	NR	1.5	mg ai/L	Yes/No				Paul et al. 1994. J. Freshwater Ecology. 9: 229-239.			Yes
Diquat HA	240 g/L	fish	Walleye	*Stizostedion vitreum*	41-43 d	Static	Water	96 hr	96 hr[34]	Mortality	LOAEC	NR	1.9	mg ai/L	Yes/No				Paul et al. 1994. J. Freshwater Ecology. 9: 229-239.			Yes
Diquat HA	240 g/L	fish	Walleye	*Stizostedion vitreum*	41-43 d	Static	Water	96 hr	96 hr[34]	Mortality	NOAEC	NR	0.9	mg ai/L	Yes/No				Paul et al. 1994. J. Freshwater Ecology. 9: 229-239.			Yes
Diquat HA	240 g/L	fish	Walleye	*Stizostedion vitreum*	84-86 d	Static	Water	96 hr	96 hr[34]	Mortality	LC_{50}	NR	4.9	mg ai/L	Yes/No				Paul et al. 1994. J. Freshwater Ecology. 9: 229-239.			Yes
Diquat HA	240 g/L	fish	Walleye	*Stizostedion vitreum*	84-86 d	Static	Water	96 hr	96 hr[34]	Mortality	LOAEC	NR	4.4	mg ai/L	Yes/No				Paul et al. 1994. J. Freshwater Ecology. 9: 229-239.			Yes
Diquat HA	240 g/L	fish	Walleye	*Stizostedion vitreum*	84-86 d	Static	Water	96 hr	96 hr[34]	Mortality	NOAEC	NR	2.6	mg ai/L	Yes/No				Paul et al. 1994. J. Freshwater Ecology. 9: 229-239.			Yes
Diquat HA	240 g/L	fish	Largemouth bass	*Micropterus salmoides*	9-13 d	Static	Water	96 hr	96 hr[34]	Mortality	LC_{50}	NR	4.9	mg ai/L	Yes/No				Paul et al. 1994. J. Freshwater Ecology. 9: 229-239.			Yes

Formulation	% purity/ai	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) [1]	Toxicity Value (ai) [1]	Units	Chemical Analysis Done/ Reported	Lab	Study Number	Report Number	Data Source[2]	EPA Reviewer	Date Reviewed	Used for TRV derivation
Diquat HA	240 g/L	fish	Largemouth bass	*Micropterus salmoides*	9-13 d	Static	Water	96 hr	96 hr[34]	Mortality	LOAEC	NR	3.6	mg ai/L	Yes/No				Paul et al. 1994. J. Freshwater Ecology. 9: 229-239.			Yes
Diquat HA	240 g/L	fish	Largemouth bass	*Micropterus salmoides*	9-13 d	Static	Water	96 hr	96 hr[34]	Mortality	NOAEC	NR	1.8	mg ai/L	Yes/No				Paul et al. 1994. J. Freshwater Ecology. 9: 229-239.			Yes
Diquat HA	240 g/L	fish	Smallmouth bass	*Micropterus dolomieu*	6-8 d	Static	Water	96 hr	96 hr[34]	Mortality	LC_{50}	NR	3.9	mg ai/L	Yes/No				Paul et al. 1994. J. Freshwater Ecology. 9: 229-239.			Yes
Diquat HA	240 g/L	fish	Smallmouth bass	*Micropterus dolomieu*	6-8 d	Static	Water	96 hr	96 hr[34]	Mortality	LOAEC	NR	3.4	mg ai/L	Yes/No				Paul et al. 1994. J. Freshwater Ecology. 9: 229-239.			Yes
Diquat HA	240 g/L	fish	Smallmouth bass	*Micropterus dolomieu*	6-8 d	Static	Water	96 hr	96 hr[34]	Mortality	NOAEC	NR	1.6	mg ai/L	Yes/No				Paul et al. 1994. J. Freshwater Ecology. 9: 229-239.			Yes
Reglone A	278 g diquat dibromide/L	fish	Rainbow trout	*Salmo gairdneri*[29]	1 yr	Static exposure	Water	24 hr	15 min	Swimming speed	NOEC	NR	< 0.5	mg ai/L	Yes/Yes[30]				Dodson & Mayfield. 1979. Environmental Pollution. 18: 147-157.			Yes
Reglone A	278 g diquat dibromide/L	fish	Rainbow trout	*Salmo gairdneri*[29]	1 yr	Static exposure	Water	24 hr	15 min	Swimming speed	LOEC	NR	0.5	mg ai/L	Yes/Yes[30]				Dodson & Mayfield. 1979. Environmental Pollution. 18: 147-157.			Yes
Diquat	0.02	fish	common carp	*Cyprinus carpio*	6-9 weeks	Static	Water	96 hr	96 hr	Mortality	LC_{50}	NR	50.3	mg ai/L	No/No				Chin & Sudderuddin. 1979. Environmental Pollution. 18: 213-220.			Yes
Diquat	0.02	fish	common carp	*Cyprinus carpio*	6-9 weeks	Static	Water	96 hr	96 hr	Mortality	LC_{95}	NR	141.8	mg ai/L	No/No				Chin & Sudderuddin. 1979. Environmental Pollution. 18: 213-220.			Yes
Diquat	**technical grade**	**fish**	**Rainbow trout**	***Salmo gairdneri*[29]**	**1 yr**	**Static exposure**	**Water**	**24 hr**	**15 min**	**Swimming speed**	**NOEC**	**NR**	**< 0.5**	**mg ai/L**	**Yes/Yes[30]**				**Dodson & Mayfield. 1979. Environmental Pollution. 18: 147-157.**			**Yes**
Diquat	35.3 [10]	fish	brown trout	*Salmo trutta*	40.3 mm fingerling	Static	Water	24 hr	24 hr	Mortality	TLm[35]	NR	32.6	mg ai/L	No/No				Simonin & Skea. 1977. NY Fish & Game Journal. 24: 38-45.			No
Diquat	35.3	fish	Grass carp	*Ctenopharyngodon idella*	23.5 g	Static	Water	96 hr	96 hr	Mortality	LC_{50}	NR	53	mg ai/L	No/No				Salah El-Deen & Rogers. 1992. J. Aquatic Animal Health. 4: 277-280.			Yes
Aquacide (commercial form.)	13.5	fish	Grass carp	*Ctenopharyngodon idella*	1+ yr	Flow through	Water	96 h	5 d	Mortality	LC_{50}	1718	NR	mg/L	No/No				Tooby et al. 1980. J. Fish Biol. 16: 591-597.			Yes
Diquat	3.73 lb salt/gal; 2.0 lb diquat cation[14]	fish	Striped bass	*Morone saxatilis*	fingerling (2.7 g)	Static	Water	96 hr	96 hr	Mortality	LC_{50}[36]	80	NR	mg/L	No/No				Wellborn. 1969. Prog. Fish-Culturist. 31: 27-32.			Yes
Diquat	3.73 lb salt/gal; 2.0 lb diquat cation[14]	fish	Striped bass	*Morone saxatilis*	fingerling (2.7 g)	Static	Water	96 hr	96 hr	Mortality	LC_{16}[36]	70	NR	mg/L	No/No				Wellborn. 1969. Prog. Fish-Culturist. 31: 27-32.			Yes
Diquat	35.3	fish	bluegill sunfish	*Lepomis macrochirus*	1.3 g	Static	Water	96 hr	96 hr	Mortality	LC_{50}	245	NR	mg/L		FWS	MRID 40094602		1980. In USEPA 2033.	Johnson & Finley	1985	Yes
Diquat	19.8	fish	bluegill sunfish	*Lepomis macrochirus*	0.11 g	Static	Water	96 hr	96 hr	Mortality	LC_{50}	13.9	NR	mg/L		ABC	MRID 00138962		1980. In USEPA 2033.	C. Lewis	1985	Yes
Diquat	35.3	fish	bluegill sunfish	*Lepomis macrochirus*	0.85 g	Static	Water		72 hr	Mortality	LC_{50}	64.51	NR	mg/L		ARC	MRID 00115572		1965. In USEPA 2003.	C. Lewis	1985	Yes
Diquat	35.3	fish	brown trout	*Salmo trutta*	fingerling	Static	Water		96 hr	Mortality	LC_{50}	17.77	NR	mg/L		CCC	MRID 00115858		1977. In USEPA 2003.	C. Lewis	1985	Yes
Diquat		fish	Emerald Shiner	*Notropis atherinoides*		Static	Water		96 hr	Mortality	LC_{50}	25.8	NR	mg/L		REF	MRID 00027203		1963. In USEPA 2003.	C. Lewis	1985	Yes
Diquat	41	fish	Fathead minnow	*Pimephales promelas*	early life	Flow through	Water		34 d		LOEC	1.5	NR	mg/L		SBI	MRID 40380703		1987. In USEPA 2003.	C. Lewis	1990	Yes
Diquat	technical grade	fish	Rainbow trout	*Salmo gairdneri*[29]	1 yr	Static exposure	Water	24 hr	15 min	Swimming speed	LOEC	NR	0.5	mg ai/L	Yes/Yes[30]				Dodson & Mayfield. 1979. Environmental Pollution. 18: 147-157.			Yes
Diquat	technical grade	fish	Mosquitofish	*Gambusia affinis*	3 cm	Static	Water	24 hr	96 hr	Mortality	LC_{50}	723	NR	mg/L	No/No				Leung et al. 1983. Environmental Pollution. 30: 153-150.			Yes
Diquat	technical grade	fish	Mosquitofish	*Gambusia affinis*	3 cm	Static	Water	96 hr	96 hr	Mortality	LC_{50}	289	NR	mg/L	No/No				Leung et al. 1983. Environmental Pollution. 30: 153-150.			Yes
Diquat	**19.8**	**fish**	**Rainbow trout**	***Oncorhynchus mykiss***	**0.56 g**	**Static**	**Water**		**96 hr**	**Mortality**	**LC_{50}**	**14.83**	**NR**	**mg/L**		**ABC**	**MRID 00138961**		**1980. In USEPA 2003.**	**C. Lewis**	**1985**	**Yes**
Diquat	99.6	insect	Honeybee	*Apis mellifera*	Adult	Dermal	Dermal	48 hr		Mortality	LD_{50}	100	NR	ug/bee		UCR	MRID 00072012		In USEPA 2003.	C. Lewis		Yes

Formulation	% purity/ai	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) [1]	Toxicity Value (ai) [1]	Units	Chemical Analysis Done/ Reported	Lab	Study Number	Report Number	Data Source [2]	EPA Reviewer	Date Reviewed	Used for TRV derivation
Diquat	**technical grade**	**insect**	**Honeybee**	***Apis mellifera***	**Adult**	**Dermal**	**Dermal**	**5 d**		**Mortality**	**LD_{50}**	**47**	**NR**	**ug/bee**		**ICI**	**MRID 40208001**		**1987. In USEPA 2003.**	**C. Lewis**	**1990**	**Yes**
1, 1'-ethylene-2,2'-bipyridylium		mammal	Rat	Sprague-Dawley rat	6-8 weeks	I.P. injection	Organism[38]	Single dose	72 hr	Weight	LOEC	27	NR	mg/kg	No/No				Lam et al. 1980. Toxicology 18: 111-123.			No
9,10 dihydro-8a,10a-diazoniaphenanthrene dibromide monohydrate	technical grade	mammal	Rat	Sherman strain rat	adult male	Oral	Organism	Single dose	at least 14 d	Mortality	LD_{50}	147	NR	mg/kg	No/No				Gaines & Linder. 1986. Fund. Appl. Toxicol. 7: 299-308.			Yes
9,10 dihydro-8a,10a-diazoniaphenanthrene dibromide monohydrate	**technical grade**	**mammal**	**Rat**	**Sherman strain rat**	**adult female**	**Oral**	**Organism**	**Single dose**	**at least 14 d**	**Mortality**	**LD_{50}**	**121**	**NR**	**mg/kg**	**No/No**				**Gaines & Linder. 1986. Fund. Appl. Toxicol. 7: 299-308.**			**Yes**
9,10 dihydro-8a,10a-diazoniaphenanthrene dibromide monohydrate	technical grade	mammal	Rat	**Sherman strain rat**	**adult male**	**Dermal**	**Organism**	**Single dose**	at least 14 d	Mortality	LD_{50}	433	NR	mg/kg	No/No				Gaines & Linder. 1986. Fund. Appl. Toxicol. 7: 299-308.			Yes
Crystalline diquat dichloride[37]		mammal	Rat	Alderley Park (Wistar-derived) rats	adult	Oral	Organism	Single oral dose	14 d	Mortality	LD_{50}[39]	900	NR	umol/kg	No/No				Crabtree et al. 1977. Toxicol. Appl. Pharmacol. 41: 585-595.			Yes
Crystalline diquat dichloride[37]		mammal	Rat	Alderley Park (Wistar-derived) rats	adult	Subcutaneous injection	Organism[38]	Single injection	14 d	Mortality	LD_{50}[39]	90	NR	umol/kg	No/No				Crabtree et al. 1977. Toxicol. Appl. Pharmacol. 41: 585-595.			No
Diquat		mammal	Rat			Acute	Oral				LD_{50}	NR	810 (m), 600 (f)	mg ai/kg					In USEPA 2002.			Yes
Diquat		mammal	Rabbit			Dermal	Dermal			Mortality	LD_{50}	NR	262 (m), 315 (f)	mg ai/kg			MRID 00100614		In USEPA 1995, 2002.			Yes
Diquat		mammal	Rat			Inhalation	air				LC_{50}	NR	0.80 (m), 1.09 (f)	mg ai/L					In USEPA 2002.			Yes
Diquat	20.64	mammal	Rat			Dermal	Dermal	21-28 d		Dermal	NOAEL	NR	5	mg ai/kg/d			MRID 4038101		In USEPA 2002.			Yes
Diquat	20.64	mammal	Rat			Dermal	Dermal	21-28 d		Dermal	LOAEL	NR	5	mg ai/kg/d			MRID 4038101		In USEPA 2002.			Yes
Diquat	20.64	mammal	Rat			Dermal	Dermal	21-28 d		Systemic	NOAEL	NR	5	mg ai/kg/d			MRID 4038101		In USEPA 2002.			Yes
Diquat	20.64	mammal	Rat			Dermal	Dermal	21-28 d		Systemic	LOAEL	NR	20	mg ai/kg/d			MRID 4038101		In USEPA 2002.			Yes
Diquat	20.64	mammal	Rabbit			Dermal	Dermal	20 d		Dermal	NOAEL	NR	< 20	mg ai/kg/d					In USEPA 2002.			Yes
Diquat	20.64	mammal	Rabbit			Dermal	Dermal	20 d		Dermal	LOAEL	NR	20	mg ai/kg/d					In USEPA 2002.			Yes
Diquat	20.64	mammal	Rabbit			Dermal	Dermal	20 d		Systemic	NOAEL	NR	20	mg ai/kg/d					In USEPA 2002.			Yes
Diquat	20.64	mammal	Rabbit			Dermal	Dermal	20 d		Systemic	LOAEL	NR	40	mg ai/kg/d					In USEPA 2002.			Yes
Diquat	26.2	mammal	Rat			Reproduction	Gavage	gestation days 7 to 16		Maternal	NOAEL	NR	4	mg ai/kg/d			MRID 41198902		In USEPA 1995, 2002.			Yes
Diquat	26.2	mammal	Rat			Reproduction	Gavage	gestation days 7 to 16		Maternal	LOAEL	NR	12	mg ai/kg/d			MRID 41198902		In USEPA 1995, 2002.			Yes
Diquat	26.2	mammal	Rat			Reproduction	Gavage	gestation days 7 to 16		Developmental	NOAEL	NR	12	mg ai/kg/d			MRID 41198902		In USEPA 1995, 2002.			Yes
Diquat	26.2	mammal	Rat			Reproduction	Gavage	gestation days 7 to 16		Developmental	LOAEL	NR	40	mg ai/kg/d			MRID 41198902		In USEPA 1995, 2002.			Yes
Diquat	26.2	mammal	Rabbit			Reproduction	Oral?			Maternal	NOAEL	NR	1	mg ai/kg/d					In USEPA 2002.			Yes
Diquat	26.2	mammal	Rabbit			Reproduction	Oral?			Maternal	LOAEL	NR	3	mg ai/kg/d					In USEPA 2002.			Yes
Diquat	26.2	mammal	Rabbit			Reproduction	Oral?			Developmental	NOAEL	NR	3	mg ai/kg/d					In USEPA 2002.			Yes
Diquat	26.2	mammal	Rabbit			Reproduction	Oral?			Developmental	LOAEL	NR	10	mg ai/kg/d					In USEPA 2002.			Yes

Formulation	% purity/ai	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product)[1]	Toxicity Value (ai)[1]	Units	Chemical Analysis Done/ Reported	Lab	Study Number	Report Number	Data Source[2]	EPA Reviewer	Date Reviewed	Used for TRV derivation
Diquat	unknown	mammal	Mouse			Prenatal Development	Oral?			Maternal	NOAEL	NR	1	mg ai/kg/d					In USEPA 2002.			Yes
Diquat	unknown	mammal	Mouse			Prenatal Development	Oral?			Maternal	LOAEL	NR	2	mg ai/kg/d					In USEPA 2002.			Yes
Diquat	unknown	mammal	Mouse			Prenatal Development	Oral?			Developmental	NOAEL	NR	2	mg ai/kg/d					In USEPA 2002.			Yes
Diquat	unknown	mammal	Mouse			Prenatal Development	Oral?			Developmental	LOAEL	NR	4	mg ai/kg/d					In USEPA 2002.			Yes
Diquat	**20.09**	**mammal**	**Rat or Mouse**			**Reproduction**	**Oral?**			**Prenatal**	**NOAEL**	**NR**	**16 (0.8)**	**ppm ai (mg ai/kg/d)**			**MRID 41531301**		**In USEPA 2002.**			**Yes**
Diquat	20.09	mammal	Rat or Mouse			Repro & Fert Test	Oral?			Prenatal	LOAEL	NR	80 (4)	ppm ai (mg ai/kg/d)					In USEPA 2002.			Yes
Diquat	20.09	mammal	Rat or Mouse			Reproduction	Oral?			Reprod/ Develop	NOAEL	NR	80 (4)	ppm ai (mg ai/kg/d)			MRID 41531301		In USEPA 2002.			Yes
Diquat	20.09	mammal	Rat or Mouse			Repro & Fert Test	Oral?			Reprod/ Develop	LOAEL	NR	400/240e (12)	ppm ai (mg ai/kg/d)					In USEPA 2002.			Yes
Diquat	**26.7**	**mammal**	**Beagle dog**			**Chronic (52 w)**	**Diet**	**52 w**			**NOAEL**	**NR**	**0.5**	**mg ai/kg/d**			**MRID 41730301**		**In USEPA 2002.**			**Yes**
Diquat	26.7	mammal	Beagle dog			Chronic (52 w)	Diet	52 w			LOAEL	NR	2.5	mg ai/kg/d			MRID 41730301		In USEPA 2002.			Yes
Diquat	21.09	mammal	Mouse	CD-1		Carcin. Test (104 w)	Oral?	104 w			NOAEL	NR	30 (3.56/4.78)f	ppm ai (mg ai/kg/d)					In USEPA 2002.			Yes
Diquat	21.09	mammal	Mouse	CD-1		Carcin. Test (104 w)	Oral?	104 w			LOAEL	NR	100 (11.96/16.03)f	ppm ai (mg ai/kg/d)					In USEPA 2002.			Yes
Diquat	**26.5**	**mammal**	**Rat**			**Carcinogencity**	**Oral?**	**104 w**			**NOAEL**	**NR**	**15 (0.58/0.72)f**	**ppm ai (mg ai/kg/day)**			**MRID 41085601, MRID 00145855**		**In USEPA 2002.**			**Yes**
Diquat	26.5	mammal	Rat			Carcinogencity	Oral?	104 w			LOAEL	NR	75 (2.91/3.64)f	ppm ai (mg ai/kg/d)			MRID 41085601, MRID 00145855		In USEPA 2002.			Yes
Diquat	20.1	mammal	Rat			Neurotoxicity	Oral?				NOAEL	NR	75	mg ai/kg					In USEPA 2002.			Yes
Diquat	20.1	mammal	Rat			Neurotoxicity	Oral?				LOAEL	NR	150	mg ai/kg					In USEPA 2002.			Yes
Diquat	20.8	mammal	Rat	Alpk:APfSD Rat		Neurotoxicity	Oral?			Systemic	NOAEL	NR	100 (8.0/9.5)f	ppm ai (mg ai/kg/d)					In USEPA 2002.			Yes
Diquat	20.8	mammal	Rat	Alpk:APfSD Rat		Neurotoxicity	Oral?			Systemic	LOAEL	NR	400 (32.4/38.5)f	ppm ai (mg ai/kg/d)					In USEPA 2002.			Yes
Diquat	technical grade	mammal	Rabbit			Dermal	Dermal			Mortality	LD_{50}	NR	288.5 (m&f)	mg ai/kg			MRID 00100614		In USEPA 1995			Yes
Diquat		mammal	Rat			Reproduction	Diet	gestation days 1 to 20		Maternal	LOAEL	NR	500 (32 -56)	ppm ai (mg ai/kg/day)			Accession 224405		In USEPA 1995			Yes
Diquat		mammal	Rat			Reproduction	Diet	gestation days 1 to 20		Maternal	NOAEL	NR	125 (8-14)	ppm ai (mg ai/kg/d)			Accession 224405		In USEPA 1995			Yes
Diquat		mammal	Rat			Reproduction	Diet	gestation days 1 to 20		Developmental	LOAEL	NR	500 (32 -56)	ppm ai (mg ai/kg/d)			Accession 224405		In USEPA 1995			Yes
Diquat		mammal	Rat			Reproduction	Diet	gestation days 1 to 20		Developmental	NOAEL	NR	125 (8-14)	ppm ai (mg ai/kg/d)			Accession 224405		In USEPA 1995			Yes
Diquat		mammal	Rabbit			Reproduction	Gavage	gestation days 1 to 28		Developmental	LOAEL	NR	2.5	mg ai/kg/d			MRID 00061635		In USEPA 1995			Yes
Diquat		mammal	Rabbit			Reproduction	Gavage	gestation days 1 to 28		Developmental	NOAEL	NR	5	mg ai/kg/d			MRID 00061635		In USEPA 1995			Yes
Diquat	technical grade	mammal	Rat			Neurotoxicity	gavage	single dose		Neurotoxicity	LOAEL	NR	75	mg ai/kg/d			MRID 42666801		In USEPA 1995			Yes
Diquat	technical grade	mammal	Rat			Neurotoxicity	gavage	single dose		Neurotoxicity	NOAEL	NR	25	mg ai/kg/d			MRID 42666801		In USEPA 1995			Yes
Diquat dibromide monohydrate	49.1	mammal	Rat	Sprague-Dawley rats	adult	Oral	Organism[40]	up to 10 d	up to 14 d	Maternal survival	NOEC	65	NR	mg/kg/d	No/No				Chernoff et al. 1990, Teratology. 42: 651-658.			Yes

For ulation	% purity/ai	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) [1]		Toxicity Value (ai) [1]		Units	Chemical Analysis Done/ Reported	Lab	Study Number	Report Number	Data Source [2]	EPA Reviewer	Date Reviewed	Used for TRV derivation
Diquat dibromide monohydrate	49.1	mammal	Rat	Sprague-Dawley rats	adult	Oral	Organism[40]	up to 10 d	up to 14 d	Maternal survival	LOEC	>	65	>	NR	mg/kg/d	No/No				Chernoff et al. 1990. Teratology. 42: 651-658.			Yes
Diquat dibromide monohydrate	49.1	mammal	Rat	Sprague-Dawley rats	adult	Oral	Organism[40]	up to 10 d	up to 14 d	Fetal toxicity	NOEC		65		NR	mg/kg/d	No/No				Chernoff et al. 1990. Teratology. 42: 651-658.			Yes
Diquat dibromide monohydrate	49.1	mammal	Rat	Sprague-Dawley rats	adult	Oral	Organism[40]	up to 10 d	up to 14 d	Fetal toxicity	LOEC	>	65	>	NR	mg/kg/d	No/No				Chernoff et al. 1990. Teratology. 42: 651-658.			Yes
Diquat[37]		mammal	Rat	Sprague-Dawley rats	fetus	Intravenous	Organism[38]	Single iv dose	1-14 d	Fetal viability	LOEC		15		NR	mg/kg	Yes/No				Bus et al. 1975. Toxicol. Appl. Pharmacol. 33: 450-460.			No
Diquat	28.6 (w/v)	mammal	Mouse	*Mus musculus*	10-12 w	Oral	Organism	5 d	3 w	Mortality	NOEC		1		NR	mg/kg BW/d	No/No				Anderson et al. 1976. Mutation Res. 40: 349-358.			Yes
Diquat	28.6 (w/v)	mammal	Mouse	*Mus musculus*	10-12 w	Oral	Organism	5 d	Variable	Mating Success	NOEC		1		NR	mg/kg BW/d	No/No				Anderson et al. 1976. Mutation Res. 40: 349-358.			Yes
Diquat	28.6 (w/v)	mammal	Mouse	*Mus musculus*	10-12 w	Oral	Organism	5 d	Variable	Pregnancy Success	NOEC		1		NR	mg/kg BW/d	No/No				Anderson et al. 1976. Mutation Res. 40: 349-358.			Yes
Diquat		terrestrial plant	crop species	10 species						seed emergence & germination	EC_{25}		NR	>	7.49	lb ai/acre				In USEPA 1995			Yes
Diquat		terrestrial plant	crop species	10 species						seed emergence & germination	NOEAC		NR		7.49	lb ai/acre				In USEPA 1995			Yes
Diquat		terrestrial plant	corn	*Zea mays*						desication	EC_{25}		NR		0.016	lb ai/acre				In USEPA 1995			Yes
Diquat	35.3	terrestrial plant	Wheat	*Triticum aestivum*		vegetative vigor				desication	EC_{25}		NR		0.016	lb ai/acre				In USEPA 1995			Yes
Diquat	**35.3**	**terrestrial plant**	**cotton**	***Gossypium spp.***		**vegetative vigor**				**vigor**	**EC_{25}**		**NR**		**0.0047**	**lb ai/acre**				**In USEPA 1995**			**Yes**
Diquat	**35.3**	**terrestrial plant**	**Soybean**	***Glycine max***	**juvenile plant**	**vegetative vigor**			**14 d**	**vigor**	**EC_{25}**		**NR**		**0.0100**	**lb ai/acre**	**CCI**	**MRID 41883001**		**1990. In USEPA 2003.**	**M. Davy**	**1994**	**Yes**
Diquat	35.3	terrestrial plant	Soybean	*Glycine max*	juvenile plant	vegetative vigor			14 d	vigor	NOEL		NR		0.0197	lb ai/acre	CCI	MRID 41883001		1990. In USEPA 2003.	M. Davy	1994	Yes
Diquat	35.3	terrestrial plant	Soybean	*Glycine max*		vegetative vigor				vigor	EC_{25}		NR		0.0074	lb ai/acre				In USEPA 1995.			Yes
Diquat		terrestrial plant	corn	*Zea mays*	juvenile plant	vegetative vigor			4 wks	vigor	EC_{25}		NR		0.04	lb ai/acre	Wildlife International	MRID 44755601		1999. In USEPA 2003.	GAI	2000	Yes
Diquat		terrestrial plant	corn	*Zea mays*						vigor	NOEAC		NR		0.01064	lb ai/acre				In USEPA 1995.			Yes
Diquat	35.3	terrestrial plant	Wheat	*Triticum aestivum*	juvenile plant	vegetative vigor			4 wks	vigor	EC_{25}		NR		0.1700	lb ai/acre	Wildlife International	MRID 44755601		1999. In USEPA 2003.	GAI	2000	Yes
Diquat	35.3	terrestrial plant	Wheat	*Triticum aestivum*	juvenile plant	vegetative vigor			4 wks	vigor	NOEAC		NR		0.1300	lb ai/acre	Wildlife International	MRID 44755601		1999. In USEPA 2003.	GAI	2000	Yes
Diquat		terrestrial plant	corn	*Zea mays*	juvenile plant	vegetative vigor			4 wks	vigor	NOEL		NR		0.031	lb ai/acre	Wildlife International	MRID 44755601		1999. In USEPA 2003.	GAI	2000	Yes
Diquat	35.3	terrestrial plant	cotton	*Gossypium spp.*	juvenile plant	vegetative vigor			14 d	vigor	NOEL		NR		0.0197	lb ai/acre	CCI	MRID 41883001		1990. In USEPA 2003.	M. Davy	1994	Yes
Diquat (c.)	21.6 & 23.5		Unknown			21 day chronic	Inhalation	21 d			NOAEL		NR		0.1 (0.024 (M), 0.026 (f)	g ai/L/day (mg ai/kg/d)				In USEPA 2002.			Yes
Diquat (c.)	21.6 & 23.5		Unknown			20 day chronic	Inhalation	20 d			LOAEL		NR		0.49 (0.117 (M), 0.128 (f)	g ai/L/day (mg ai/kg/d)				In USEPA 2002.			Yes

Boldface indicates study selected for derivation of toxicity reference value (TRV) used in risk assessment.

[1]Toxicity values relate the dose of a compound with a potentially adverse effect. Values are reported as they were presented in the reviewed sou

[2]See the bibliography of this ERA document, Appendix A of the associated Literature Review document, and source footnote for complete citations.

[3]tested product identified as diquat

[4]diquat led to macrophyte die-off, faster algae growth rate, and increased tadpole food supply.

[5]at 13 days.

Abbreviations

m - male
f - female
a.i. - active ingredient
NR - Not reported.

Formulation	% purity/ai	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) [1]	Toxicity Value (ai) [1]	Units	Chemical Analysis Done/ Reported	Lab	Study Number	Report Number	Data Source [2]	EPA Reviewer	Date Reviewed	Used for TRV derivation

[6]Diquat as a.i. Long-term application of diquat keeping concentration constant.
[7]no statistical analysis but substantial effects seen.
[8]24 h LC50 also available.
[9]As cited in USEPA 2003.
[10]diquat dibromide as active ingredient.
[11]Diaptomus spp comprised 90% of copepods; Eucyclops spp comprised 10%.
[12]Chautauqua Lake water.
[13]median tolerance limit.
[14]aka 6,7-dihydrodipyrido(1,2-a:2,1'-c) pyrazinedium dibromide.
[15]Sieved mud in test chambers.
[16]48-h value.
[17]20% mortality at highest concentration (10 ppm).
[18]Addition of soil-sand mix increased LOEC to > 3 ppm (highest concentration tested).
[19]Sediment exposed to aqueous diquat concentration for 9 days before rinsing and testing.
[20]nominal concentrations.
[21]all dead within a few days of initiation, none returned.
[22]not sure if this is per tested product or a.i. Diquat concentrations measured analytically.
[24]5 d treated followed by 3 d untreated.
[25]ppm diquat in feed.
[26]EPA RED (1995) reports study date as 1975.
[27]33% mortality @ 5000 ppm.
[28]Cation concentration in concentrate.
[29]now Oncorhynchus mykiss.
[30]5 ppm treatment and tissue residues only.
[31]Hydrilla treated with 2 ppm diquat 5 days before feeding experiments began.
[32]Not certain if measured or nominal concentrations were used in calculation of the LC_{50}.
[33]96-h LC50s range from 115 to 498 mg/L for pH of 6.5-9.5 at hardness of 44 mg/L.
[34]Endpoints from 24, 48, and 72 hours also available.
[35]Based on diquat cation.
[36]All results reported in ppm of commercial formulation and not of active ingredient.
[37]Inappropriate exposure route.
[38]N,N'-ethylene 2,2'-bipyridilium.
[39]Doses based on previous studies.
[40]Doses administered on days 6-15 of gestation.

MRID - Master Record Identification Number

Endpoints

EC_{25} - 25% effect concentration
EC_{50} - 50% effect concentration
IC_0 - concentration causing 0% inhibition of a process
IC_{100} - concentration causing 100% inhibition of a process
IC_{25} - concentration causing 25% inhibition of a process
IC_{50} - concentration causing 50% inhibition of a process
LC_{16} - lethal concentration, 16% mortality
LC_{50} - median lethal concentration, 50% mortality
LC_{70} - lethal concentration, 70% mortality
LC_{95} - lethal concentration, 95% mortality
LD_{50} - median lethal dose, 50% mortality
LOAEC - lowest-observable-adverse effect concentration
LOAEL - lowest-observable-adverse effect level
LOEC - lowest-observable-effect concentration
LOEL - lowest-observable-effect level
MATC - maximum acceptable toxicant concentration
NOAEC - no-observable-adverse effect concentration
NOAEL - no-observable-adverse effect level
NOEC - no-observable-effect concentration
NOEL - no-observable-effect level

Durations

hr - hours
d - days
w - weeks
m - months
y - years

APPENDIX B

Ecological Risk Assessment Worksheet - Diquat

DERIVATION OF EECS

Section 3.0 of the Methods Document (ENSR 2004c) presents the details of the exposure scenarios considered in the risk assessments. The following sub-sections describe the scenarios that were evaluated for bromacil. Note that in many cases, units were converted during the calculations (e.g., lb/acre converted to mg/cm^2). These conversions were not included in the equations presented below.

Direct Spray

Plant and wildlife species may be unintentionally impacted during normal application of a terrestrial herbicide as a result of a direct spray of the receptor or the waterbody inhabited by the receptor, indirect contact with dislodgeable foliar residue after herbicide application, or consumption of prey items sprayed during application. These exposures may occur within the application area (consumption of prey items) or outside of the application area (waterbodies accidentally sprayed during application of terrestrial herbicide). Generally, impacts outside of the intended application area are accidental exposures and are not typical of BLM application practices. The following direct spray scenarios were evaluated:

Direct Spray of Terrestrial Wildlife

Small mammal or Insect 100% Dermal Absorption

Surface Areas (A): $cm^2 = 12.3 \times BW^{0.65}$

Where: BW = body weight in grams

Amount deposited on ½ receptor (Amnt): $0.5 \times A \times R$

Where: A = Surface area in cm^2

R = Application rate in lb a.i./acre

Small mammal 1st order

Proportion absorbed over period T (Prop): $1-\exp(-k\ T)$

Where: k = First order dermal absorption rate ($hour^{-1}$)

T = Time (24 hours)

Absorbed Dose: $Amnt \times Prop \div BW$

Ingestion of Food Items Contaminated by Direct Spray

All herbivorous receptors ingestion acute

Concentration on food (C): $R \times rr$

Where: R = Application rate (lb a.i./acre)

rr = Residue rate as determined from Kenaga nomagram (mg/kg per lb/acre)

Dose estimates (D): $C \times A \div BW$

Where: C = Concentration on food (mg/kg food)

A = Wet weight food ingestion rate (kg/day)

BW = Body Weight

All herbivorous receptors ingestion chronic

Initial concentration on food (C0): $R \times rr \times Drift$

Where: R = Application rate (lb a.i./acre)

rr = Residue rate as determined from Kenaga nomagram (mg/kg per lb/acre)

Drift = 1

Concentration on food at time T: $C0 \times \exp(-k \times T)$

Where: C0 = Concentration on food at time zero (mg/kg food)

k = Decay Coefficient: $\ln(2) \div t50$ ($days^{-1}$)

T = Time (90 days)

Time-weighted Average Concentration on vegetation (CTWA): $C0 \times (1-\exp(-k \times T)) \div (k \times T)$

Dose estimates (D): $CTWA \times A \times Prop \div BW$

Where: CTWA = Time Weighted Concentration on food (mg/kg food)

A = Wet weight food ingestion rate (kg/day)

Prop = Proportion of food impacted by direct spray (100%)

BW = Body Weight

Large carnivorous mammal ingestion acute

Amount deposited on small mammal prey (Amnt_mouse): 0.5 × SurfaceArea × R
Where: R = Application rate (lb a.i./acre)
Dose estimates: Drift × Prop × Amnt_mouse ÷ BW_mouse × A ÷BW
Where: Drift = 1
Prop = Proportion of food impacted by direct spray (100%)
A = Wet weight food ingestion rate (kg/day)
BW = Body Weight of carnivore
BW_mouse = Body weight of food (small mammal; mouse)

Large carnivorous mammal ingestion chronic
Initial concentration on mammal (C0): 0.5 × SurfaceArea × R ÷ BW_smallmammal
Where: R = Application rate (lb a.i./acre)
SurfaceArea = Surface area of food (small mammal; mouse)
BW_smallmammal = Body weight of food (small mammal; mouse)
Concentration absorbed in small mammal at time T (C90): C0 × exp(-k × T)
Where: C0 = Concentration on food at time zero (mg/kg food)
k = Decay Coefficient: ln(2)/t50 ($days^{-1}$)
T = Time (90 days)
Dose estimates: C90 × FIR_coyote × Prop ÷ BW
Where: C90 = Concentration of herbicide in food at 90 days
FIR = Wet weight food ingestion rate (mg/kg-day)
Prop = Proportion of food impacted by direct spray (100%)
BW = Body Weight

Accidental Direct Spray Over Pond
Mass in Pond (Mp): Ap × R
Where: Ap = Area of pond
R = Application rate (lb a.i./acre)
Concentration in Pond: Mp ÷ (Vp)
Where: Vp = Volume of pond

Accidental Direct Spray Over Stream
Mass in Stream Reach (Ms): As × R
Where: Ap = Area of stream affected by spray
R = Application rate (lb a.i./acre)
Concentration in Pond: Ms ÷ (Vs)
Where: Vs = Volume of stream reach affected by spray

Off-Site Drift

During normal application of herbicides, it is possible for a portion of the herbicide to drift outside of the treatment area and deposit onto non-target receptors. To simulate these off-site herbicide transport mechanisms, AgDRIFT® software was used to evaluate a number of possible drift scenarios. These models provide concentrations in media. Details of the model and calculations used to obtain soil and water concentrations are presented in the Methods document (ENSR, 2004). The surface water concentrations were used in the ERAs to estimate fish concentrations and consumption of these fish by an avian piscivore. The following presents those calculations:

Consumption of Fish From Contaminated Pond
Concentration in fish = Cw × BCF × FCM TL2 × FCM TL3
Where: Cw = Concentration in water (obtained from model) mg/L
BCF = Bioconcentration factor (L/kg fish)
FCM TL2 = Trophic Level 2 food chain multiplier (unitless)
FCM TL3 = Trophic Level 3 food chain multiplier (unitless)
Dose estimates (D): C × A × Prop ÷ BW
Where: C = Concentration in fish (mg/kg food)
A = Wet weight food ingestion rate (kg/day)

Prop = Proportion of food impacted (100%)
BW = Body Weight

Accidental Spill to Pond

To represent worst-case potential impacts to ponds, a spill scenario was considered. A truck or helicopter spilling an entire load of herbicide mixed for the maximum application rate into a 1/4 acre, 1 meter deep pond.

Truck or Helicopter Spill into Pond

Concentrations in water (Cw): $Cm \times Vspill \div Vp$

Where: Cm = Herbicide concentration in the truck or helicopter mixture (mg a.i./L)
Vspill = Volume of the spill (L)
Vp = Volume of the pond (L)

LIST OF TABLES

B-1 Direct Spray of Terrestrial Receptors and Exposure from Indirect Contact with Foliage. B-1
B-2 Potential Risks to Small Herbivorous/Omnivorous Mammal (Deer Mouse) From Consumption of Contaminated Fruit (Acute Exposure Scenario)…….B-2
B-3 Potential Risks to Small Herbivorous/Omnivorous Mammal (Deer Mouse) From Consumption of Contaminated Fruit (Chronic Exposure Scenario)..... B-3
B-4 Potential Risks to Large Herbivorous Mammal (Mule Deer) From Consumption of Contaminated Vegetation (Acute Exposure Scenario)……..B-4
B-5 Potential Risks to Large Herbivorous Mammal (Mule Deer) From Consumption of Contaminated Vegetation (Chronic Exposure Scenario). B-5
B-6 Potential Risks to Carnivorous Mammal (Coyote) From Consumption of Contaminated Small Mammals (Acute Exposure Scenario).....B-6
B-7 Potential Risks to Carnivorous Mammal (Coyote) From Consumption of Contaminated Small Mammals (Chronic Exposure Scenario) B-7
B-8 Potential Risks to Insectivorous Bird (American Robin) From Consumption of Contaminated Insects (Acute Exposure Scenario) B-8
B-9 Potential Risks to Insectivorous Bird (American Robin) From Consumption of Contaminated Insects (Chronic Exposure Scenario).....B-9
B-10 Potential Risks to Herbivorous Bird (Canada goose) From Consumption of Contaminated Vegetation (Acute Exposure Scenario).....B-10
B-11 Potential Risks to Herbivorous Bird (Canada goose) From Consumption of Contaminated Vegetation (Chronic Exposure Scenario) B-11
B-12 Potential Risk to Predatory Bird from Consumption of Contaminated Fish from Pond (Pond Impacted by Regular Application of Herbicide) B-12
B-13 Potential Risks to Non-Target Terrestrial Plants from Direct Spray and Spray Drift B-13
B-14 Potential Risks to Aquatic Species from Accidental Spill to Pond (Acute Exposure) B-14
B-15 Potential Risk to Aquatic Species from Direct Spray of Pond and Stream (Acute Exposure).....B-15

General note: Exposure parameters and equations in the following tables are described in more detail in the *Vegetation Treatments Programmatic EIS Ecological Risk Assessment Methodology* (ENSR 2004) and Section 4 of the ecological risk assessment for this herbicide.

TABLE B-1

Direct Spray of Terrestrial Receptors and Exposure from Indirect Contact with Foliage

Parameter		Pollinating Insect	Small Mammal	Units
Duration of exposure (T)		24	24	hours
Body weight (BW)		0.000093	0.02	kg
Surface areas (A): cm^2 = 12.3 × BW(g)^0.65 [1]		2.63	86.21	cm^2
Application rates (R)	Typical	1	1	lb/acre
	Maximum	4	4	lb/acre
Amount deposited on ½ receptor	Typical	0.0147	0.4831	mg
(Amnt): 0.5 × A × R × cf [2]	Maximum	0.059	1.9326	mg
Dose Estimate Assuming 100% Dermal Adsorption[3]				
Absorbed Dose: (Amnt × Prop) / BW	Typical	1.58E+02	2.42E+01	mg/kg bw
	Maximum	6.34E+02	9.66E+01	mg/kg bw
Dose Estimate Assuming First Order Dermal Adsorption[4]				
First-order dermal absorption coefficient (k)	Central estimate (ka)	0.0231	0.0231	$hour^{-1}$
Proportion absorbed over period T (Prop):	Typical	0.0048	0.0048	unitless
1-exp(-k×T) [5]	Maximum	0.0048	0.0048	unitless
Absorbed dose: (Amnt × Prop) / BW	Typical	7.59E-01	1.16E-01	mg/kg bw
	Maximum	3.04E+00	4.63E-01	mg/kg bw

RISK QUOTIENTS[6] **- Direct Spray**	**Toxicity Reference Value (mg/kg bw)**[7]	**Typical Application**	**Maximum Application**
Small mammal - 100% absorption	247	2.48E-02	9.93E-02
Pollinating insect - 100% absorption	505	3.14E-01	1.26E+00
Small mammal - 1st order dermal adsorption	247	1.19E-04	4.76E-04
Pollinating insect - 1st order dermal adsorption	505	1.50E-03	6.01E-03

RISK QUOTIENTS - Indirect Contact[8]	**Toxicity Reference Value (mg/kg bw)**[7]	**Typical Application**	**Maximum Application**
Small mammal - 100% absorption	247	2.48E-03	9.93E-03
Pollinating insect - 100% absorption	505	3.14E-02	1.26E-01
Small mammal - 1st order dermal adsorption	247	1.19E-05	4.76E-05
Pollinating insect - 1st order dermal adsorption	505	1.50E-04	6.01E-04

[1] Surface area calculation for mammals from Stahl (1967; presented in USEPA 1993). No surface area calculation identified for insects. Mammalian equation used as a surrogate.
[2] A conversion factor (cf) of 0.011208493 was used to convert the application rate (R) from lb/acre to mg/cm2.
[3] 100% dermal absorption - all of the herbicide falling on the receptor was assumed to penetrate the skin within 24 hours.
[4] 1st order dermal absorption - absorption occurs over 24 hours, taking into consideration the potential for some herbicide to not be absorbed.
[5] exp(-k×T) = e^(-k×T), where e is a constant = 2.7828.
[6] Risk Quotient = Estimated Dose/Toxicity Reference Value.
[7] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs (mg/kg bw) were selected during a review of the ecotoxicological literature.
[8] Exposure from indirect contact assumed to be 1/10 of direct spray exposure (Harris and Solomon 1992).

TABLE B-2

Potential Risks to Small Herbivorous/Omnivorous Mammal (Deer Mouse) from Consumption of Contaminated Fruit (Acute Exposure Scenario)

Parameters/Assumptions		Value	Units
Body weight (W)		0.02	kg
Food ingestion rate (dry weight [dw]) [1]		0.0034	kg dw/day
Food ingestion rate (wet weight [ww]) ir [2]		0.0146	kg ww/day
Application rates (R)	Typical	1	lb/acre
	Maximum	4	lb/acre
Residue rate - berries (rr) [3]	Typical	5.4	mg/kg per lb/acre
	Maximum	40.7	mg/kg per lb/acre
Concentration on berries (C): R × rr	Typical	5.4	mg/kg fruit
	Maximum	162.8	mg/kg fruit
Dose estimates (D): C × ir / BW	Typical	3.95E+00	mg/kg bw
	Maximum	1.19E+02	mg/kg bw

RISK QUOTIENTS[4] - Ingestion	**Toxicity Reference Value (mg/kg bw)[5]**	**Typical Application**	**Maximum Application**
Small mammalian herbivore/omnivore – (acute exposure)	247	1.60E-02	4.82E-01

[1] Calculated using algorithm developed by Nagy (1987) for rodents; where food ingestion rate (g dw/day) = 0.621× (BW g)^0.564; converted into kg dw/day.
[2] Assumes fruit is 77% water (USEPA 1993; Table 4-2 - value for fruit pulp and skin).
[3] Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994) and are vegetation-specific.
[4] Risk Quotient = Estimated Dose/Toxicity Reference Value.
[5] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs (mg/kg bw) were selected during a review of the ecotoxicological literature.

TABLE B-3

Potential Risks to Small Herbivorous/Omnivorous Mammal (Deer Mouse) from Consumption of Contaminated Fruit (Chronic Exposure Scenario)

Parameters/Assumptions		Value	Units
Duration of exposure (T)		90	days
Body weight (W)		0.02	kg
Food ingestion rate (dry weight [dw]) [1]		0.0034	kg dw/day
Food ingestion rate (wet weight [ww]) ir [2]		0.0146	kg ww/day
Half life on vegetation (t_{50})	Herbicide specific	30	days
Application rates (R)	Typical	1	lb/acre
	Maximum	4	lb/acre
Residue rate - berries (rr) [3]	Typical	5.4	mg/kg per lb/acre
	Maximum	40.7	mg/kg per lb/acre
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Decay Coefficient (k): $\ln(2)/t_{50}$ [4]	Typical	0.0231	$days^{-1}$
	Maximum	0.0231	$days^{-1}$
Initial concentration on berries (C_0): R × rr × Drift	Typical	5.4	mg/kg fruit
	Maximum	162.8	mg/kg fruit
Concentration on berries at time T: $C_0 \times \exp(-k \times T)$ [5]	Typical	0.675	mg/kg fruit
	Maximum	20.35	mg/kg fruit
Time-weighted Average Concentration on vegetation (CTWA): C0 * (1-exp(-k×T))/(k×T) [5]	Typical	2.2722	mg/kg fruit
	Maximum	68.5040	mg/kg fruit
Proportion of Diet Contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates (D): (CTWA × ir × PC) / BW	Typical	1.66E+00	mg/kg bw/day
	Maximum	5.01E+01	mg/kg bw/day

RISK QUOTIENTS[6] – Ingestion	Toxicity Reference Value (mg/kg bw/day)[7]	Typical Application	Maximum Application
Small mammalian herbivore/omnivore – (chronic exposure)	1.64	1.01E+00	3.05E+01

[1] Calculated using algorithm developed by Nagy (1987) for rodents; where food ingestion rate (g dw/day) = 0.621×(BW g)^0.564; converted into kg dw/day.
[2] Assumes fruit is 77% water (USEPA 1993; Table 4-2 - value for fruit pulp and skin).
[3] Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994) and are vegetation-specific.
[4] ln = Natural log function.
[5] exp(-k×T) = e^(-k×T), where e is a constant = 2.7828.
[6] Risk Quotient = Estimated Dose/Toxicity Reference Value.
[7] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs (mg/kg bw) were selected during a review of the ecotoxicological literature.

TABLE B-4

Potential Risks to Large Herbivorous Mammal (Mule Deer) from Consumption of Contaminated Vegetation (Acute Exposure Scenario)

Parameters/Assumptions		Value	Units
Body weight (BW)		70	kg
Food ingestion rate (dry weight [dw]) [1]		1.9212	kg dw/day
Food ingestion rate (wet weight [ww]) ir [2]		6.4039	kg ww/day
Duration of exposure (D)		1	day
Application rates (R)	Typical	1	lb/acre
	Maximum	4	lb/acre
Residue rate - grass (rr) [3]	Typical	36	mg/kg per lb/acre
	Maximum	197	mg/kg per lb/acre
Concentration on grass (C): R × rr	Typical	36	mg/kg grass
	Maximum	788	mg/kg grass
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates: (Drift × PC × C × ir) / BW	Typical	3.29E+00	mg/kg bw/day
	Maximum	7.21E+01	mg/kg bw/day

RISK QUOTIENTS[4] – Ingestion	Toxicity Reference Value (mg/kg bw/day)[5]	Typical Application	Maximum Application
Large mammalian herbivore/gramivore – (acute exposure)	32	1.03E-01	2.25E+00

[1] Calculated using algorithm developed by Nagy (1987) for herbivores; where food ingestion rate (g dw/day) = 0.577×(BW g)^0.727; converted into kg dw/day.
[2] Assumes grass is 70% water (USEPA 1993; Table 4-2 - lowest value for young grasses).
[3] Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994) and are vegetation-specific.
[4] Risk Quotient = Estimated Dose/Toxicity Reference Value.
[5] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs (mg/kg bw) were selected during a review of the ecotoxicological literature.

TABLE B-5

Potential Risks to Large Herbivorous Mammal (Mule Deer) from Consumption of Contaminated Vegetation (Chronic Exposure Scenario)

Parameters/Assumptions		Value	Units
Duration of exposure (T)		90	day
Body weight (BW)		70	kg
Food ingestion rate (dry weight [dw]) [1]		1.9212	kg dw/day
Food ingestion rate (wet weight [ww]) ir [2]		6.4039	kg ww/day
Half life on vegetation (t_{50})	Herbicide specific	30	days
Application rates (R)	Typical	1	lb/acre
	Maximum	4	lb/acre
Residue rate - grass (rr) [3]	Typical	36	mg/kg per lb/acre
	Maximum	197	mg/kg per lb/acre
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Decay Coefficient (k): $ln(2)/t_{50}$ [4]	Typical	0.0231	$days^{-1}$
	Maximum	0.0231	$days^{-1}$
Initial concentration on grass (C_0): R × rr × Drift	Typical	36	mg/kg grass
	Maximum	788	mg/kg grass
Concentration on grass at time T: $C_0 \times exp(-k \times T)$ [5]	Typical	4.5	mg/kg grass
	Maximum	98.5	mg/kg grass
Time-weighted average concentration on vegetation (CTWA): $C_0 * (1-exp(-k \times T))/(k \times T)$ [5]	Typical	15.1483	mg/kg vegetation
	Maximum	331.5794	mg/kg vegetation
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates: (CTWA ×ir × PC) / BW	Typical	1.39E+00	mg/kg bw/day
	Maximum	3.03E+01	mg/kg bw/day

RISK QUOTIENTS[6] – Ingestion	Toxicity Reference Value (mg/kg bw/day)[6]	Typical Application	Maximum Application
Large mammalian herbivore/gramivore – (chronic exposure)	0.33	4.20E+00	9.19E+01

[1] Calculated using algorithm developed by Nagy (1987) for herbivores; where food ingestion rate (g dw/day) = 0.577×(BW g)^0.727; converted into kg dw/day.
[2] Assumes grass is 70% water (USEPA 1993; Table 4-2 - lowest value for young grasses).
[3] Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994) and are vegetation-specific.
[4] ln = Natural log function.
[5] exp(-k×T) = e^(-k×T), where e is a constant = 2.7828.
[6] Risk Quotient = Estimated Dose/Toxicity Reference Value.
[7] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs (mg/kg bw) were selected during a review of the ecotoxicological literature.

TABLE B-6

Potential Risks to Carnivorous Mammal (Coyote) from Consumption of Contaminated Small Mammals (Acute Exposure Scenario)

Parameters/Assumptions		Value	Units
Body weight (BW)		12	kg
Body weight small mammal (BW_mouse)		0.02	kg
Surface area small mammal (A)		86.21	cm^2
Food ingestion rate (dry weight [dw]) [1]		0.5297	kg dw/day
Food ingestion rate (wet weight [ww]) ir [2]		1.6554	kg ww/day
Duration of exposure (D)		1	day
Application rates (R)	Typical	1	lb/acre
	Maximum	4	lb/acre
Amount deposited on small mammal prey	Typical	0.4831	mg
(Amount_mouse): 0.5 × A × R [3]	Maximum	1.9326	mg
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates: ([(Drift × PC ×	Typical	3.33E+00	mg/kg bw
Amount_mouse) / BW_mouse] × ir) / BW	Maximum	1.33E+01	mg/kg bw

RISK QUOTIENTS[4] – Ingestion	Toxicity Reference Value (mg/kg bw)[5]	Typical Application	Maximum Application
Large carnivorous mammal – (acute exposure)	50	6.66E-02	2.67E-01

[1] Calculated using algorithm developed by Nagy (1987); where food ingestion rate (g dw/day) = 0.0687×(BW g)^0.822; converted into kg dw/day.
[2] Assumes mammals are 68% water (USEPA 1993).
[3] Surface area (A) and body weight of mouse receptor presented in Table B-1. Surface area calculation for mammals from Stahl (1967; presented in USEPA 1993).
[4] Risk Quotient = Estimated Dose/Toxicity Reference Value.
[5] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs (mg/kg bw) were selected during a review of the ecotoxicological literature.

TABLE B-7

Potential Risks to Carnivorous Mammal (Coyote) from Consumption of Contaminated Small Mammals (Chronic Exposure Scenario)

Parameters/Assumptions		Value	Units
Duration of exposure (T)		90	day
Body weight (BW)		12	kg
Body weight small mammal (BW_mouse)		0.02	kg
Surface area small mammal (A)		86.21	cm^2
Food ingestion rate (dry weight [dw]) [1]		0.5297	kg dw/day
Food ingestion rate (wet weight [ww]) ir [2]		1.6554	kg ww/day
Application rates (R)	Typical	1	lb/acre
	Maximum	4	lb/acre
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Decay coefficient (k): $ln(2)/t_{50}$ [3]	Typical	0.0231	$days^{-1}$
	Maximum	0.0231	$days^{-1}$
Initial concentration on mammal	Typical	24.1571	mg/kg mammal
(C_0): (0.5 × A × R) / BW_mouse	Maximum	96.6284	mg/kg mammal
Concentration absorbed in small mammal at time T	Typical	0.1157	mg/kg mammal
(C_{90}): $C_0 \times \exp(-k \times T)$ [4]	Maximum	0.4627	mg/kg mammal
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates (D) : (C_{90} × ir × PC) / BW	Typical	1.60E-02	mg/kg bw/day
	Maximum	6.38E-02	mg/kg bw/day

RISK QUOTIENTS[5] – Ingestion	Toxicity Reference Value (mg/kg bw/day)[6]	Typical Application	Maximum Application
Large mammalian carnivore – (chronic exposure)	0.51	3.13E-02	1.25E-01

[1] Calculated using algorithm developed by Nagy (1987); where food ingestion rate (g dw/day) = 0.0687×(BW g)^0.822; converted into kg dw/day.
[2] Assumes mammals are 68% water (USEPA 1993).
[3] ln = Natural log function.
[4] exp(-k×T) = e^(-k×T), where e is a constant = 2.7828.
[5] Risk Quotient = Estimated Dose/Toxicity Reference Value.
[6] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs (mg/kg bw) were selected during a review of the ecotoxicological literature.

TABLE B-8

Potential Risks to Insectivorous Bird (American robin) from Consumption of Contaminated Insects (Acute Exposure Scenario)

Parameters/Assumptions		Value	Units
Body weight (BW)		0.08	kg
Food ingestion rate (dry weight [dw]) [1]		0.0112	kg dw/day
Food ingestion rate (wet weight [ww]) ir [2]		0.0363	kg ww/day
Duration of exposure (D)		1	day
Application rates (R)	Typical	1	lb/acre
	Maximum	4	lb/acre
Residue rate - insects (rr) [3]	Typical	45	mg/kg per lb/acre
	Maximum	350	mg/kg per lb/acre
Concentration on insects (C): R × rr	Typical	45	mg/kg insect
	Maximum	1400	mg/kg insect
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates (D) : (Drift × PC × C × ir) / BW	Typical	2.04E+01	mg/kg bw
	Maximum	6.35E+02	mg/kg bw

RISK QUOTIENTS[4] - Ingestion	**Toxicity Reference Value (mg/kg bw)[5]**	**Typical Application**	**Maximum Application**
Small insectivorous bird – (acute exposure)	150	1.36E-01	4.23E+00

[1] Calculated using algorithm developed by Nagy (1987) for all birds; where food ingestion rate (kg dw/day) = 0.0582×(BW)^0.651.
[2] Assumes insects are 69% water (USEPA 1993; Table 4-1 - value for grasshoppers and crickets).
[3] Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994).
[4] Risk Quotient = Estimated Dose/Toxicity Reference Value.
[5] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs (mg/kg bw) were selected during a review of the ecotoxicological literature.

TABLE B-9

Potential Risks to Insectivorous Bird (American robin) from Consumption of Contaminated Insects (Chronic Exposure Scenario)

Parameters/Assumptions		Value	Units
Duration of exposure (T)		90	day
Body weight (BW)		0.08	kg
Food ingestion rate (dry weight [dw]) [1]		0.0112	kg dw/day
Food ingestion rate (wet weight [ww]) ir [2]		0.0363	kg ww/day
Half life on insect (t_{50})	Herbicide specific	30	days
Application rates (R)	Typical	1	lb/acre
	Maximum	4	lb/acre
Residue rate - insects (rr) [3]	Typical	45	mg/kg per lb/acre
	Maximum	350	mg/kg per lb/acre
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Decay coefficient (k): $\ln(2)/t_{50}$ [4]	Typical	0.0231	$days^{-1}$
	Maximum	0.0231	$days^{-1}$
Initial concentration on insects	Typical	45	mg/kg insect
(C_0): R × rr × Drift	Maximum	1400	mg/kg insect
Concentration on insects at time T	Typical	5.625	mg/kg insect
(C_{90}) : $C_0 \times \exp(-k \times T)$ [5]	Maximum	175	mg/kg insect
Time-weighted Average Concentration on insects	Typical	18.9354	mg/kg insect
(CTWA): $C_0 \times (1-\exp(-k \times T))/(k \times T)$ [5]	Maximum	589.1005	mg/kg insect
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates (D): (CTWA × ir × PC) / BW	Typical	8.58E+00	mg/kg bw/day
	Maximum	2.67E+02	mg/kg bw/day

RISK QUOTIENTS[6] - Ingestion	**Toxicity Reference Value (mg/kg bw/day)[7]**	**Typical Application**	**Maximum Application**
Small insectivorous bird – (chronic exposure)	12	7.15E-01	2.23E+01

[1] Calculated using algorithm developed by Nagy (1987) for all birds; where food ingestion rate (kg dw/day) = 0.0582×(BW)^0.651.
[2] Assumes insects are 69% water (USEPA 1993; Table 4-1 - value for grasshoppers and crickets).
[3] Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994).
[4] ln = Natural log function.
[5] exp(-k×T) = e^(-k×T), where e is a constant = 2.7828.
[6] Risk Quotient = Estimated Dose/Toxicity Reference Value.
[7] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs (mg/kg bw) were selected during a review of the ecotoxicological literature.

TABLE B-10

Potential Risks to Herbivorous Bird (Canada goose) from Consumption of Contaminated Vegetation (Acute Exposure Scenario)

Parameters/Assumptions		Value	Units
Body weight (BW)		3.72	kg
Food ingestion rate (dry weight [ww]) [1]		0.1369	kg dw/day
Food ingestion rate (wet weight [ww]) ir [2]		0.9126	kg ww/day
Duration of exposure (D)		1	day
Application rates (R)	Typical	1	lb/acre
	Maximum	4	lb/acre
Residue rate – vegetation (rr) [3]	Typical	35	mg/kg per lb/acre
	Maximum	296	mg/kg per lb/acre
Concentration on vegetation (C): R × rr	Typical	35	mg/kg veg
	Maximum	1184	mg/kg veg
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates: (Drift × PC × C × ir) / BW	Typical	8.59E+00	mg/kg bw
	Maximum	2.90E+02	mg/kg bw

RISK QUOTIENTS[4] – Ingestion	**Toxicity Reference Value (mg/kg bw)[5]**	**Typical Application**	**Maximum Application**
Large herbivorous bird – (acute exposure)	215	3.99E-02	1.35E+00

[1] Calculated using algorithm developed by Nagy (1987) for all birds; where food ingestion rate (kg dw/day) = 0.0582×(BW)^0.651.
[2] Assumes vegetation is 85% water (USEPA 1993; Table 4-2 - value for dicotyledons).
[3] Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994) and are vegetation-specific.
[4] Risk Quotient = Estimated Dose/Toxicity Reference Value.
[5] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs (mg/kg bw) were selected during a review of the ecotoxicological literature.

TABLE B-11

Potential Risks to Herbivorous Bird (Canada goose) from Consumption of Contaminated Vegetation (Chronic Exposure Scenario)

Parameters/Assumptions		Value	Units
Duration of exposure (T)		90	day
Body weight (BW)		3.72	kg
Food ingestion rate (dry weight [dw]) [1]		0.1369	kg dw/day
Food ingestion rate (wet weight [ww]) ir [2]		0.9126	kg ww/day
Half life on vegetation (t_{50})	Herbicide specific	30	days
Application rates (R)	Typical	1	lb/acre
	Maximum	4	lb/acre
Residue rate - vegetation (rr) [3]	Typical	35	mg/kg per lb/acre
	Maximum	296	mg/kg per lb/acre
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Decay coefficient (k): ln(2)/t_{50} [4]	Typical	0.0231	$days^{-1}$
	Maximum	0.0231	$days^{-1}$
Initial concentration on vegetation	Typical	35	mg/kg veg
(C_0): R × rr × Drift	Maximum	1184	mg/kg veg
Concentration on vegetation at time T	Typical	4.375	mg/kg veg
(C_{90}): C_0 × exp(-k×T) [5]	Maximum	148	mg/kg veg
Time-weighted average concentration on vegetation	Typical	14.7275	mg/kg veg
(CTWA): C_0 × (1-exp(-k×T))/(k×T) [5]	Maximum	498.2107	mg/kg veg
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates (D): (CTWA × ir × PC) / BW	Typical	3.61E+00	mg/kg bw/day
	Maximum	1.22E+02	mg/kg bw/day

RISK QUOTIENTS[6] – Ingestion	Toxicity Reference Value (mg/kg bw/day)[7]	Typical Application	Maximum Application
Large herbivorous bird – (chronic exposure)	0.6	6.02E+00	2.04E+02

[1] Calculated using algorithm developed by Nagy (1987) for all birds; where food ingestion rate (kg dw/day) = 0.0582×(BW)^0.651.
[2] Assumes vegetation is 85% water (USEPA 1993; Table 4-2 - value for dicotyledons).
[3] Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994) and are vegetation-specific.
[4] ln = Natural log function.
[5] exp(-k×T) = e^(-k×T), where e is a constant = 2.7828.
[6] Risk Quotient = Estimated Dose/Toxicity Reference Value.
[7] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs (mg/kg bw) were selected during a review of the ecotoxicological literature.

TABLE B-12

Potential Risk to Predatory Bird from Consumption of Contaminated Fish from Pond (Pond Impacted by Regular Application of Herbicide)

Parameters/ Assumptions		Value	Units
Body weight (BW)		5.15	kg
Food ingestion rate (dry weight [dw]) [1]		1.02E-01	kg dw/day
Food ingestion rate (wet weight [ww]) ir [2]		4.07E-01	kg ww/day
Bioconcentration factor (BCF)		1.03	L/kg fish
Food Chain Multiplier Trophic Level 2 (FCM_TL2)		1	unitless
Food Chain Multiplier Trophic Level 3 (FCM_TL3)		1	unitless
Proportion of diet contaminated (PC)		1	unitless
Toxicity reference value (TRV)		0.6	mg/kg-bw/day
Concentration in fish[3]	Typical	1.15E-01	mg/kg bw fish
(C_{fish}) : Pond_conc × BCF × FCM_TL2 x FCM_TL3	Maximum	4.62E-01	mg/kg bw fish
Dose estimate (D) : (C_{fish} × ir × PC) / BW	Typical	9.13E-03	mg/kg bw/day
	Maximum	3.65E-02	mg/kg bw/day

RISK QUOTIENTS[4] - Ingestion	Toxicity Reference Value (mg/kg bw/day)[5]	Typical Application	Maximum Application
Piscivorous bird – (chronic exposure)	0.6	1.52E-02	6.08E-02

Risk Quotient = Estimated Dose/Toxicity Reference Value.

[1] Calculated using algorithm developed by Nagy (1987) for all birds; where Food Ingestion Rate (kg dw/day) = 0.0582*(BW)^0.651.

[2] Assumes fish are 75% water (USEPA 1993; Table 4-2 - value for dicotyledons).

[3] Pond concentrations presented in Table B-15.

[4] Risk Quotient = Estimated Dose/Toxicity Reference Value.

[5] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs (mg/kg bw) were selected during a review of the ecotoxicological literature.

TABLE B-13

Potential Risks to Non-Target Terrestrial Plants from Direct Spray and Spray Drift

DIRECT SPRAY	Terrestrial Concentration (lb/acre)[1]	Typical Species RQ[2]	Rare, Threatened. and Endangered Species RQ[2]
Typical application rate	1	2.13E+02	6.25E+02
Maximum application rate	4	8.51E+02	2.50E+03

OFF-SITE DRIFT - modeled in AgDrift
TYPICAL APPLICATION RATE

Mode of Application	Application Height or Type	Distance From Receptor (ft)	Soil Concentration (lb/acre)[1]	Typical Species RQ[2]	Rare, Threatened, and Endangered Species RQ[2]
Plane	Non-Forested	100	9.81E-02	2.09E+01	6.13E+01
Plane	Non-Forested	300	4.46E-02	9.49E+00	2.79E+01
Plane	Non-Forested	900	1.78E-02	3.80E+00	1.12E+01
Helicopter	Non-Forested	100	8.92E-02	1.90E+01	5.58E+01
Helicopter	Non-Forested	300	3.57E-02	7.59E+00	2.23E+01
Helicopter	Non-Forested	900	1.78E-02	3.80E+00	1.12E+01
Ground	Low Boom	25	8.92E-03	1.90E+00	5.58E+00
Ground	Low Boom	100	4.43E-03	9.43E-01	2.77E+00
Ground	Low Boom	900	6.82E-04	1.45E-01	4.26E-01
Ground	High Boom	25	1.78E-02	3.80E+00	1.12E+01
Ground	High Boom	100	6.99E-03	1.49E+00	4.37E+00
Ground	High Boom	900	8.73E-04	1.86E-01	5.45E-01

OFF-SITE DRIFT - modeled in AgDrift
MAXIMUM APPLICATION RATE

Mode of Application	Application Height or Type	Distance From Receptor (ft)	Soil Concentration (lb/acre)[1]	Typical Species RQ[2]	Rare, Threatened, and Endangered Species RQ[2]
Plane	Non-Forested	100	4.55E-01	9.68E+01	2.84E+02
Plane	Non-Forested	300	2.05E-01	4.37E+01	1.28E+02
Plane	Non-Forested	900	5.35E-02	1.14E+01	3.35E+01
Helicopter	Non-Forested	100	3.93E-01	8.35E+01	2.45E+02
Helicopter	Non-Forested	300	1.52E-01	3.23E+01	9.48E+01
Helicopter	Non-Forested	900	2.68E-02	5.69E+00	1.67E+01
Ground	Low Boom	25	5.35E-02	1.14E+01	3.35E+01
Ground	Low Boom	100	1.78E-02	3.80E+00	1.12E+01
Ground	Low Boom	900	2.73E-03	5.81E-01	1.71E+00
Ground	High Boom	25	8.03E-02	1.71E+01	5.02E+01
Ground	High Boom	100	2.68E-02	5.69E+00	1.67E+01
Ground	High Boom	900	3.49E-03	7.42E-01	2.18E+00

[1] a.i. = active ingredient.
[2] Risk Quotient = Estimated Dose/Toxicity Reference Value.

TABLE B-14

Potential Risks to Aquatic Species from Accidental Spill to Pond (Acute Exposure)

Parameters/Assumptions	Value	Units
Volume of pond (Vp)	1,011,715	L
Volume of spill		
Truck ($Vspill_t$)	757	L
Helicopter($Vspill_h$)	529.9	L
Herbicide concentration (Cm) [1]		
Truck mixture (Cm_t)	19,174.30	mg/L
Helicopter mixture (Cm_h)	9,5871.49	mg/L

Scenario	Concentrations in water (Cw): Cm × Vspill / Vp	Units	Risk Quotients[2]		
			Fish	Aquatic Invertebrates	Non-Target Aquatic Plants
Truck spill into pond	14.35	mg/L	1.91E+01	1.02E+02	1.91E+04
Helicopter spill into pond	50.21	mg/L	6.70E+01	3.59E+02	6.70E+04

[1] Based on herbicide mixed for the maximum application rate, where truck spray rate is 25 gallons per acre and helicopter spray rate is 5 gallons per acre. Cm = [application rate x (1/spray rate)] converted from lb/gallon to mg/L.
[2] Risk Quotient = Estimated Dose/Toxicity Reference Value.

TABLE B-15

Potential Risk to Aquatic Species from Direct Spray of Pond and Stream (Acute Exposure)

Parameters/Assumptions		Value	Units
Pond			
Application rates (R)	Typical	1	lb/acre
	Maximum	4	lb/acre
Area of pond (Area)		0.25	acre
Volume of pond (Vol)		1,011,715	L
Mass sprayed on pond (R x Area)	Typical	113,398	mg
	Maximum	453,592	mg
Concentration in pond water (Mass/Volume)	Typical	0.1121	mg/L
	Maximum	0.4483	mg/L
Stream			
Width of stream		2	m
Length of stream impacted by direct spray		636.15	m
Area of stream impacted by spray (Area)		1,272.3	m^2
Depth of stream		0.2	m
Instantaneous volume of stream impacted by direct spray (Vol)		254,460	L
Mass sprayed on stream (R x Area)	Typical	0.314	lb
	Maximum	1.258	lb
Mass sprayed on stream - converted to mg	Typical	142,607.060	mg
	Maximum	570,428.239	mg
Concentration in stream water (Mass/Vol)	Typical	0.5604	mg/L
	Maximum	2.2417	mg/L

Scenario	Concentration in water (mg/L)	Risk Quotients[1]		
		Fish	Aquatic Invertebrates	Non-Target Aquatic Plants
Acute				
Direct spray to pond - Normal Application				
Typical application	1.12E-01	1.49E-01	8.01E-01	1.49E+02
Maximum application	4.48E-01	5.98E-01	3.20E+00	5.98E+02
Direct spray to stream - Accidental Spray				
Typical application	5.60E-01	7.47E-01	4.00E+00	7.47E+02
Maximum application	2.24E+00	2.99E+00	1.60E+01	2.99E+03
Chronic				
Direct spray to pond - Normal Application				
Typical application	1.12E-01	6.59E-01	2.55E+01	3.74E+02
Maximum application	4.48E-01	2.64E+00	1.02E+02	1.49E+03
Direct spray to stream - Accidental Spray				
Typical application	5.60E-01	3.30E+00	1.27E+02	1.87E+03
Maximum application	2.24E+00	1.32E+01	5.09E+02	7.47E+03

[1] Risk Quotient = Estimated Dose/Toxicity Reference Value.

REFERENCES

ENSR. 2004. Vegetation Treatments Programmatic EIS Ecological Risk Assessment Methodology Final Report. Prepared for the Bureau of Land Management. December 2004.

Fletcher, J.S., J.E. Nellessen, and T.G. Pfleeger. 1994. Literature Review and Evaluation of the EPA Food-Chain (Kenaga) Nomogram: An Instrument for Estimating Pesticide Residue on Plants. Environmental Toxicology and Chemistry 13(9):1383-1391.

Harris, S.A., and K.R. Solomon. 1992. Human Exposure to 2,4-D Following Controlled Activities on Recently Sprayed Turf. Journal of Environmental Science and Health 27(1):9-22.

Hoerger, F. and E.E. Kenaga. 1972. Pesticide Residues on Plants: Correlation of Representative Data as a Basis for Estimation of Their Magnitude in the Environment. *In* Environmental Quality and Safety, Volume I: Global Aspects of Toxicology and Technology as Applied to the Environment. F. Coulston and F. Kerte (eds.). Academic Press. New York, New York.

Nagy, K.A. 1987. Field Metabolic Rate and Food Requirement Scaling in Mammals and Birds. Ecological Monographs 57(2):111-128.

Stahl, W.R. 1967. Scaling of Respiratory Variables in Mammals. Journal of Applied Physiology 22:453-460.

USEPA. 1993. Wildlife Exposure Factors Handbook. Volume I. Office of Research and Development, Washington, D.C. EPA/600-R/R-93/187a, 187b.

APPENDIX C

List of Rare, Threatened, and Endangered Species for 17 BLM States

TABLE C-2
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	General Diet of Vertebrates	State Listed																	
			AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Amphibians																			
Ambystoma californiense	salamander, California tiger	I[(1)]; V[(2)]			E[(a)]														
Ambystoma tigrinum stebbinsi	salamander, Sonora tiger	I/Inv[(1)]; C/R[(2)]		E															
Batrachoseps aridus	salamander, desert slender	Inv			E														
Bufo baxteri	toad, Wyoming	I																	E
Bufo californicus	toad, arroyo (=arroyo southwestern)	H[(1)]; Inv[(2)]			E														
Rana aurora draytonii	frog, California red-legged	H[(1)]; Inv[(2)]			T[(b)]														
Rana chiricahuensis	frog, Chiricahua leopard	H[(1)]; Inv[(2)]		T							T								
Birds																			
Brachyramphus marmoratus marmoratus	murrelet, marbled	Ps			T									T				T	
Charadrius alexandrinus nivosus	plover, western snowy	G		T	T	T			T	T	T		T	T		T	T	T	
Charadrius melodus	plover, piping	H																	
Empidonax traillii extimus	flycatcher, southwestern willow	I		E	E	E				E	E					E	E		
Falco femoralis septentrionalis	falcon, northern aplomado	C														E			
Glaucidium brasilianum cactorum	pygmy-owl, cactus ferruginous	C		E															
Grus americana	crane, whooping	O [Ps,H]				E[(c)],XN	E[(c)],XN	E[(c)]	E[(c)]		E[(c)],XN	E[(c)]	E[(c)]		E[(c)]	E[(c)]	E[(c)],XN		E[(c)],XN[(d)]
Gymnogyps californianus	condor, California	C		XN	E												XN		
Haliaeetus leucocephalus	eagle, bald	Ps		T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Pelecanus occidentalis	pelican, brown	P			E									E		E		E	
Pipilo crissalis eremophilus	towhee, Inyo California	O [G, I]			T														
Polioptila californica californica	gnatcatcher, coastal California	I			T														
Polysticta stelleri	eider, Steller's	I	T[(e)]																
Rallus longirostris yumanensis	rail, Yuma clapper	C		E	E														
Somateria fischeri	eider, spectacled	O [H, Inv]	T																

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	General Diet of Vertebrates	State Listed																
			AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Sterna antillarum	tern, least	Ps				E[f]		E[f]	E[f]		E[f]	E[f]	E[f]		E[f]	E[f]			
Strix occidentalis caurina	owl, northern spotted	C			T									T				T	
Strix occidentalis lucida	owl, Mexican spotted	C		T		T					T					T	T		
Vireo bellii pusillus	vireo, least Bell's	I			E														
Crustaceans																			
Branchinecta conservatio	fairy shrimp, Conservancy				E														
Branchinecta longiantenna	fairy shrimp, longhorn				E														
Branchinecta lynchi	fairy shrimp, vernal pool				T									T					
Gammarus desperatus	amphipod, Noel's										PE[g]								
Lepidurus packardi	tadpole shrimp, vernal pool				E														
Thermosphaeroma thermophilus	isopod, Socorro										E								
Fish																			
Acipenser transmontanus	sturgeon, white						E[i]	E[i]											
Catostomus microps	sucker, Modoc				E														
Catostomus warnerensis	sucker, Warner													T					
Chasmistes brevirostris	sucker, shortnose				E									E					
Chasmistes cujus	cui-ui									E									
Chasmistes liorus	sucker, June																E		
Crenichthys baileyi baileyi	springfish, White River									E									
Crenichthys baileyi grandis	springfish, Hiko White River									E									
Crenichthys nevadae	springfish, Railroad Valley									T									
Cyprinella formosa	shiner, beautiful			T							T								
Cyprinodon diabolis	pupfish, Devils Hole									E									
Cyprinodon macularius	pupfish, desert			E	E														
Cyprinodon nevadensis mionectes	pupfish, Ash Meadows Amargosa									E									
Cyprinodon nevadensis pectoralis	pupfish, Warm Springs									E									
Cyprinodon radiosus	pupfish, Owens				E														

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	General Diet of Vertebrates	State Listed																
			AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Deltistes luxatus	sucker, Lost River				E									E					
Empetrichthys latos	poolfish, Pahrump									E									
Eremichthys acros	dace, desert									T									
Gambusia nobilis	gambusia, Pecos										E					E			
Gasterosteus aculeatus williamsoni	stickleback, unarmored threespine				E														
Gila bicolor mohavensis	chub, Mohave tui				E														
Gila bicolor snyderi	chub, Owens tui				E														
Gila bicolor ssp.	chub, Hutton tui													T[(j)]					
Gila bicolor vaccaceps	chub, Cowhead Lake tui				PE[(k)]														
Gila boraxobius	chub, Borax Lake													E					
Gila cypha	chub, humpback			E		E											E		
Gila ditaenia	chub, Sonora			T															
Gila elegans	chub, bonytail			E	E	E				E							E		
Gila intermedia	chub, Gila			PE[(l)]							PE[(l)]								
Gila purpurea	chub, Yaqui			E															
Gila robusta jordani	chub, Pahranagat roundtail									E									
Gila seminuda	chub, Virgin River			E						E							E		
Hybognathus amarus	minnow, Rio Grande silvery										E					E			
Ictalurus pricei	catfish, Yaqui			T															
Lepidomeda albivallis	spinedace, White River									E									
Lepidomeda mollispinis pratensis	spinedace, Big Spring									T									
Lepidomeda vittata	spinedace, Little Colorado			T															
Meda fulgida	spikedace			T							T								
Moapa coriacea	dace, Moapa									E									
Notropis girardi	shiner, Arkansas River										T[(m)]		T[(m)]			T[(m)]			
Notropis simus pecosensis	shiner, Pecos bluntnose										T								
Oncorhynchus keta	salmon, chum													T[(n)]				T[(n,o)]	
Oncorhynchus kisutch	salmon, coho				T[(p)]									T					

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	General Diet of Vertebrates	State Listed																
			AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Oncorhynchus mykiss	steelhead				E[(q)],T[(p,r,s,t)]		T[(u)]							T[(u,v,w,x)]				E[(y)],T[(w,x)]	
Oncorhynchus nerka	salmon, sockeye						E[(z)]							E[(z)]				E[(z)],T[(aa)]	
Oncorhynchus tshawytscha	salmon, chinook				E[(ab)],T[(ac,ad)]		T[(ae)]							T[(v,x)]				E[(af)],T[(v,ae,ag)]	
Oncorhynchus clarki henshawi	trout, Lahontan cutthroat				T					T				T			T		
Oncorhynchus clarki stomias	trout, greenback cutthroat					T													
Oncorhynchus gilae	trout, Gila			E							E								
Oregonichthys crameri	chub, Oregon													E					
Plagopterus argentissimus	woundfin			E[(ah)], XN						E[(ah)]	E[(ah)], XN						E[(ah)]		
Poeciliopsis occidentalis occidentalis	topminnow, Gila (incl. Yaqui)			E							E								
Poeciliopsis occidentalis sonoriensis	topminnow, Gila (incl. Yaqui)			E															
Ptychocheilus lucius	pikeminnow (=squawfish), Colorado			E[(ai)],XN	XN	XN											XN		XN
Rhinichthys osculus lethoporus	dace, Independence Valley speckled									E									
Rhinichthys osculus nevadensis	dace, Ash Meadows speckled									E									
Rhinichthys osculus oligoporus	dace, Clover Valley speckled									E									
Rhinichthys osculus ssp.	dace, Foskett speckled													T[(aj)]					
Rhinichthys osculus thermalis	dace, Kendall Warm Springs																		E
Salvelinus confluentus	trout, bull						T	T		T				T				T	
Scaphirhynchus albus	sturgeon, pallid							E	E			E			E				
Tiaroga cobitis	minnow, loach			T							T								
Xyrauchen texanus	sucker, razorback			E	E	E				E	E						E		E

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	General Diet of Vertebrates	State Listed																	
			AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Insect																				
Ambrysus amargosus	naucorid, Ash Meadows									T									
Boloria acrocnema	butterfly, Uncompahgre fritillary					E													
Desmocerus californicus dimorphus	beetle, valley elderberry longhorn				T														
Euphydryas editha quino	butterfly, Quino checkerspot				E														
Euproserpinus euterpe	moth, Kern primrose sphinx				T														
Hesperia leonardus montana	skipper, Pawnee montane					T													
Icaricia icarioides fenderi	butterfly, Fender's blue													E					
Nicrophorus americanus	beetle, American burying								E				E		E				
Pseudocopaeodes eunus obscurus	skipper, Carson wandering				E					E									
Speyeria zerene hippolyta	butterfly, Oregon silverspot				T									T				T	
Mammals																			
Antilocapra americana sonoriensis	pronghorn, Sonoran	H		E															
Brachylagus idahoensis	rabbit, pygmy	H																E(ak)	
Canis lupus	wolf, gray	C		E(al),XN(am)	T(an)	E(al),T(an)	XN,T(an)	XN,T(an)	T(ao)	T(an)	XN(am)	T(ao)	E(al)	T(an)	T(ao)	XN(am)	E(al),T(an)	T(an)	XN,T(an)
Cynomys parvidens	prairie dog, Utah	H															T		
Dipodomys heermanni morroensis	kangaroo rat, Morro Bay	H			E														
Dipodomys ingens	kangaroo rat, giant	G			E														
Dipodomys nitratoides exilis	kangaroo rat, Fresno	H			E														
Dipodomys nitratoides nitratoides	kangaroo rat, Tipton	G			E														
Dipodomys stephensi	kangaroo rat, Stephens'	G			E														
Enhydra lutris nereis	otter, southern sea	C			XN,T©														

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	General Diet of Vertebrates	State Listed																
			AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Eumetopias jubatus	sea-lion, Steller	C	E(ap),T(aq)		T(aq)									T(aq)				T(aq)	
Herpailurus (=Felis) yaguarundi tolteca	jaguarundi, Sinaloan	C		E															
Leopardus (=Felis) pardalis	ocelot	C		E												E			
Leptonycteris curasoae yerbabuenae	bat, lesser long-nosed	N, F		E							E								
Leptonycteris nivalis	bat, Mexican long-nosed	H									E					E			
Lynx canadensis	lynx, Canada	C				T	T	T										T	T
Microtus californicus scirpensis	vole, Amargosa	H			E														
Microtus mexicanus hualpaiensis	vole, Hualapai Mexican	H		E															
Mustela nigripes	ferret, black-footed	C		XN,E(c)		XN,E(c)		XN,E(c)							XN,E(c)		XN,E(c)		XN,E(c)
Neotoma fuscipes riparia	woodrat, riparian (=San Joaquin Valley)	H			E														
Odocoileus virginianus leucurus	deer, Columbian white-tailed	H												E(ak)				E(ak)	
Ovis canadensis	sheep, bighorn	H			E(ar)														
Ovis canadensis californiana	sheep, bighorn	Gm			E(as)														
Panthera onca	jaguar	C		E							E					E			
Rangifer tarandus caribou	caribou, woodland	H					E											E	
Spermophilus brunneus brunneus	squirrel, northern Idaho ground	H					T												
Ursus arctos horribilis	bear, grizzly	O [H, I, Ps]					T(at)	T(at)										T(ag)	T(ag)
Vulpes macrotis mutica	fox, San Joaquin kit	C			E														
Zapus hudsonius preblei	mouse, Preble's meadow jumping	O [Inv, H]				T													T
Molluscs																			
Assiminea pecos	snail, Pecos assiminea										PE(g)					PE(g)			
Fontelicella idahoensis	springsnail, Idaho						E												
Helminthoglypta walkeriana	snail, Morro shoulderband (=Banded dune)				E														
Lanx sp.	limpet, Banbury Springs						E												

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	General Diet of Vertebrates	State Listed																
			AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Oxyloma haydeni kanabensis	ambersnail, Kanab			E													E		
Physa natricina	snail, Snake River physa						E												
Pyrgulopsis bruneauensis	springsnail, Bruneau Hot						E												
Pyrgulopsis neomexicana	springsnail, Socorro										E								
Pyrgulopsis roswellensis	springsnail, Roswell										PE[g]								
Taylorconcha serpenticola	snail, Bliss Rapids						T												
Tryonia alamosae	springsnail, Alamosa										E								
Tryonia kosteri	snail, Koster's tryonia										PE[g]								
Valvata utahensis	snail, Utah valvata						E										E		
Reptiles																			
Crotalus willardi obscurus	rattlesnake, New Mexican ridge-nosed	C									T								
Gambelia silus	lizard, blunt-nosed leopard	I			E														
Gopherus agassizii	tortoise, desert	H		T(SA)[au], T[av]	T(SA)[au], T[av]					T(SA)[au], T[av]							T(SA)[au], T[av]		
Thamnophis gigas	snake, giant garter	Ps			T														
Uma inornata	lizard, Coachella Valley fringe-toed	O [H, I]			T														

General Diet

[1]For amphibians, refers to juvenille stage only
[2]For amphibians, refers to adult stage only
C = Carnivore; meat-eating
F = Frugivore; fruit-eating
G = Granivore; seed-eating
Gm = Gramnivore; grass-eating
H = Herbivore; plant-eating
I = Insectivore; insect-eating
Inv = Invertevore; invertebrate-eating
N = Nectivore; nectar-eating
O = Omnivore; generalist

(a) Santa Barbara and Sonoma Counties
(b) subspecies range clarified
(c) except where XN
(d) western half
(e) breeding population
(at) except where listed as experimental population
(f) interior population
(g) proposed for listing February 12, 2002
(i) proposed for listing but resolved March 17, 2000
(j) Hutton
(k) proposed for listing March 30, 1998
(l) proposed for listing August 9, 2002

(v) lower Columbia River
(w) middle Columbia River
(x) upper Willamette River
(y) upper Columbia River Basin
(z) Snake River, ID stock wherever found
(aa) Ozette Lake
(ab) winter Sacramento River
(ac) Central Valley spring run
(ad) coastal
(ae) fall and spring/summer Snake River
(af) spring upper Columbia River

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Ps = Piscivore; fish-eating	(m) Arkansas River Basin	(ag) Puget Sound
R = Ranivore; frog-eating	(n) Columbia River	(ah) except Gila River drainage
V = Vermivore; earthworm-eating	(o) summer-run Hood Canal	(ai) except Salt and Verde River
drainages		
Status	(p) central coast	(aj) Foskett
T = Threatened	(q) southern coast	(ak) Columbia Basin DPS
E = Endangered	(r) Central Valley	(al) Southwestern Distinct
Population Segment		
XN = Experimental population	(s) south central coast	(am) Mexican gray wolf,
P = Proposed		experimental population
T(SA) = Similarity in appearance to a threatened taxon	(t) northern Segment	(an) Western Distinct Population
(u) Snake River Basin (ao) Eastern Distinct Population		

TABLE C-2
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	State Listed																
		AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Acanthomintha ilicifolia	thornmint, San Diego			T														
Agave arizonica	agave, Arizona		E															
Allium munzii	onion, Munz's			E														
Ambrosia pumila	ambrosia, San Diego			E														
Amsonia kearneyana	blue-star, Kearney's		E															
Arabis mcdonaldiana	rock-cress, McDonald's			E									E					
Arctomecon humilis	bear-poppy, dwarf															E		
Arctostaphylos morroensis	manzanita, Morro			T														
Arctostaphylos myrtifolia	manzanita, Ione			T														
Arenaria paludicola	sandwort, Marsh			E									E				E	
Argemone pleiacantha ssp. pinnatisecta	poppy, Sacramento prickly									E								
Asclepias welshii	milkweed, Welsh's		T													T		
Astragalus albens	milk-vetch, Cushenbury			E														
Astragalus ampullarioides	milk-vetch, Shivwitz															E		
Astragalus applegatei	milk-vetch, Applegate's												E					
Astragalus brauntonii	milk-vetch, Braunton's			E														
Astragalus desereticus	milk-vetch, Deseret															T		
Astragalus holmgreniorum	milk-vetch, Holmgren		E													E		
Astragalus humillimus	milk-vetch, Mancos				E					E								
Astragalus jaegerianus	milk-vetch, Lane Mountain			E														
Astragalus lentiginosus var. coachellae	milk-vetch, Coachella Valley			E														
Astragalus lentiginosus var. piscinensis	milk-vetch, Fish Slough			T														
Astragalus magdalenae var. peirsonii	milk-vetch, Peirson's			T														
Astragalus montii	milk-vetch, heliotrope															T		
Astragalus osterhoutii	milk-vetch, Osterhout				E													
Astragalus phoenix	milk-vetch, Ash meadows								T									
Astragalus tricarinatus	milk-vetch, triple-ribbed			E														
Atriplex coronata var. notatior	crownscale, San Jacinto Valley			E														
Baccharis vanessae	baccharis, Encinitas			T														
Berberis nevinii	barberry, Nevin's			E														
Brodiaea filifolia	brodiaea, thread-leaved			T														
Calystegia stebbinsii	morning-glory, Stebbins'			E														
Camissonia benitensis	evening-primrose, San Benito			T														
Carex specuicola	sedge, Navajo		T													T		
Castilleja campestris ssp. succulenta	owl's-clover, fleshy			T														
Castilleja levisecta	paintbrush, golden												T				T	

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	State Listed																
		AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Caulanthus californicus	jewelflower, California			E														
Ceanothus roderickii	ceanothus, Pine Hill			E														
Centaurium namophilum	centaury, spring-loving			T					T									
Chamaesyce hooveri	spurge, Hoover's			T														
Chlorogalum purpureum	amole, purple			T														
Chorizanthe howellii	spineflower, Howell's			E														
Chorizanthe orcuttiana	spineflower, Orcutt's			E														
Chorizanthe pungens var. pungens	spineflower, Monterey			T														
Cirsium fontinale var. obispoense	thistle, Chorro Creek bog			E														
Cirsium loncholepis	thistle, La Graciosa			E														
Clarkia springvillensis	clarkia, Springville			T														
Coryphantha robbinsorum	cactus, Cochise pincushion		T															
Coryphantha scheeri var. robustispina	cactus, Pima pineapple		E															
Coryphantha sneedii var. leei	cactus, Lee pincushion									T								
Coryphantha sneedii var. sneedii	cactus, Sneed pincushion									E					E			
Cycladenia jonesii (=humilis)	Cycladenia, Jones		T													T		
Deinandra (=Hemizonia) conjugens	tarplant, Otay			T														
Dodecahema leptoceras	spineflower, slender-horned			E														
Dudleya cymosa ssp. marcescens	dudleya, marcescent			T														
Echinocactus horizonthalonius var. nicholii	cactus, Nichol's Turk's head		E															
Echinocereus fendleri var. kuenzleri	cactus, Kuenzler hedgehog									E								
Echinocereus triglochidiatus var. arizonicus	cactus, Arizona hedgehog		E															
Enceliopsis nudicaulis var. corrugata	sunray, Ash Meadows								T									
Eremalche kernensis	mallow, Kern			E														
Eriastrum densifolium ssp. sanctorum	woolly-star, Santa Ana River			E														
Erigeron decumbens var. decumbens	daisy, Willamette												E					
Erigeron maguirei	daisy, Maguire															T		
Erigeron parishii	daisy, Parish's			T														

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	State Listed																
		AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Erigeron rhizomatus	fleabane, Zuni		T							T								
Eriodictyon altissimum	mountain balm, Indian Knob			E														
Eriodictyon capitatum	yerba santa, Lompoc			E														
Eriogonum apricum (incl. var. prostratum)	buckwheat, Ione (incl. Irish Hill)			E														
Eriogonum gypsophilum	wild-buckwheat, gypsum									T								
Eriogonum ovalifolium var. vineum	buckwheat, cushenbury			E														
Eriogonum ovalifolium var. williamsiae	buckwheat, steamboat								E									
Eriogonum pelinophilum	wild-buckwheat, clay-loving				E													
Erysimum menziesii	wallflower, Menzies'			E														
Eutrema penlandii	mustard, Penland alpine fen				T													
Fremontodendron californicum ssp. decumbens	flannelbush, Pine Hill			E														
Fremontodendron mexicanum	flannelbush, Mexican			E														
Fritillaria gentneri	Fritillary, Gentner's												E					
Galium californicum ssp. sierrae	bedstraw, El Dorado			E														
Gaura neomexicana var. coloradensis	Butterfly plant, Colorado				T			T										T
Gilia tenuiflora ssp. arenaria	gilia, Monterey			E														
Grindelia fraxino-pratensis	gumplant, Ash Meadows			T					T									
Hackelia venusta	stickseed, showy																E	
Hedeoma todsenii	pennyroyal, Todsen's									E								
Helianthus paradoxus	sunflower, Pecos (=puzzle, =paradox)									T					T			
Howellia aquatilis	howellia, water			T		T	T						T				T	
Ipomopsis sancti-spiritus	ipomopsis, Holy Ghost									E								
Ivesia kingii var. eremica	ivesia, Ash Meadows								T									
Lasthenia conjugens	goldfields, Contra Costa			E														
Layia carnosa	layia, beach			E														
Lepidium barnebyanum	ridge-cress, Barneby															E		
Lesquerella congesta	bladderpod, Dudley Bluffs				T													
Lesquerella tumulosa	bladderpod, kodachrome															E		
Lilaeopsis schaffneriana var. recurva	water-umbel, Huachuca		E															
Lilium occidentale	lily, Western			E									E					

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	State Listed																
		AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Limnanthes floccosa grandiflora	Meadowfoam, large-flowered wooly												E					
Limnanthes floccosa ssp. californica	meadowfoam, Butte County			E														
Lomatium bradshawii	desert-parsley, Bradshaw's												E				E	
Lomatium cookii	lomatium, Cook's												E					
Lupinus sulphureus (=oreganus) ssp. kincaidii (=var. kincaidii)	Lupine, Kincaid's												T				T	
Mentzelia leucophylla	blazingstar, Ash Meadows								T									
Mirabilis macfarlanei	four-o'clock, MacFarlane's					T							T					
Monolopia (=Lembertia) congdonii	wooly-threads, San Joaquin			E														
Nitrophila mohavensis	niterwort, Amargosa			E					E									
Opuntia treleasei	cactus, Bakersfield			E														
Orcuttia californica	Orcutt grass, California			E														
Orcuttia inaequalis	Orcutt grass, San Joaquin			T														
Orcuttia pilosa	Orcutt grass, hairy			E														
Orcuttia tenuis	Orcutt grass, slender			T														
Oxytheca parishii var. goodmaniana	oxytheca, cushenbury			E														
Pediocactus (=Echinocactus,=Utahia) sileri	cactus, Siler pincushion		T													T		
Pediocactus bradyi	cactus, Brady pincushion		E															
Pediocactus despainii	cactus, San Rafael															E		
Pediocactus knowltonii	cactus, Knowlton				E					E								
Pediocactus peeblesianus peeblesianus	cactus, Peebles Navajo		E															
Pediocactus winkleri	cactus, Winkler															T		
Penstemon haydenii	penstemon, blowout							E										E
Penstemon penlandii	beardtongue, Penland				E													
Phacelia argillacea	phacelia, clay															E		
Phacelia formosula	phacelia, North Park				E													
Phlox hirsuta	phlox, Yreka			E														
Physaria obcordata	twinpod, Dudley Bluffs				T													
Plagiobothrys hirtus	popcornflower, rough												E					
Platanthera praeclara	orchid, western prairie fringed							T			T	T						
Pogogyne nudiuscula	mesa-mint, Otay			E														
Primula maguirei	primrose, Maguire															T		
Pseudobahia bahiifolia	sunburst, Hartweg's golden			E														
Pseudobahia peirsonii	sunburst, San Joaquin adobe			T														

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	State Listed																
		AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Purshia (=Cowania) subintegra	Cliff-rose, Arizona		E															
Ranunculus aestivalis (=acriformis)	Buttercup, autumn															E		
Schoenocrambe argillacea	reed-mustard, clay															T		
Schoenocrambe barnebyi	reed-mustard, Barneby															E		
Schoenocrambe suffrutescens	reed-mustard, shrubby															E		
Sclerocactus glaucus	Cactus, Uinta Basin hookless				T											T		
Sclerocactus mesae-verdae	cactus, Mesa Verde				T					T								
Sclerocactus wrightiae	cactus, Wright fishhook															E		
Senecio layneae	butterweed, Layne's			T														
Sidalcea keckii	Checker-mallow, Keck's			E														
Sidalcea nelsoniana	checker-mallow, Nelson's												T				T	
Sidalcea oregana var. calva	checkermallow, Wenatchee Mountains																E	
Silene spaldingii	Catchfly, Spalding's					T	T						T				T	
Spiranthes delitescens	ladies'-tresses, Canelo Hills		E															
Spiranthes diluvialis	ladies'-tresses, Ute				T	T	T	T								T	T	T
Spiranthes parksii	ladies'-tresses, Navasota														E			
Stephanomeria malheurensis	wire-lettuce, Malheur												E					
Streptanthus albidus ssp. albidus	jewelflower, Metcalf Canyon			E														
Streptanthus niger	jewelflower, Tiburon			E														
Styrax texanus	snowbells, Texas														E			
Suaeda californica	seablite, California			E														
Swallenia alexandrae	grass, Eureka Dune			E														
Taraxacum californicum	taraxacum, California			E														
Thelypodium howellii spectabilis	thelypody, Howell's spectacular												T					
Thelypodium stenopetalum	mustard, slender-petaled			E														
Thlaspi californicum	penny-cress, Kneeland Prairie			E														
Thymophylla tephroleuca	dogweed, ashy														E			
Thysanocarpus conchuliferus	fringepod, Santa Cruz Island			E														
Townsendia aprica	townsendia, Last Chance															T		
Trichostema austromontanum ssp. compactum	bluecurls, Hidden Lake			T														
Trifolium amoenum	clover, showy Indian			E														
Trifolium trichocalyx	clover, Monterey			E														
Tuctoria greenei	tuctoria, Greene's			E														
Tuctoria mucronata	grass, Solano			E														

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	State Listed																
		AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Verbena californica	vervain, Red Hills			T														
Verbesina dissita	crownbeard, big-leaved			T														
Yermo xanthocephalus	yellowhead, desert																	T
Zizania texana	wild-rice, Texas														E			

Status
T = Threatened
E = Endangered

APPENDIX D

Review of Confidential Business Information Memo

MEMORANDUM

To:	Mark Gerath, ENSR	**Date:**	November 2, 2004
From:	Karl Ford, BLM		
RE:	Review of Confidential Business Information on Inert Ingredients Herbicides Proposed for Use on BLM Lands		

Pesticide products contain both "active" and "inert" ingredients. The terms "active ingredient" (a.i.) and "inert ingredient" have been defined by Federal law, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), since 1947. An a.i. is one that prevents, destroys, repels, or mitigates a pest, or is a plant regulator, defoliant, desiccant, or nitrogen stabilizer. By law, the a.i. must be identified by name on the label together with its percentage by weight. An inert ingredient is simply any ingredient in the product that is not intended to affect a target pest. For example, isopropyl alcohol may be an a.i. and antimicrobial pesticide in some products; however, in other products, it is used as a solvent and may be considered an inert ingredient. The law does not require inert ingredients to be identified by name and percentage on the label, but the total percentage of such ingredients must be declared.

In September 1997, the U.S. Environmental Protection Agency (USEPA) issued **Pesticide Regulation Notice 97-6** which encourages manufacturers, formulators, producers, and registrants of pesticide products to voluntarily substitute the term "other ingredients" as a heading for the "inert" ingredients in the ingredient statement. The USEPA made this change after learning the results of a consumer survey on the use of household pesticides. Many comments from the public and the consumer interviews prompted USEPA to discontinue the use of the term "inert." Many consumers are misled by the term "inert ingredient," believing it to mean "harmless." Since neither the federal law nor the regulations define the term "inert" on the basis of toxicity, hazard or risk to humans, non-target species, or the environment, it should not be assumed that all inert ingredients are non-toxic.

The Bureau of Land Management (BLM) scientists received clearance from USEPA to review Confidential Business Information (CBI) on inert compounds identified in products containing the following ten a.i.:

- Sulfometuron methyl
- Fluridone
- Dicamba (as an a.i. in the herbicide Overdrive)
- Diquat
- Diflufenzopyr
- Imazapic
- Diuron
- Bromacil
- Chlorsulfuron
- Tebuthiuron

The information received listed the inert ingredients, their chemical abstract number, supplier, USEPA registration number, percentage of the formulation, and purpose in the formulation. Because this information is confidential, this information, including the name of the ingredients may not be disclosed.

The USEPA has a listing of regulated inert ingredients at http://www.epa.gov/opprd001/inerts/index.html. This listing categorizes inert ingredients into four categories. The listing of categories and the number of inert ingredients found among the ingredients listed for the herbicides are shown below:

- Inert Ingredients of Toxicological Concern. None.
- Potentially Toxic Inert Ingredients. None.
- Inerts of Unknown Toxicity. 12.
- Inerts of Minimal Toxicity. Over 50.
- Nine inerts were not found on USEPA's lists.

Toxicity information was also searched via the following sources:

- TOMES (a proprietary toxicological database including USEPA's Integrated Risk Information System [IRIS], the Hazardous Substance Data Bank [HSDB], the Registry of Toxic Effects of Chemical Substances (RTECS)
- USEPA's ECOTOX database which includes AQUIRE
- TOXLINE, a literature searching tool
- Material Safety Data Sheets (MSDSs) from suppliers
- Other sources, such as the Farm Chemicals Handbook
- Other cited literature sources.

Relatively little toxicity information was found. A few acute studies on aquatic or terrestrial species were reported. Little chronic data, no cumulative effects data, and almost no indirect effects data (food chain species) were found.

A number of the List 4 compounds are naturally-occurring earthen materials (e.g., clay materials or simple salts) that would produce no toxicity at applied concentrations. However, some of the inerts, particularly the List 3 inert compounds and unlisted compounds, may have moderate to high potential toxicity to aquatic species based on MSDSs or published data.

As a tool to evaluate List 3 and unlisted inerts in the ecological risk assessment, the exposure concentration of the inert compound was calculated and compared to toxicity information. Toxicity information from the above sources was used in addition to the work of Dorn et al. (1997), Wong et al. (1997), Lewis (1991), and Muller (1980) concerning aquatic toxicity of surfactants. These sources generally suggested that acute toxicity to aquatic life for surfactants and anti-foam agents ranged from 1-10 mg/L, and that chronic toxicity ranged to as low as 0.1 mg/L.

Exposure concentrations were computed using Groundwater Loading Effects of Agricultural Management Systems (GLEAMS). Inert compounds incorporated into the herbicide mixture are generally considered to be very stable compounds and tend to be highly mobile in the environment, primarily because of their inability to react with other materials or compounds. However, while these inert compounds are very mobile and relatively inactive they can potentially be toxic to aquatic organisms. To quantify the potential toxicity of inert compounds to aquatic organisms, the concentration of an inert compound in a river or pond adjacent to an herbicide application area was predicted using the GLEAMS model. The GLEAMS model was set up to simulate the effects of a generalized inert

compound in the previously described "base-case" watershed with a sand soil type. The chemical characteristics of the generalized inert compound were set at extremely high/low environmental fate values to describe it as a very mobile and stable compound; the application rate of the inert compound was fixed at 1 pound (lb) a.i./acre. The watershed characteristics were that of a typical sand watershed with atmospheric conditions representative of Medford, Oregon. The annual precipitation rate used in the inert compound simulation was 50 in/year, distributed in the same fashion as during a representative precipitation year in Medford, Oregon. The simulation was run to quasi-steady state conditions and the daily-predicted inert compound export rates from a single steady-state year of the simulation were used to calculate the annual average (chronic) and annual maximum 3-day average river and pond inert compound concentrations. The following table indicates the predicted river and pond concentrations for the inert compound resulting from an application rate of 1 lb a.i./acre. The concentrations per 1 lb a.i./acre application rate for each of eight herbicides simulated by GLEAMS, using the same watershed type, atmospheric conditions, and precipitation rate, is also listed for comparison.

Ratio of Concentration to Herbicide Application Rate (mg/L per lb a.i./acre)				
Herbicide	Average Annual River	Maximum 3 Day Average River	Average Annual Pond	Maximum 3 Day Average Pond
Diflufenzopyr	5.39E-06	3.33E-04	8.38E-04	7.52E-03
Imazapic	3.64E-04	8.19E-03	2.64E-02	5.45E-02
Sulfometuron	1.87E-04	5.81E-03	1.19E-02	3.77E-02
Tebuthiuron	4.68E-04	1.68E-02	4.33E-02	2.04E-01
Diuron	2.74E-04	4.67E-03	2.27E-02	3.35E-02
Bromacil	5.73E-04	1.72E-02	4.18E-02	1.27E-01
Chlorsulfuron	1.27E-04	2.31E-03	1.79E-02	5.31E-02
Dicamba	3.25E-04	1.30E-02	2.03E-02	1.72E-01
Inert Compound	**1.20E-03**	**3.80E-02**	**3.20E-01**	**6.90E-01**

The results of the GLEAMS simulations from the table above indicate that the ratio of river or pond concentration to application rate is highest for the inert compound. This was expected because of the extent that the chemical parameters were adjusted to represent a highly mobile and stable compound. In the case of the river, the concentrations were largely the result of characteristics related to the inert compound's mobility but in the pond the stability of the compound was also important. The inert compound concentrations were predicted to be higher than the concentrations of each herbicide in all cases, albeit to varying degrees, and the extent of these higher concentrations was similar between each of the four statistical measures.

The exposure concentration was estimated by multiplying the percentage of the inert in the formulation times the application rate in pounds/acre times the dilution rates shown in the above table. Due to the constraints of the CBI process, the inerts of potential interest can not be disclosed but the following observations were made. Low application rates for sulfometuron methyl, fluridone, diquat, dicamba, diflufenzopyr, and imazapic resulted in low exposure concentrations of inerts of much less than 1 mg/L in all cases including the worst case (maximum 3-day pond) scenario. Higher application rates for diuron and bromacil yielded higher exposure concentrations of surfactant inerts, exceeding 1 mg/L for the maximum pond scenario. These results suggest that the inert compounds of diuron and bromacil may contribute acute toxicity to aquatic organisms if they reach the aquatic environment. Inerts did not seem to be an issue with chlorsulfuron and tebuthiuron.

This approach to estimating the exposure concentration will have relatively little uncertainty for several exposure scenarios such as spills where subsequent fate processes are relatively unimportant. Considerably more uncertainty will occur in scenarios that account for the physical-chemical properties of the constituent (e.g., the GLEAMS-dependent scenarios). The exposure concentration models are very conservative, e.g. if there is uncertainty, the exposure concentrations are likely to be overestimated, not underestimated. Considerable uncertainty also exists with the toxicity information as many of these substances had no specific toxicity information and toxicity information for surfactants was used as a surrogate.

References

Dorn, P.B., J.H. Rodgers, Jr., W.B. Gillespie, Jr., R.E. Lizotte, Jr., and A.W. Dunn. 1997. The Effects of C12-13 Linear Alcohol Ethoxylate Surfactant on Periphyton, Macrophytes, Invertebrates and Fish in Stream Mesocosms. Environmental Toxicology and Chemistry 16(8):1634-1645.

Lewis, M.A. 1991. Chronic and Sublethal Toxicities of Surfactants to Aquatic Animals: A Review and Risk Assessment. Water Research 25(1):101-113.

Muller, R. 1980. Fish Toxicity and Surface Tension of Non-ionic Surfactants: Investigations of Anti-foam Agents. Journal of Fish Biology 16:585-589.

Wong, D., P.B. Dorn, and E.Y. Chai. 1997. Acute Toxicity and Structure-activity Relationships of Nine Alcohol Ethoxylate Surfactants to Fathead Minnow and *Daphnia magna*. Environmental Toxicology and Chemistry 16(9):1970-1976.