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MEMORANDUM

Subject: Registration Review – Preliminary Problem Formulation for the Ecological Risk Assessment of Diquat Dibromide

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Attached is the preliminary problem formulation for the ecological risk assessment to be conducted as part of the Registration review of the non-selective contact herbicide, desiccant and plant growth regulator (Diquat Dibromide)

REGISTRATION REVIEW

ECOLOGICAL RISK ASSESSMENT
PROBLEM FORMULATION FOR:

DIQUAT DIBROMIDE

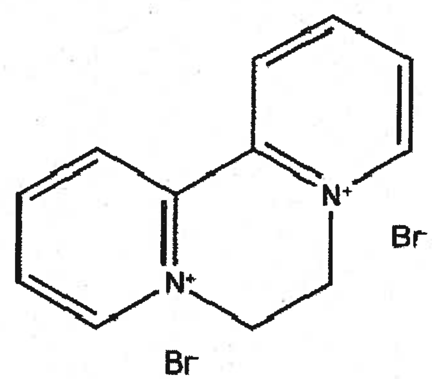

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TABLE OF CONTENTS

Stressor Source and Distribution

Diquat dibromide is a non-selective contact herbicide and desiccant used as a general herbicide to control broadleaf and grassy weeds in terrestrial and aquatic areas; as a desiccant in seed crops and potatoes; and for tassel control and spot weed control in sugarcane. When used as a dessicant, diquat can be applied by aircraft or ground equipment. In aquatic sites, diquat may be injected below the water surface for submerged weeds, or sprayed for weed control along the edges of aquatic sites. Diquat is used for terrestrial food and feed crops, terrestrial non-food crops, outdoor residential, greenhouse non-food crops and food crops, aquatic food crops, aquatic non-food outdoor, aquatic non-food industrial, and forestry. Diquat is expected to be transported by spray drift and runoff to non-targeted areas. Since it binds very strongly to soil and organic matter, diquat may also be transported to non-target areas by soil and transported dust. In addition, because available studies suggest that diquat degrades slowly, if at all, the potential for accumulation/build-up exists in areas of continual use. There were no major degradates isolated from any of the environmental fate studies.

Pesticidal Mechanism of Action

Diquat dibromide belongs to the bipyridyliums group of chemicals. Compounds in this group result in rapid disruption of cell membranes and very rapid death. Diquat penetrates into the cytoplasm, causes the formation of peroxides and free electrons (light is required) which destroy the cell membranes almost immediately. Herbicidal oils dissolve membranes directly causing rapid destruction of cell membranes and preventing translocation to other regions of the plant. Severe injury is evident hours after application, first as water-soaked areas which later turn yellow or brown. Maximum kill is attained in a week or less. Partial coverage of a plant with spray results in spotting and/or partial shoot kill. New growth on surviving plants will be normal in appearance. Foliar activity alone can provide only shoot kill. Additional information can be found at http://www.ces.purdue.edu/extmedia/WS/WS-23-W.html .

Integration of Available Information

The most recent risk assessments available in the docket which serve as the basis for this problem formulation include the following:

- Drinking water assessment for diquat use as a landscape and aquatic herbicide, 2008
- Report of the Food Quality Protection Act (FQPA) Tolerance Reassessment Progress and Risk Management Decision (TRED), 2002.
- Reregistration Eligibility Document (RED), 1995.

A summary of the most recent ecological assessment from the 1995 Diquat dibromide RED follows:

Diquat dibromide is immobile (binds irreversibly to the soil), is persistent, and may accumulate in soil. Diquat dibromide exceeded the levels of concern (LOCs) for acute and chronic effects to aquatic freshwater and estuarine organisms: however these effects may be ameliorated in actual practice because of diquat dibromide rapidly binding to suspended matter in the water column. The 1995 risk assessment concluded that diquat dibromide was biologically unavailable. Diquat dibromide also exceeded the levels of concern for chronic effects to birds and terrestrial mammals.

Ecological Effects

The Agency evaluates the potential for adverse affects as a result of diquat usage. As described in the Agency's Overview Document (U.S. USEPA, 2004), the most sensitive endpoint for each taxon is evaluated. Assessment endpoints include direct toxic effects on the survival, reproduction, and growth of terrestrial and aquatic life, as well as indirect effects, such as reduction in prey base and/or modification of habitat. The evaluated taxa include freshwater fish, freshwater aquatic invertebrates, birds, small mammals, terrestrial invertebrates, algae, and terrestrial plants.

Acute (short-term) and chronic (long-term) toxicity information is characterized based on registrant-submitted studies and a comprehensive review of the open literature on diquat. Other sources of information, including use of the acute probit dose response relationship to establish the probability of an individual effect and reviews of the Ecological Incident Information System (EIIS), are conducted to further refine the characterization of potential ecological effects associated with exposure to diquat. A summary of the available ecotoxicity information and the incident information for diquat are provided below.

Table 1 and Table 2 summarize the most sensitive ecological toxicity endpoints based on an evaluation of both submitted studies and the open literature. A brief summary of submitted data considered relevant to this ecological risk assessment is presented below. The toxicity unit is based on cations since the toxic mechanism of action is the diquat cation.

Table 1. Applicable Diquat Dibromide measurement endpoints and values for use in RQ calculations for the terrestrial effects determination.

Assessment Endpoint	Measures of Effect	Species	Toxicity Value	Study classification (Selection basis)	Reference
Abundance (i.e., survival, reproduction, and growth) of individuals and populations of birds	Avian (single dose) acute oral LD_{50}	Mallard duck *(Anas platyrhynchos)*	60.6 mg cation/kg-bw	Acceptable (1) (Most sensitive)	MRID 00106559 (Fink, 1982)
	Avian subacute 5-day dietary LC_{50}	Northern bobwhite quail *(Colinus virginianus)*	Dietary sub-acute LC_{50} = 540 ppm cation	Supplemental (2) (Most sensitive)	MRID 00116565 (Fink, 1982)
	Avian reproduction NOAEL	Mallard duck	Reproductive study NOAEL = 4.2 ppm cation (3)	Supplemental (Most sensitive)	MRID 00114230 (Fink, 1982)
Abundance (i.e., survival, reproduction, and growth) of individuals and populations of mammals	Mammalian acute oral (single dose) LD_{50}	Rat	Acute oral LD_{50} = 120 mg cation/kg bw	Acceptable (4) (Most sensitive)	MRID 00081506 (Rittenhouse, (1979)
	Mammalian 2-generation rat reproduction NOAEL	Rat	NOAEL = 80 ppm cation) (5)	Acceptable	MRID 41531301 (Hodge, 1990)
Survival of beneficial insect populations	Honey bee acute contact LD_{50}	Honey bee	acute contact LD_{50} = 47 ug cation/bee	Acceptable (6)	MRID 40208001 (Gough, 1987)
Survival and growth of terrestrial plants	Seedling Emergence	All species	EC_{25} > 4.65 lb cation/A	Acceptable	MRID 40165101 (Shilling, 1987)
	Vegeative Vigor	cotton	EC_{25} = 0.0047 lb cation/A	Supplemental (7)	MRID 41883001 (Bellet, 1990)

1 Producted tested contains 45.6 % cation.
2 Supplemental; is a screening test and not a guideline study. Product tested contains 18.9 % cation.
3 Based on number of eggs laid, hatching, and 14-day old survival. Supplemental due to insufficient number of birds tested (At least five replicate pens should be used for mallards housed in groups of seven. For other arrangements, at least 12 pens should be used, but considerably more may be used if birds are kept in pairs. For this study, only 12 pairs of birds per level where tested). These were differences, although not statistically-significant, were considered to be related to treatment and biologically meaningful.
4 Product tested contained 20% cation.
5 Decreased number of F1 pups per litter and decreased body weight gain during lactation in both generations. Product tested contained 21.1% cation.
6 Product tested is considered to be technical diquat dibromide.
7 Supplemental due to lack of raw data, insufficient number of species and no plant population numbers provided. Only the Florida study was used since the Wisconsin study had too many uncertainties.

Table 2. Applicable Diquat Dibromide endpoints and values for use in RQ calculations for the aquatic effects determination.

Assessment Endpoint	Measures of Effect	Species	Toxicity Value	Study classification (Selection basis)	Reference
Survival and reproduction of individuals and communities of freshwater fish	Freshwater fish acute 96-hr LC_{50}	Rainbow trout, (*Salmo gairdneri*)	LC_{50} = 14.8 ppm cation	Supplemental (1) (most sensitive)	MRID 0138961 (Thompson et. al., 1980)
	Freshwater fish early life-stage NOAEC	Fathead minnow (*Pimephales promelas*)	NOAEC = 0.122 ppm cation (2) Basis is wet wt and length	Acceptable	40380703 Surprenant, 1987
Survival and reproduction of individuals and communities of freshwater invertebrates	Freshwater invertebrate acute 96-h LC_{50}	Water flea (*Daphnia magna*)	EC_{50} = 0.77 ppm cation	Supplemental (3) (Most sensitive)	MRID 00115576 Wheeler et. al., 1978
	Freshwater invertebrate reproductive NOAEC	Water flea (*Daphnia magna*)	NOAEC < 0.036 ppm cation Basis is survival	Supplemental (4)	MRID 40380702 Surprenant, 1987
Survival and reproduction of individuals and communities of estuarine and marine fish	Estuarine and marine acute 96-h LC_{50}	Sheepshead minnow (*Cyprinodon variegates*)	LC_{50} = 51.1 ppm cation	Supplemental (5)	MRID 40316101 Nicholson, 1987
	Estuarine and marine reproductive NOAEC	No Data			
Survival and reproduction of individuals and communities of estuarine and marine invertebrates	Estuarine and marine invertebrate acute 96-h LC_{50}	Mysid shrimp (*Mysidopsis bahia*	LC_{50} = 0.42 ppm cation	Acceptable (6)	MRID 40315701
	Estuarine and marine invertebrate reproductive NOAEC	No Data			
Standing crop or biomass and growth of aquatic plants	Freshwater green algae, cyanobacteria or diatom 96-h IC_{50} for biomass.	Green algae (*Kirchneria subcapitata*)	EC_{50} = 0.0094 ppm cation (9.4 ppb cation)	Acceptable (Most sensitve)	43532703 Smyth and Tapp, 1988
	Vascular aquatic plants	Giant duckweed (*Spirodela punctata*)	EC_{50} = 0.00075 ppm cation (0.75 ppb cation)	Supplemental (7) (Most sensitve)	41883002 Bellet, 1990

1 Tested at 12°C, 9.5 pH, 44 mg/L hardness; Supplemental due to lack of data; 19.8% cation product tested

2 0.58 ppm ai / 4.745 = 0.122 ppm cation. Diquat concentrate is 41.4% ai and the ai (Diquat Dibromide Monohydrate) is 50.9% cation.

3 Supplemental due to lack of raw data. Product tested contained 17.92 % cation

4 0.17 ppm ai / 4.745 = 0.036 ppm cation. Diquat concentrate is 41.4% ai and the ai (Diquat Dibromide Monohydrate) is 50.9% cation. Supplemental due to no NOAEC determined and no raw data. Endpoint is survival.

5 LC50 = 228 ppm diquat concentrate which is 41.4%.diquat monohydrate of which is 50.9 % diquat cation. In this study there was gentle aeration at 72 hrs and onward, salinity of water was 31 °/∞ instead of 10 to 17 °/∞. The slope = 2.14. Study is classified as acceptable.

6 Product tested contained 21.1 % cation. Slope = 5.4

7 Supplemental since it was submitted as Tier III outdoor study. Due to lack of protocol, study was accepted as Tier II study

Incident Database Review

A preliminary review on August 25, 2009, of the Ecological Incident Information System (EIIS, version 2.1), which is maintained by the Agency's Office of Pesticide Programs, and the Avian Montoring Information System (AIMS), which is maintained by the American Bird Conservancy, indicates a total of 12 reported ecological incidents associated with the use of Diquat Dibromide. These incidents are summarized in Table 3. This total excludes incidents classified as 'unlikely' and only includes those incidents with certainty categories of 'possible', 'probable', and 'highly probable'. In the EIIS database, the "unlikely" category is used when a chemical is not likely to be responsible for the incident. For example, an 'unlikely' classification might be applied in situations where a given chemical is practically nontoxic to the category of organism killed and/or there is evidence that another pesticide or stressor likely caused the incident. Incidents classified as 'unlikely' the result of Diquat Dibromide will not be included in this Problem Formulation or the ecological risk assessment conducted for Registration Review. The results of this review for terrestrial animals, non-target plants, and aquatic animal incidents are discussed below and found in Table 3.

All of the Diquat Dibromide incidents occurred between 1982 and 2007. Five of the Diquat Dibromide incidents involved aquatic animals; one involved terrestrial animals (reptiles), and six involved plants. The certainty categories on the likelihood that the use of Diquat Dibromide caused the 12 incidents ranged from probable (8 incidents) to possible (4 incidents). Five of the incidents were considered registered uses at the time of the incident, 4 involved misuses, and the legality of use was undetermined in 3 incidents. One of the incidents involved additional chemicals besides Diquat. Diquat residues were reported in one of the incident reports. (See Table 3). The reported incidents for Diquat involved 10 uses that are currently registered [potato, aquatic weed control, banks of waterbodies], and 2 in which the use site was not specified. The reported incidents associated with the 3 currently registered uses, had certainty categories of possible and probable. .

In addition to the incidents recorded in EIIS, additional incidents have been reported to the Agency in aggregated incident reports. Pesticide registrants report certain types of incidents to the Agency as aggregate counts of incidents occurring per product per quarter. Ecological incidents reported in aggregate reports include those categorized as "minor fish and wildlife" (W-B), "minor plant" (P-B), and "other nontarget" (ONT) incidents. "Other nontarget" incidents include reports of adverse effects to insects and other terrestrial invertebrates. For Diquat, registrants have reported 17 minor fish and wildlife incidents, 43 minor plant incidents, and 2 other nontarget incidents.

In the risk assessment, the incidents will be further evaluated to determine if the reported incidents represent current patterns of use for Diquat. Examples of additional considerations are mitigation (*e.g.*, reduced application rates), product cancellations, and changes in use patterns that have occurred since the date of the reported incident(s).

Table 3. Wildlife Incidents Associated with Diquat Dibromide.

Incident Number (Source)	Taxa Involved	Magnitude	Year	Location	Use	Legality of Use	Certainty Category[1]	Residues	Other Chemicals Involved
I013255-007	clam	thousands	2002	WI	Aquatic weed control	Registered Use	probable	N/R	$CuSO_4$
I001058-001	Frog, fish, tadpoles, snails, snakes, crawdads, wildflowers,	unknown	1994	TX	Stream-bank control	unknown	possible	N/R	
B0000-300-33	Fish – spot, mullet, reddrum, trout	unknown	1982	SC	N/R	unknown	probable	N/R	malathion
I003654-006	Bream fingerlings Carp	30-40 16-17	1993	NC	Edges of 2 ponds	Registered use	possible	None found in water	
I007494-001	Bass	N/R	1998	OH	¼ acre pond	Registered Use	probable	N/R	
I006107-019	strawberry	unknown	1995	OR	potato	Accidental misuse	probable	N/R	
I013857-013	spinach	Spinach crop rejected	2003	CO	unknown	unknown	possible	Not detected	
I013587-054	alfalfa	N/R	1999	WA	potato	misuse	probable	Diquat residues detected on plant surface	

Incident Number (Source)	Taxa Involved	Magnitude	Year	Location	Use	Legality of Use	Certainty Category[1]	Residues	Other Chemicals Involved
I019027-007	Alfalfa	50% field	2007	ND	potato	Registered Use	probable	N/R	
I014404-020	Ornamentals and trees	N/R	1990	WA	potato	Registered Use	possible	N/R	
I011901-001	American alligator, turtle (1)	5 400	2001	SC	Sewage treatment pond	Accidental misuse	probable	N/R	
I014410-037	alfalfa	Whole field	1993	WA	potato	Accidental misuse	probable	N/R	

1 animals found at bottom of 6 ft. pond after it was drained. Pond has very steep walls.

Exposure Characteristics

Table 4 summarizes important physical/chemical properties of diquat dibromide while Table 5 summarizes important fate/transport properties.

Table 4. Nature of the Chemical Stressor Diquat Dibromide

Common name	diquat dibromide
Chemical name	6,7-dihydrodipyrido(1,2-a:2',1'-c)pyrazinediium dibromide
Pesticide type	algicide, defoliant, desiccant, herbicide
Chemical class	Bipyridylium, dipyridylium
CAS number	85-00-7
Empirical formula	$C_{12}H_{12}Br_2N_2$
Molecular mass (g/mol)	344.05
Vapor pressure (torr)	$<1X10^{-7}$
Henry's Law Constant (atm-m^3/mol)	$1.4X10^{-13}$
Solubility in water (g/L) @ 20 °C,	700
Log K_{ow}	3.81

Table 5. Summary of Fate and Transport Properties for Diquat Dibromide

Parameter	**Value**	**Source**
Soil adsorption coefficient K_d (mL/g)	5839 (avg.)	MRID# 40348601
Hydrolysis half-Life pH = 5 pH = 7 pH = 9	stable	MRID 40418801
Photolysis half-life in water (day)	Stable	MRID# 40418801
Photolysis half-life in soil (day)	Stable	MRID# 40246101
Aerobic metabolism half-life in soil (day)	270	MRID# 40972301
anaerobic soil metabolism half-life (day)	Stable	MRID# 40972302
anaerobic aquatic metabolism half-life (day)	Stable	MRID# 40972302
aerobic aquatic metabolism half-life (day)	Stable	MRID# 40927601
Aquatic Field Dissipation half-life (day)	1-2	MRID# 40971403
Terrestrial field dissipation half-life (day)	stable	MRID# 42060301-02
Fish bioconcentration factors	≤2.5X	MRID# 40326901

The primary route of environmental dissipation of diquat is strong adsorption to soil particles. Diquat does not hydrolyse or photodegrade and is resistant to microbial degradation under aerobic and anaerobic conditions. There were no major degradates isolated from any of the environmental fate studies. When used as an aquatic herbicide, diquat is removed from the water column by adsorption to soil sediments, aquatic vegetation, and organic matter. Adsorbed diquat is persistent and immobile, and is not expected to be a ground-water contaminant.

Reinert and Rodgers (1987) studied various sediment types and found that unbound, biologically available diquat can be biodegraded by bacteria in the laboratory. However, because of the rapid adsorption of diquat to sediments in the environment which may renders it unavailable to biodegradation, the opportunity for microbial decomposition is not very great.

The basic environmental fate data base for diquat is complete.

Monitoring Data

No surface water or groundwater monitoring data were found from searches of the following data bases: EPA Pesticides in groundwater database (1994); and the USGS National Water-Quality Assessment Program (NAWQA).

Some surface and ground water monitoring data are available for diquat from the following sources: the South Florida Water Management District (SFWMD), and the EPA Office of Water. An MCL of 0.02 mg/L was established for diquat in 1999 (still valid), and the Florida Department of Environmental Protection (FDEP) has accepted such standard.

The SFWMD database contained a total of 42 samples that were taken from April 1992 to November 2000 at approximately a 1-3 month interval. For diquat, the only detection observed in surface water was 0.0045 ppm in 1994. Further monitoring beyond 1994 has shown no detections in surface water. Also in the SFWMD, diquat was detected in 9 sediment samples from canals with a maximum concentration of 3.1 ppm (LOD of 0.25 ppm, Miles and Pfeuffer, Pesticides in Canals of South Florida, Arch. Environ. Contam. Toxicol. 32:337-345, 1997). This would suggest that build-up in sediment may be possible, although maybe not wide-spread.

The EPA Office of Water has also collected monitoring data for diquat at intake pumps of drinking water utilities that use surface water and ground water, provided by community water systems (**CWS**). Monitoring was conducted in 14 states over many years. However, data from only eight states in the years 1993-1997 were included in the report. In these eight states, the percent of combined surface water and ground water systems reporting exceedences of the 20 ppb MCL was 0.06 %, resulting in a 0.27 % population exceedence (Occurrence of Regulated Contaminants in Drinking Water: First Stage Occurrence and Exposure Report for Six-Year Regulatory Review, Working Draft dated May 12, 2000).

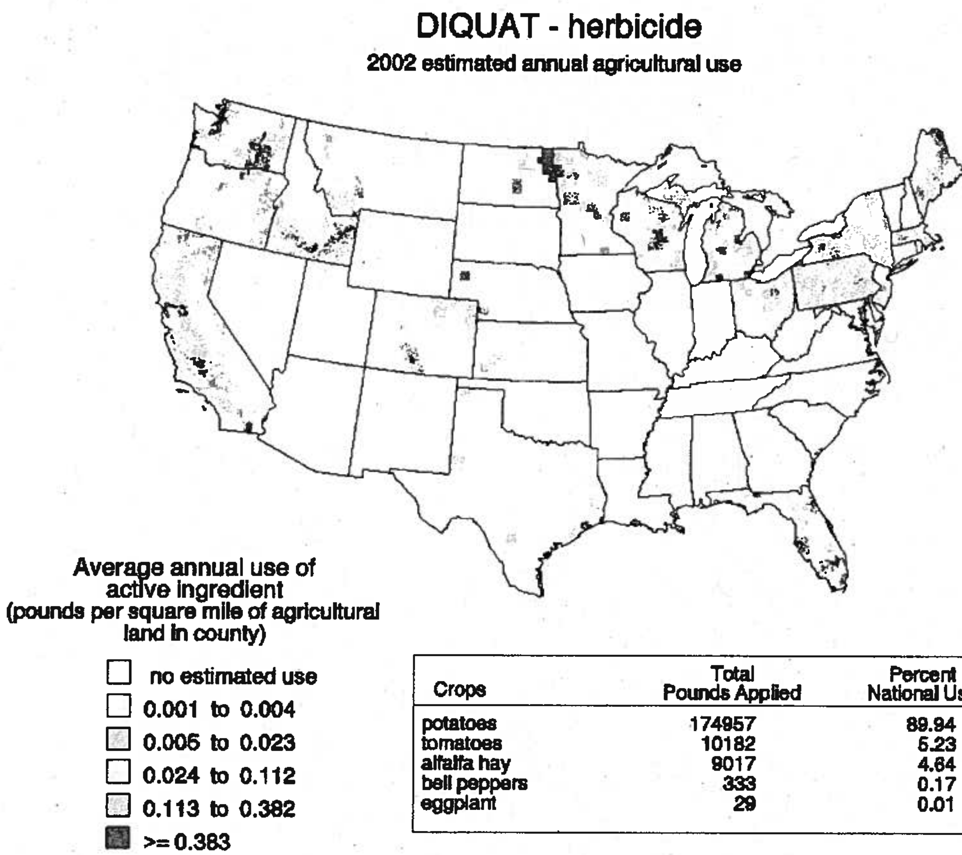
Clean Water Act

Diquat dibomide is not identified as a cause of impairment for any water bodies listed as impaired under section 303(d) of the Clean Water Act, based on information provided at http://iaspub.epa.gov/tmdl_waters10/attains_nation_cy.cause_detail_303d?p_cause_group_id=885. In addition, no Total Maximum Daily Loads (TMDL) have been developed for diquat dibromide, based on information provided at http://iaspub.epa.gov/tmdl_waters10/attains_nation.tmdl_pollutant_detail?p_pollutant_group_id=885&p_pollutant_group_name=PESTICIDES. More information on impaired water bodies and TMDLs can be found at http://www.epa.gov/owow/tmdl/.

The Agency invites submission of water quality data for this pesticide. To the extent possible, data should conform to the quality standards in Appendix A of the *OPP Standard Operating Procedure: Inclusion of Impaired Water Body and Other Water Quality Data in OPP's Registration Review Risk Assessment and Management Process* (see: http://www.epa.gov/oppfead1/cb/ppdc/2006/november06/session1-sop.pdf), in order to ensure they can be used quantitatively or qualitatively in pesticide risk assessments.

Characteristics of Ecosystems Potentially at Risk

Diquat is applied as a desiccant in seed crops and potatoes and for tassel control and spot weed control in sugarcane. In addition, it is used for aquatic weed control in various types of water bodies. There are many other use sites for Diquat which are shown in the Stressor Source and Distribution section.



Crops	Total Pounds Applied	Percent National Use
potatoes	174957	89.94
tomatoes	10182	5.23
alfalfa hay	9017	4.64
bell peppers	333	0.17
eggplant	29	0.01

Figure 1. 2002 Estimated Annual Agricultural Use Map for Diquat (Source: USGS)

Agricultural use of diquat is widespread throughout the United States. Figure 1 shows a national map of annual uses in 2002 where approximately 99% of the total annual use of diquat was distributed among three crops: potatoes (89.94%); tomatoes (5.23%); and alfalfa hay (4.64%). In 2009, these crops (except alfalfa) continued to reflect the major uses of diquat with the introduction of other major crops such as avocados and apples shown in Table 2.

Diquat is used for aquatic, indoor, greenhouse, aquatic non-food industrial, outdoor, greenhouse and residential; and outdoor residential uses. Information on the geographic extent of these uses and their amounts are of concern, and will be included in the Agency's assessment

Table 6 below shows the estimates of agricultural uses of diquat as of March 26, 2009.

Table 6. Screening Level Estimates of Agricultural Uses of Diquat Dibromide (032201) as of March 26, 2009.

Sorted Alphabetically

	Crop	Lbs. A.I.	Percent Crop Ttd. Avg.	Percent Crop Ttd. Max.
1	Alfalfa	<500	<1	<2.5
2	Almonds	1,000	<1	<2.5
3	Apples	1,500	<1	<2.5
4	Avocados	3,000	5	5
5	Cherries	<500	<1	<2.5
6	Grapes	<500	<1	<2.5
7	Olives *	<500	N/C	N/C
8	Peaches	<500	<1	<2.5
9	Pecans	<500	<1	<2.5
10	Peppers	<500	<1	<2.5
11	Potatoes	150,000	30	35
12	Strawberries +	<500	<2.5	<2.5
13	Tomatoes	1,500	<1	<2.5

All numbers rounded.
'<500' indicates less than 500 pounds of active ingredient.
'<2.5' indicates less than 2.5 percent of crop is treated.
'<1' indicates less than 1 percent of crop is treated.
* CA data only, but 95% or more of U.S. acres are in California
N/C = Not Calculated
+ = These crops were not known to be listed on active end use product registrations when this report was run.

SLUA data sources include:

USDA-NASS (United States Department of Agriculture's National Agricultural Statistics Service);
Private Pesticide Market Research,
NPUD 2002 (National Pesticide Use Database) of the CropLife America Foundation and California
DPR data.
These results reflect amalgamated data developed by the Agency and are releasable to the public.

Assessment Endpoints

Assessment endpoints are defined as "explicit expressions of the actual environmental value that is to be protected." Defining an assessment endpoint involves two steps: 1) identifying the valued attributes of the environment that are considered to be at risk; and 2) operationally defining the assessment endpoint in terms of an ecological entity (i.e., a community of fish and aquatic invertebrates) and its attributes (i.e., survival and reproduction). Therefore, selection of the assessment endpoints is based on valued entities (i.e., ecological receptors), the ecosystems potentially at risk, the migration pathways of pesticides, and the routes by which ecological receptors are exposed to pesticide-related contamination. The selection of clearly defined assessment endpoints is important because they provide direction and boundaries in the risk assessment for addressing risk management issues of concern. Changes to assessment endpoints are typically estimated from the available toxicity studies, which are used as the measures of effects to characterize potential ecological risks associated with exposure to a pesticide, such as diquat.

To estimate exposure concentrations, the ecological risk assessment considers applications at maximum rates. If multiple applications are allowed, the maximum amount per application and minimum interval between applications are used – provided that maximum total annual application amounts are also included in this configuration. Several EFED exposure models (e.g., PRZM-EXAMS, T-REX) are used to estimate likely high-end exposure to diquat. The most sensitive toxicity endpoints are used from surrogate test species to estimate treatment-related direct effects on acute mortality and chronic reproductive, growth and survival assessment endpoints. Toxicity tests are intended to determine effects of pesticide exposure on birds, mammals, fish, terrestrial and aquatic invertebrates, and plants. These tests include short-term acute, sub-acute, and reproduction studies and are typically arranged in a hierarchical or tiered system that progresses from basic laboratory tests to applied field studies. The toxicity studies are used to evaluate the potential of a pesticide to cause adverse effects, to determine whether further testing is required, and to determine the need for precautionary label statements to minimize the potential adverse effects to non-target animals and plants.

Diquat's mode of action and available toxicity data results suggest that there will be potential direct adverse effects to terrestrial and aquatic plants. Diquat is classified as moderately toxic to birds and moderately toxic to mammals on an acute oral basis and moderately toxic to practically non-toxic to birds on a subacute dietary basis. Diquat is also practically non-toxic to bees on an acute basis. Avian chronic studies resulted in reductions in number of eggs laid, hatching, and 14-day old survival at 25 ppm cation. In a two generation rat reproductive study, decreased number of F1 pups per litter and decreased body weight gain during lactation in both generations were observed at 240 ppm.

Diquat is slightly toxic to practically non-toxic to freshwater fish, practically non-toxic to estuarine/marine fish, moderately toxic to practically non-toxic to freshwater invertebrates, and highly toxic to estuarine/marine invertebrates on an acute basis. In a chronic freshwater fish study, larval wet weight was significantly reduced at 1.5 ppm cation. In a chronic freshwater invertebrate study at 0.036 ppm cation affected survival of parents and offspring.

Thirteen aquatic plant studies have been submitted to the Agency. The most sensitive algal species is green algae with an EC_{50} of 9.4 ppb cation. The most sensitive aquatic vascular plant submitted is giant duckweed with an EC_{50} of 0.75 ppb cation.

Terrestrial plant studies were submitted to the Agency. The most sensitive species tested is cotton with an EC_{25} of 0.0047 lb ai/A.

Conceptual Model

In order for a chemical to pose an ecological risk, it must reach ecological receptors in biologically significant concentrations. An exposure pathway is the means by which a pesticide moves in the environment from a source to an ecological receptor. For an ecological exposure pathway to be complete, it must have a source, a release mechanism, an environmental transport medium, a point of exposure for ecological receptors, and a feasible route of exposure.

The conceptual model depicts the potential pathways for ecological risk associated with diquat use. Figure 2 is the conceptual model for aquatic exposure and Figure 3 is the conceptual model for terrestrial exposure. The conceptual model provides an overview of the expected exposure routes for organisms.

Potential transport mechanisms for pesticides may include surface water runoff, spray drift, and secondary drift of volatilized or soil-bound residues leading to deposition onto nearby or more distant ecosystems. Diquat dibromide is not subject to significant volatility, so long-range atmospheric transport via volatility is unlikely. However, diquat is sorbed strongly to soil and organic matter particles. Therefore, diquat can be subjected to long-range atmospheric transport via wind-blown soil and dust particles. However, there is no available monitoring data to support this exposure pathway. Surface water runoff is expected to be the major route of exposure for diquat dibromide.

Diquat dibromide belongs to the bipyridyliums. Compounds in this group result in rapid disruption of cell membranes and very rapid kill. Diquat penetrates into the cytoplasm, causes the formation of peroxides and free electrons (light is required) which destroy the cell membranes almost immediately. Herbicidal oils dissolve membranes directly. Rapid destruction of cell membranes prevents translocation to other regions of the plant. Severe injury is evident hours after application, first as water-soaked areas which later turn yellow or brown. Maximum kill is attained in a week or less. Partial coverage of a plant with spray results in spotting and/or partial shoot kill. New growth on surviving plants will be normal in appearance. Foliar activity alone can provide only shoot kill. Additional information can be found at http://www.ces.purdue.edu/extmedia/WS/WS-23-W.html .

Figure 2. Ecological conceptual diagram for diquat dibromide aquatic exposure

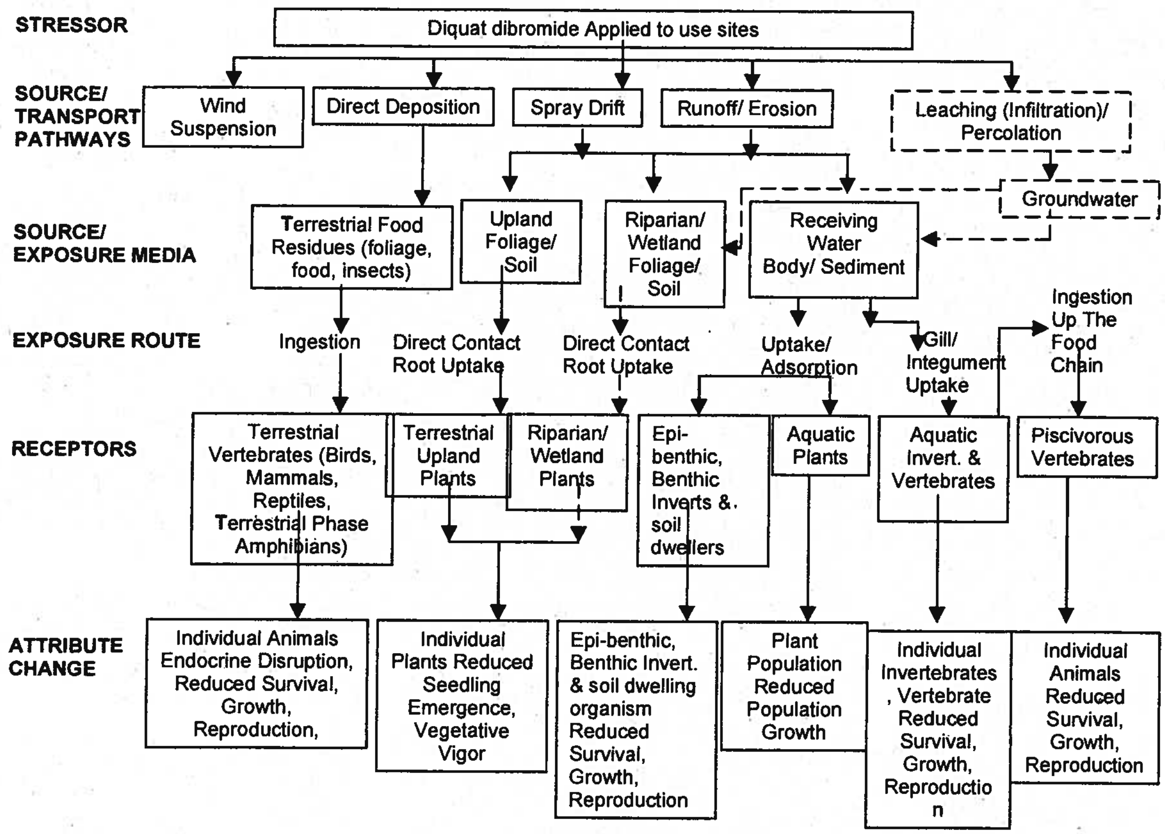
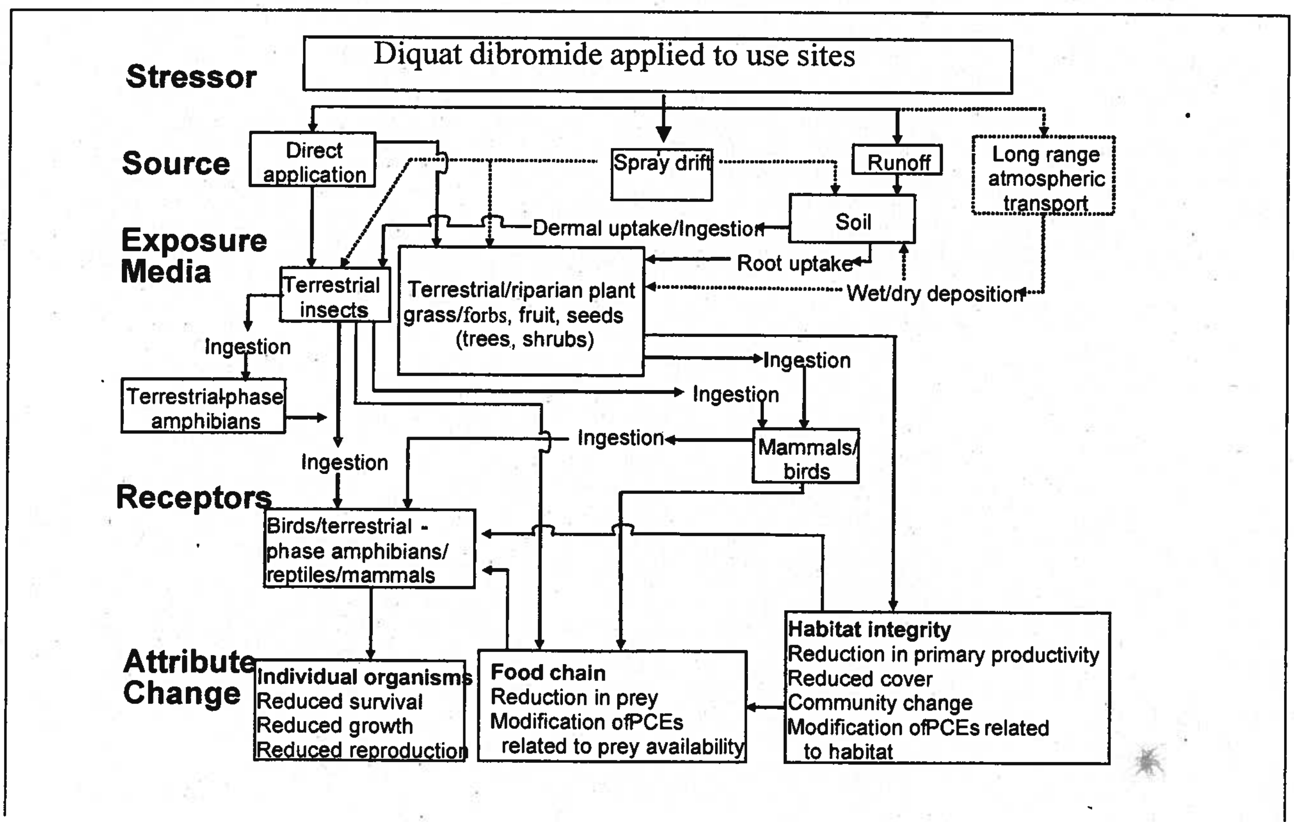


Figure 3. Ecological conceptual diagram for diquat dibromide terrestrial exposure



Risk Hypothesis

Based on an examination of the physical/chemical properties of diquat dibromide, its fate and disposition in the environment, and its mode of application, a conceptual model was developed that represents the possible relationships between this pesticide as a stressor, ecological receptors, and the assessment endpoints.

For diquat dibromide, the following ecological risk hypothesis is being employed for this baseline risk assessment:

Due to incident data, there is relatively high certainty that drift from aerial spraying of diquat dibromide will result in adverse effects to plants. Aquatic and terrestrial plants are sensitive to diquat and therefore will be adversely affected from spray drift.

Diquat is persistent but essentially immobile in the environment, indicating that it will most likely be associated with the soil and sediment instead of water. Sorption to soil and sediment may result in a lower potential risk to sensitive non-target plant species from runoff.

Diquat is expected to directly pose a significant risk to aquatic animals, and may also affect animals indirectly from lower dissolved oxygen as a result of decomposing plant matter.

Mammals and birds are expected to be chronically affected from the labeled use of diquat. They are not expected to be affected acutely from the labeled use of diquat.

There were no major degradates isolated from any of the environmental fate studies. For aquatic exposure, when used as an aquatic herbicide, much of diquat is removed from the water column by adsorption to soil sediments and organic matter including aquatic vegetation. Adsorbed diquat is persistent and immobile, and is not expected to be a ground-water contaminant.

Since diquat adsorbs strongly to soil and organic matter, much of the diquat is expected to partition to sediment where it may potentially accumulate due to its persisitence. Therefore there may be a potential chronic risk to invertebrates that inhabit the sediment.

Analysis Plan Options

In registration review, pesticide ecological risk assessments will follow the Agency's Guidelines for Ecological Risk Assessment, will be in compliance with the paper titled "Overview of the Ecological Risk Assessment Process in the Office of Pesticide Programs, U.S. Environmental Protection Agency" ("Overview Document") (January 2004), and will be done in accordance with Section 7 of the Endangered Species Act.

Use information will be retrieved from registration labels and used as inputs for estimating exposure concentrations from the various use scenarios.

Freshwater Organisms

Diquat is expected to enter freshwater environment from use patterns. Since diquat is persistent, binds to sediment, and is expected to patition to sediment, it is necessary to have freshwater invertebrate chronic toxicity study in sediment. In addition, there is much uncertainty associated with whether diquat is bioavailable in the sediment because of the binding to the sediment. Also, because of its persistence, diquat has the potential to accumulate in concentrations in the sediment, thereby necessitating the need to assess chronic toxicity risk to invertebrates in the sediment environment. In the absence of such data, we will need to make some conservative assumptions regarding risk to estuarine invertebrates that inhabit the sediment and also to endangered aquatic species that may be affected directly or indirectly from adverse impact to freshwater invertebrates.

Since information on the label is not clear, we will use conservative assumption regarding frequency of applications, number of applications, and the maximum application rate.

Estuarine/Marine Organisms

Due to fate characteristics and use patterns, we will need a chronic estuarine fish and estuarine invertebrate toxicity study. In the absence of chronic data, an estimated chronic estuarine fish and estuarine invertebrate toxicity value will need to be calculated using conservative assumptions and data from similar chemicals. The conservative acute to chronic ratio approach will be used to calculate the chronic NOAEC for these estuarine taxa.

Diquat is expected to enter estuarine/marine environment from use patterns. Since diquat is persistent, binds to sediment, and is expected to patition to sediment, it is necessary to have estuarine invertebrate chronic toxicity study in sediment. In addition, there is much uncertainty associated with whether diquat is bioavailable in the sediment because of the binding to the sediment. Also, because of its persistence, diquat has the potential to accumulate in concentrations in the sediment, thereby necessitating the need to assess chronic toxicity risk to invertebrates in the sediment environment. In the absence of such data, we will need to make some conservative assumptions regarding risk to estuarine invertebrates that inhabit the sediment and also to endangered aquatic species that may be affected directly or indirectly from adverse impact to estuarine invertebrates.

In addition, the lack of information on bioavailability of diquat in the sediment would necessitate an evaluation of the Reinert and Rodgers 1987 study on bioavailability of diquat in sediment as well as any other data that can be found in the literature.

Since information on the label is not clear, we will use conservative assumption regarding ferequency of applications, number of applications, and the maximum application rate.

There will be a revision of the risk assessment in the event that new or revised information becomes available that changes the outcome or determinations made in this document. The following data needs may result in reassessment of risks. Other changes may be made if current information is substantially re-evaluated.

Anticipated Data Needs

The Agency does foresee requiring additional ecological effects studies prior to conducting the planned assessments. Data gaps, uncertainties and potential paths forward for the assessment of diquat are described below.

The environmental fate data base for diquat is complete for reregistration of diquat dibromide.

Several toxicity studies are needed to better assess the potential risk of diquat exposure to non-target organisms. The studies listed below should be submitted to increase certainty in the risk estimation.

- Guideline Number: 850.1450, Study Title: Fish Early-Life Stage Toxicity (estuarine/marine) Sheepshead minow is the preferred fish species.
- Guideline Number: 850.1350, Study Title: Aquatic Invertebrate Life Cycle Toxicity (estuarine/marine) Mysid shrimp (*Mysidopsis bahia*) is the preferred species.
- Guideline Number: 850.1740, Study Title: Chronic Toxicity of Estuarine and Marine Sediment-associated contaminants with the Amphipod *Leptocheirus plumulosa*. This is a 28-day study found in First Edition, EPA Report 600/R-01/020, March 2001.
- Guideline Number: 850.1735, Study Title: Toxicity and bioaccumulation of Sediment-associated contaminants with Freshwater Invertebrates. This is a 42-day study with Hyallela found in Second Edition EPA/600/R-99/064, Duluth, MN.
- Guideline Number: 850.1790, Study Title: Chironomid sediment toxicity test. This a 50-56 day study of life cycle of Chironomid found in Second Edition EPA/600/R-99/064, Duluth, MN.
- Guideline Number: 850.4150 (123-1b), Vegetative Vigor Tier II study using cotton and soybean to determine the EC_{25} and NOAEC.

The Agency will conduct a search of the open literature to ensure that all best available science is utilized. The Agency uses the ECOTOX database as its mechanism for searching the open literature for ecological effects information. ECOTOX integrates three previously independent databases - AQUIRE, PHYTOTOX, and TERRETOX - into a system which includes toxicity data derived predominately from the peer-reviewed literature, for aquatic life, terrestrial plants, and terrestrial wildlife, respectively.

Other Information Needs

There is specific information that will assist the Agency in refining the ecological risk assessment, including any species-specific effects determinations. The Agency is very much interested in obtaining the following information:

1. confirmation on the following label information
    a. frequency of application, application intervals, and maximum number of applications per season
    b. geographic limitations on use
2. use or potential use distribution (e.g., acreage and geographical distribution of relevant crops)
3. use history
4. median and 90th percentile reported use rates (lbs. a.i./acre) from usage data – national, state, and county
5. application timing (date of first application and application intervals) by crop – national, state, and county
6. sub-county crop location data
7. usage/use information for non-agricultural uses (e.g., forestry, residential, rights-of-way)
8. directly acquired county-level usage data (not derived from state level data)
    a. maximum reported use rate (lbs. a.i./acre) from usage data – county
    b. percent crop treated – county
    c. median and 90th percentile number of applications – county
    d. total pounds per year – county
    e. the year the pesticide was last used in the county/sub-county area
    f. the years in which the pesticide was applied in the county/sub-county area
9. typical interval (days)
10. state or local use restrictions
11. ecological incidents (non-target plant damage and avian, fish, reptilian, amphibian and mammalian mortalities) not already reported to the Agency
12. monitoring data
13. Diquat doesn't break down, so we'd expect accumulation in the soil and sediments over time, even if it is sorbed. Thus accumulation over time could be a issue. Although there is some evidence (literature review) that indicates a minor breakdown of diquat after adsorption. This is still uncertainity in the assessment. Any additional information support such biodegradaion is welcome.

The analysis plan will be revisited and may be revised depending upon the data available in the open literature and the information submitted by the public in response to the opening of the Registration review docket.

Guideline Number: 850.1450 **Study Title: Fish Early-Life Stage Toxicity (estuarine/marine, sheepshead minnow is the preferred species)**
Rationale for Requiring the Data

The requested data would allow EPA to refine its chronic risk (growth and reproduction) estimates for freshwater fish, and allow it to define an action area for endangered species. Risk mitigation strategies (*e.g.*, determining maximum diquat application rate that results in an RQ below the LOC) cannot be evaluated without these data.

Since the registration of diquat, the Agency has worked to finalize its update to the data requirements in 40 CFR Part 158. These updated data requirements were promulgated in October 2007. Now one estuarine/marine fish early life stage study is required to support all terrestrial, aquatic, forestry, and residential turf use patterns that may create estuarine exposure to diquat.

40 CFR Part 158 was revised to list the fish early-life stage and aquatic invertebrate life-cycle studies as separate requirements in the data table; then identify each test organism as a freshwater or saltwater species. For the estuarine fish early-life stage and estuarine invertebrate life-cycle data requirements, the Agency requires testing of one fish species and one aquatic invertebrate species, respectively, for the terrestrial, aquatic, forestry, and residential turf use patterns. Previously, the estuarine invertebrate life cycle and estuarine fish early life stage tests were combined under one data requirement with testing required of only the more sensitive species in acute studies. However, when a pesticide enters the estuarine aquatic environment, both groups of organisms are exposed. Moreover, acute sensitivity is not a reliable indicator of chronic sensitivity, particularly when looking across different groups of organisms, so chronic data are needed regardless of the results of acute testing.

This change was warranted because the relative sensitivity of fish and invertebrates can vary widely across chemicals. Previously, only the more sensitive of the two organisms, either fish or aquatic invertebrates, as determined by Tier I acute studies, was tested. However, since both organisms are exposed when a pesticide enters an aquatic environment and the acute sensitivity of an invertebrate may not accurately predict the chronic sensitivity in fish and vice versa, both species must now be tested for chronic effects. The Agency cannot make the assumption that a chemical is not chronically toxic at much lower concentrations than some ratio of the LC_{50} value would suggest.

Practical Utility of the Data

How will the data be used?
Data are needed for a registration review decision and for an endangered species assessment, which will be conducted as part of that decision. The effects data would be used to determine the likelihood that the chronic risks can potentially impact freshwater aquatic communities, by direct effects on fish and their reproduction. In the absence of data, the Agency will use EPA's WEB-ICE model to deterime the acute-to-chronic ratio (ACR) using conservative assumptions to be more protective, especially of endangered species. In addition, other sources of data from other chemicals in similar chemical class or mode of action group may be used to derive ACR using most conservative assumptions. By refining the assessment, the Agency would be able to determine the appropriate mitigation for diquat.

How could the data impact the Agency's future decision-making?
If future endangered species risk assessments are performed without these data, the Agency

would have to assume that diquat "may affect" endangered fish directly (and endangered species from other taxa indirectly). Thus, use of diquat might need to be restricted in areas where endangered species could be exposed. The lack of these data will limit the flexibility the Agency and registrants have in coming into compliance with the Endangered Species Act and could result in use restrictions for diquat which are unnecessarily severe.

Guideline Number: 850.1350
Study Title: Aquatic Invertebrate Life Cycle Toxicity (estuarine/marine, mysid shrimp is the preferred species)

Rationale for Requiring the Data

The requested data would allow EPA to refine its chronic risk (growth and reproduction) estimates for estuarine/marine invertebrates, and allow it to define an action area for endangered species. Risk mitigation strategies (*e.g.*, determining maximum diquat application rate that results in an RQ below the LOC) cannot be evaluated without these data.

Since the registration of diquat, the Agency has worked to finalize its update to the data requirements in 40 CFR Part 158. These updated data requirements were promulgated in October 2007. Now one estuarine/marine invertebrate life-cycle stage study is required to support all terrestrial, aquatic, forestry, and residential turf use patterns that may create estuarine exposure to diquat.

40 CFR Part 158 was revised to list the fish early-life stage and aquatic invertebrate life-cycle studies as separate requirements in the data table; then identify each test organism as a freshwater or saltwater species. For the estuarine fish early-life stage and estuarine invertebrate life-cycle data requirements, the Agency requires testing of one fish species and one aquatic invertebrate species, respectively, for the terrestrial, aquatic, forestry, and residential turf use patterns. Previously, the estuarine invertebrate life cycle and estuarine fish early life stage tests were combined under one data requirement with testing required of only the more sensitive species in acute studies. However, when a pesticide enters the estuarine aquatic environment, both groups of organisms are exposed. Moreover, acute sensitivity is not a reliable indicator of chronic sensitivity, particularly when looking across different groups of organisms, so chronic data are needed regardless of the results of acute testing.

This change was warranted because the relative sensitivity of fish and invertebrates can vary widely across chemicals. Previously, only the more sensitive of the two organisms, either fish or aquatic invertebrates, as determined by Tier I acute studies, was tested. However, since both organisms are exposed when a pesticide enters an aquatic environment and the acute sensitivity of an invertebrate may not accurately predict the chronic sensitivity in fish and vice versa, both species must now be tested for chronic effects. The Agency cannot make the assumption that a chemical is not chronically toxic at much lower concentrations than some ratio of the LC_{50} value would suggest.

Practical Utility of the Data

How will the data be used?
Data are needed for a registration review decision and for an endangered species assessment, which will be conducted as part of that decision. The effects data would be used to determine the

likelihood that the chronic risks can potentially impact estuarine/marine aquatic communities, by direct effects on invertebrates and their reproduction. In the absence of data, the Agency will use EPA's WEB-ICE model to deterime the acute-to-chronic ratio (ACR) using conservative assumptions to be more protective, especially of endangered species. In addition, other sources of data from other chemicals in similar chemical class or mode of action group may be used to derive ACR using most conservative assumptions. By refining the assessment, the Agency would be able to determine the appropriate mitigation for diquat.

How could the data impact the Agency's future decision-making?
If future endangered species risk assessments are performed without these data, the Agency would have to assume that diquat "may affect" endangered estuarine invertebrates directly (and endangered species from other taxa indirectly). Thus, use of diquat might need to be restricted in areas where endangered species could be exposed. The lack of these data will limit the flexibility the Agency and registrants have in coming into compliance with the Endangered Species Act and could result in use restrictions for diquat which are unnecessarily severe.

Guideline Number: Special Study
Study Title: Chronic Toxicity of Estuarine and Marine Sediment-associated contaminants with the Amphipod *Leptocheirus plumulosa*. This is a 28-day study found in First Edition, EPA Report 600/R-01/020, March 2001.

Rationale for Requiring the Data

The requested data would allow EPA to determine its chronic risk (growth and reproduction) estimates for estuarine/marine invertebrates in sediment. Risk mitigation strategies (*e.g.*, determining maximum diquat application rate that results in an RQ below the LOC) cannot be evaluated without these data.

Since the registration of diquat, the Agency has worked to finalize its update to the data requirements in 40 CFR Part 158. These updated data requirements were promulgated in October 2007. Now estuarine/marine invertebrate chronic toxicity study in sediment is conditionally required to support all terrestrial, aquatic, forestry, and residential turf use patterns that may create estuarine exposure provided that the pesticide is persistent ($t_{1/2}$ >1000 days in soil), binds to soil (Kd $\geq$ 50) or is expected to enter estuarine environment from runoff in significant concentrations. Diquat is persistent with t1/2 = stable for anaerobic soil metabolism half-life, photolysis, and hydrolysis; may be transported into estuarine emnvironments due to use pattern, and binds to soil with Kd = 5839 and Kow = 3.8. Also, because of its persistence, diquat may have the potential to accumulate in concentrations in the sediment, thereby necessitating the need to assess chronic toxicity risk to invertebrates in the sediment environment.

Practical Utility of the Data

How will the data be used?

Data are needed for a registration review decision and for an endangered species assessment, which will be conducted as part of that decision. The effects data would be used to determine the likelihood that the chronic risks can potentially impact estuarine/marine aquatic communities, by direct effects on invertebrates and their reproduction. Sediments serve as a repository for many compounds and a possible media of direct and indirect toxic exposure to benthic and epibenthic organisms (those animals living in or on the sediment) which can be essential components of various aquatic food webs. By determining the chronic risk, the Agency would be able to determine the appropriate mitigation for diquat. In addition, there is uncertainty as to whether diquat is bioavailable when bound to sediment. This study will also address this uncertainty.

How could the data impact the Agency's future decision-making?
If future endangered species risk assessments are performed without these data, the Agency would have to assume that diquat "may affect" endangered estuarine invertebrates directly (and endangered species from other taxa indirectly). Thus, use of diquat might need to be restricted in areas where endangered species could be exposed. The lack of these data will limit the flexibility the Agency and registrants have in coming into compliance with the Endangered Species Act and could result in use restrictions for diquat which are unnecessarily severe.

Guideline Number: Special Study
Study Title: Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates. This is a 42-day study with Hyallela and 50-56 day study of life cycle of Chironomid found in Second Edition EPA/600/R-99/064, Duluth, MN.

Rationale for Requiring the Data

The requested data would allow EPA to determine its chronic risk (growth and reproduction) estimates for freshwater invertebrates in sediment. Risk mitigation strategies (*e.g.*, determining maximum diquat application rate that results in an RQ below the LOC) cannot be evaluated without these data.

Since the registration of diquat, the Agency has worked to finalize its update to the data requirements in 40 CFR Part 158. These updated data requirements were promulgated in October 2007. Now freshwater invertebrate chronic toxicity study in sediment is conditionally required to support all terrestrial, aquatic, forestry, and residential turf use patterns that may create freshwater exposure provided that the pesticide is persistent ($t_{1/2}$ >1000 days in soil), binds to soil ($Kd \geq 50$) or is expected to enter aquatic environment from runoff in significant concentrations. Diquat is persistent with t1/2 = stable for anaerobic soil metabolism half-life, photolysis, and hydrolysis, and binds to soil with Kd = 5839 and Kow = 3.8. Also, because of its persistence, diquat may have the potential to accumulate in concentrations in the sediment, thereby necessitating the need to assess chronic toxicity risk to invertebrates in the sediment environment.

Practical Utility of the Data

How will the data be used?

Data are needed for a registration review decision and for an endangered species assessment, which will be conducted as part of that decision. The effects data would be used to determine the likelihood that the chronic risks can potentially impact freshwater aquatic communities, by direct effects on invertebrates and their reproduction. Sediments serve as a repository for many compounds and a possible media of direct and indirect toxic exposure to benthic and epibenthic organisms (those animals living in or on the sediment) which can be essential components of various aquatic food webs. By determining the chronic risk, the Agency would be able to determine the appropriate mitigation for diquat. In addition, there is uncertainty as to whether diquat is bioavailable when bound to sediment. This study will also address this uncertainty.

How could the data impact the Agency's future decision-making?
If future endangered species risk assessments are performed without these data, the Agency would have to assume that diquat "may affect" endangered estuarine invertebrates directly (and

endangered species from other taxa indirectly). Thus, use of diquat might need to be restricted in areas where endangered species could be exposed. The lack of these data will limit the flexibility the Agency and registrants have in coming into compliance with the Endangered Species Act and could result in use restrictions for diquat which are unnecessarily severe.

Guideline Number: 850.4150, 123-2b **Study Title: Vegetative Vigor, Tier II**
Rationale for Requiring the Data
Data from current vegetative vigor studies have some uncertainty since they were done under nonguideline protocols in field conditions and not under controlled laboratory conditions. Agency is asking only for the most sensitive species to be tested. Data from the study indicate that the most sensitive species found were soybean, sunflower, cotton and corn. Plants form the basis of most habitats and significantly contribute to overall environmental quality, and therefore a solid understanding of the potential risks to plants is essential for sound environmental management. Since the diquat RED was signed, the Agency has finalized its update to the data requirements in 40 CFR Part 158. In these updated data requirements, which were promulgated on October 26, 2007, Tier II vegetative vigor (guidelines 850.4150, 123-1b), are required for terrestrial uses. Diquat is registered for use on terrestrial crops, and therefore these data are required under the new 40 CFR Part 158 data requirements.
Practical Utility of the Data
How will the data be used? The data will be used to estimate potential risks to terrestrial plants, including the likelihood of potential risks to endangered species, either by direct effects or by indirect effects, and to reduce uncertainties associated with the current ecological risk assessment. By refining the assessment, the Agency will be able to determine whether current labeling is appropriate and whether further mitigation is necessary. **How could the data impact the Agency's future decision-making?** These data, once submitted, will allow the Agency to characterize the risk of diquat to terrestrial ecosystems. Primary producers (*i.e.* plants) provide oxygen, food and habitat vital to ecological processes. Therefore, a solid understanding of the potential risks to plants is essential in order to assess the environmental risks the use of diquat may pose. If the data indicate that diquat poses significant risks to these non-target plant species, the Agency may explore additional decision options to minimize the risks to these species. The lack of these data will limit the flexibility the Agency and registrants have in complying with the Endangered Species Act and could result in use restrictions for diquat which may otherwise be avoided, or which are unnecessarily severe.