UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

9/29/94

MEMORANDUM

SUBJECT: Transmittal of EFED List A Summary Report for Diquat dibromide (Chemical # 032201) Case # 0288

FROM: William R. Schneider, Ph.D.
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THRU: for Evert K. Byington, Chief
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TO: Esther Saito, Chief
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Special Review & Reregistration Division

Attached please find the following documents for the completed EFED summary report of diquat dibromide.

1. EFGWB Science Chapter
2. EEB Science Chapter
3. SACS Reregistration Summary Report

Diquat dibromide exceeds the levels of concern for chronic effects to birds and terrestrial mammals. Levels of concern for acute and chronic effects to aquatic and estuarine organisms have been exceeded in some cases, however these effects are likely to be minimal in actual practice because diquate dibromide apparently tends to bind rapidly to suspended matter in the water column and becomes biologically unavailable. In addition, data gaps were identified for this reregistration case. If you have any questions concerning this case, please contact Bill Schneider, 305-7682.

CC:\ (with SACS Reregistration Summary Report attached)

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C. Environmental Assessment

1. Environmental Fate

There is sufficient data for comprehensive qualitative and quantitative environmental fate, ground and surface water assessments for Diquat dibromide.

a. Environmental Chemistry, Fate and Transport

(1) Hydrolysis: 161-1

Hydrolysis was stable in water at all pHs (tested at pH 5, 7, and 9). (Accession 259950 & 259951)

(2) Photodegradation in water: 161-2

Diquat can be considered to be photolytically stable in the environment; diquat degraded with a calculated half-life of 74 days of Florida spring sunlight. Radiolabeled diquat in pH 7 buffer was continuously irradiated with a xenon lamp for a period of time that approximated 32 days of Florida spring sunlight. One degradate, 1,2,3,4-tetrahydro-1-oxopyrido (1,2-a)pyrazin-5-ium ion, comprised 12 percent of the radioactivity at the conclusion of the study. (MRID 40418801)

(3) Photodegradation on soil: 161-3

[^{14}C]Diquat did not photodegrade on loam soil irradiated with a xenon arc lamp at 20.5-29.1°C for 107.42 hours (equivalent to approximately 32 days of natural sunlight). Diquat was the only compound identified in the extracts. (MRID 40246101)

(4) Aerobic soil metabolism: 162-1

Diquat at approximately 3 ug/g did not degrade in an aerobic sandy loam soil incubated at 25°C in the dark for 9 months. (MRID 40972301)

(5) Anaerobic aquatic metabolism: 162-3

[^{14}C]Diquat did not degrade when incubated under anaerobic aquatic conditions for 9 months at 25°C. After 9 months, one unidentified degradate comprised approximately 5 percent of the applied radioactivity. Throughout the study 89 to 100 percent of the diquat residues were associated with the soil sediment portion of the system. No anaerobic aquatic half-life could be calculated. (MRID 40972302)

(6) **Aerobic aquatic metabolism: 162-4**

[^{14}C]Diquat did not degrade when incubated under aerobic aquatic conditions for 31 days at 25°C. Between 95 to 99 percent of the diquat residues were associated with the soil sediment portion of the system. No aerobic aquatic half-life could be calculated. (MRID 40927601)

(7) **Mobility -- adsorption/desorption: 163-1**

Diquat is immobile with Freundlich K_{ads} values of 15 in sand sediment, 36-42 in two sand soils, and Freundlich K_{ads} values of 1882-10740 in sandy loam, sandy clay loam, and loam soils. (MRID 40348601)

(8) **Laboratory volatility: 163-2**

Diquat has a vapor pressure of $<4 \times 10^{-9}$ mm Hg at 25°C; therefore, volatility is not expected to be a route of dissipation. There was no evidence of volatility in any study submitted to satisfy environmental fate requirements. (MRID 40245101)

(9) **Dissipation -- Terrestrial field: 164-1: and Long-term field: 164-5**

Diquat did not degrade for 3 years after application to two plots in New York; concentrations of diquat ion ranged from 0.01 to 0.32 ppm in the upper 15-cm soil depth. The two plots were planted to potatoes; the potato vegetation from the clay loam soil plot was removed prior to application to represent bare ground application, the other plot was on a loam soil and diquat was sprayed on the vegetation. There were two applications of diquat dibromide (2 lb ai/gal SC/L) at 0.25 lb diquat ion/A/application (total 0.5 lb ai/A). In general, there was no pattern of leaching; diquat was recovered at 0.01-0.03 ppm from individual soil cores from the 15- to 22.5-cm soil depth.

Diquat did not degrade for 3 years after application to two plots of loam soil in Idaho; concentrations of diquat ion ranged from 0.01 to 0.13 ppm in the upper 35-cm soil depth. Application was made to bare ground and to potato vegetation. The plots were cultivated to 35 cm and in subsequent years cropped to a rotation of sugarbeets, wheat and potatoes. There were two applications of diquat dibromide (2 lb ai/gal SC/L) at 0.25 lb diquat ion/A/application (total 0.5 lb ai/A). There were no residues recovered from below 35 cm. (MRIDs 42060301, 42060302, 40335201)

(10) **Field Dissipation - Aquatic and Aquatic Impact: 164-2**

Diquat dissipated with half-lives of 1-2 days from Florida pondwater that was treated four times at 4 lb ai/A/application at approximately monthly intervals with diquat dibromide (Ortho Diquat Herbicide-HA). Diquat was removed from the water column by adsorbing to sediment. The diquat concentrations in the sediment were variable ranging to a maximum of 1.2 ppm in the 0- to 5-cm depth with no discernible pattern of decline. In the aquatic dissipation study, the sites chosen were both near Gainesville, FL. Although the pond sites were treated under the same climatic conditions, the sediments were of different textures; one was sandy clay loam and the other was a sand sediment. The findings from these two sites were in agreement with findings from field dissipation studies conducted under a variety of climatic conditions and also were comparable to predictions from laboratory results. (MRID 40917403)

(11) Laboratory Accumulation - Fish: 165-4

Diquat residues did not significantly accumulate in bluegill sunfish exposed to [^{14}C]diquat dibromide at approximately 1030 ppb diquat ion for 14 days under flow-through conditions. The maximum mean bioconcentration factors were 0.7X for edible tissues (muscle, skin, skeleton), 2.5X for nonedible tissues (viscera) and 1.03X for whole fish. Depuration was rapid, with approximately 50 percent of the accumulated [^{14}C]residues eliminated from the fish tissues by day 3 of the depuration period. (MRID 40326901)

(12) Laboratory Accumulation - Non-target organisms: 165-5

a. ***Daphnia magna.*** Diquat residues did not significantly accumulate in *Daphnia magna* exposed to diquat dibromide at 10 ug/L in a laboratory flow-through system. The reported maximum bioconcentration factor was 8.3X, at 1 day post-exposure.

Diquat residues did not significantly accumulate in mayfly nymphs exposed to diquat dibromide at 1 mg/L in a laboratory flow-through system. The reported maximum bioconcentration factor was 32X, at 1 day post-exposure.

Diquat residues did not significantly accumulate in the soft tissue of Pacific oysters which were exposed to diquat dibromide monohydrate at 0.1 mg/L in a laboratory flow-through system for up to 28 days. The soft tissue bioconcentration factor for organisms exposed for 14 days was 5.5X; for those exposed for 28 days, the soft tissue bioconcentration factor was 10.5X.

b. Tilapia and catfish. Diquat did not significantly accumulate in tissues of tilapia and catfish from two fish ponds in Florida which were treated with diquat dibromide in four monthly applications at 4 lb diquat ion/A/application (total 16 lb diquat ion/A). Each application was equivalent to 0.36 ug diquat ion/mL. In tilapia, maximum concentrations of diquat ion were 8.5 and 0.30 ppm in nonedible (head, tail, and viscera) and edible (fillet plus skin) tissues, respectively. In catfish, the maximum concentrations of diquat ion were 0.0[illegible] and 0.15 ppm in edible (fillet) and nonedible (head, skin, tail, and viscera) tissues, respectively. Diquat ion concentrations in fish tissues did not increase with repeated applications. Diquat ion dissipated from the pond water with half-lives of 0.72-2.3 days. (MRIDs 40326903, 40326902, 40326904, 40380701)

b. Environmental Fate Assessment

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.

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

Pesticide Runoff Simulation Modeling:

An estimate of diquat runoff and its effect on surface water quality was evaluated using PRZM-EXAM models from a typical crop use on potatoes with data from a silt loam soil in Maine.

Model simulations indicate that a 10 percent exceedance probability of the maximum of 0.33 kg/ha/year diquat could potentially be found in surface water systems. This estimate is a high exposure scenario of the entire yearly application of 0.5 lb ai/A to soil on a highly eroded soil for 36 years. This assessment includes diquat adsorbed onto eroded soil particles as well as diquat in the runoff water. Estimated environmental concentrations (EEC's) at 10 percent exceedance probabilities in a one hectar water body, 2 meters deep, are shown in the table below.

Annual Average EEC of Dissolved Diquat in Maine with 10 percent Exceedance Probability.

Maximum	96 hour	21 day	60 day	90 day
48.4 ppb	47.8 ppb	45.1 ppb	45.3 ppb	43.6 ppb

While these predictions are higher than expected from the environmental assessment of diquat, the PRZM-EXAM model is predicting a high exposure scenario for diquat applied to potatoes.

2. Ecological Effects

a. Ecological Effects Data

The ecotoxicological data base is adequate to characterize the toxicity of diquat dibromide to nontarget terrestrial and aquatic organisms when used on terrestrial food, feed and nonfood sites, and on aquatic nonfood sites..

(1) Terrestrial Animal Data

In order to establish the toxicity to birds, the following tests are required using the technical grade material: an avian single-dose oral acute study (71-1) on one species (preferably mallard duck or bobwhite quail); two subacute dietary studies (71-2) on one species of waterfowl (preferably mallard duck) and on one species of upland game bird (preferably bobwhite quail); and because of persistence and multiple applications, two avian reproduction studies (71-4) on mallard duck and bobwhite quail.

Wild mammal testing is required on a case-by-case basis, depending on the results of the lower tier studies such as acute and subacute testing, intended use pattern, and pertinent environmental fate characteristics.

A honey bee acute contact LD_{50} study is required if the proposed use will result in honey bee exposure.

Effects on Non-target Birds

Nine studies were evaluated under this topic. The activity of Diquat dibromide herbicide is in the cation. In the tables below, the cation will be used for risk assessment purposes for birds since the use information is in lb cation per acre. The cation active ingredient is extrapolated from the test values whether it be in diquat formulation or cation. The acceptable toxicity studies for use in a hazard assessment are listed below:

(a) Avian Acute Toxicity

Avian Acute Oral Toxicity Findings			
Species	% Test Material (TGAI)	LD_{50} in mg/kg cation per kg	Conclusions
Mallard	45.6	60.6 mg/kg	Moderately toxic
Mallard	30.0	89.6 mg/kg	

For hazard assessment, these data indicate that diquat dibromide is moderately toxic in acute studies to birds. Typically, toxicity testing is to be done with technical grade active ingredients, usually having relatively high per cent purity. In the case of diquat dibromide, a test material containing 35 to 37 percent represents, apparently, the highest purity produced. The guideline requirement for the avian acute oral LD_{50} study is fulfilled. (MRID 00106559, HCOSTA01)

(b) Avian Subacute Dietary Toxicity

Avian Subacute Dietary Toxicity Findings			
Species	% Test Material	LC_{50} cation per Kg	Conclusions
Bobwhite quail	37.0	575 ppm	Slightly to moderately toxic
Mallard	37.0	980* ppm	
Japanese quail	37.0	264 ppm	
Ring-neck pheasant	37.0	734 ppm	
Bobwhite quail	35.3	106 ppm	

* 30 percent mortality at 980 ppm cation.

On a subacute dietary basis, diquat dibromide ranges from slightly to moderately toxic to birds. The guideline requirement for the avian subacute dietary study is fulfilled. (MRID 00034769, and 00116565)

(c) **Avian Reproduction**

Avian reproduction studies are required when birds may be exposed repeatedly or continuously through persistence, bioaccumulation, or multiple applications, or if mammalian reproduction tests indicate reproductive hazard. Present product labeling of diquat dibrimide allows several applications of the end-use product per growing season.

Avian Reproduction Findings			
Species	**% A.I.**	**Reproductive Impairment**	**Conclusions**
Bobwhite Quail	35.3	number of eggs laid, hatching, and 14-day old survival	NOEL = 5ppm LOEL = 25 ppm
Mallard Duck	35.3		

The avian reproductive study found the NOEL to be 5 ppm cation and LOEL to be 25ppm cation. These findings were based on number of eggs laid, hatching and 14-day old survival. (MRID 00119988, and 00114230)

(d) **Nontarget Insect Toxicity**

The minimum data required to establish the acute toxicity to honey bees is an acute contact LD_{50} study with the technical material.

Nontarget Insect Acute Contact Toxicity Findings			
Species	**% Test Material**	**LD_{50}**	**Conclusion**
Honey bee	99.6	100 μg/bee	practically non-toxic to bees
Honey bee		47 μg/bee*	

* This was tested as Reglone with an LD_{50} =171 μg/bee and as Reglone + Agral with an LD_{50} =66 μg/bee for acute contact toxicity. This was also tested for oral acute with Reglone (LD_{50} =47μg/bee) and Reglone + Agral ((LD_{50} =35 μg/bee). Agral is a liquid non-ionic wetting and spreading agent.

There is sufficient information to characterize diquat dibromide as practically nontoxic to bees. The guideline requirement is fulfilled. (MRID 072012, and 40208001)

(2) Aquatic Animal Data

(a) Freshwater Fish Toxicity

In order to establish the toxicity to fish, the following tests are required using the technical grade material: two 96-hour acute fish studies (72-1); one on a species of coldwater fish (preferably rainbow trout) and one on a species of warmwater fish (preferably bluegill sunfish); and because of persistence one fish early life stage study.

Eleven studies were evaluated under this topic. In the table below, the diquat cation will be used for risk assessment purposes for aquatic organisms since the availability of diquat dibromide is as a cation in aquatic environments. The value in ppm cation is extrapolated from the test values whether it be in diquat formulation, cation, or active ingredient. The acceptable toxicity studies for use in a hazard assessment are listed below:

Freshwater Fish Acute Toxicity Findings			
Species	**% Test Material (TGAI)**	**LC_{50} in ppm cations**	**Conclusions**
Brown trout	35.3	17.8	slightly to moderately toxic
Emerald Shiner	*	*	
Bluegill	35.3	12.1***	
Rainbow trout	35.3**	14.8	
Bluegill	35.3	13.9	
Rainbow trout	35.3	>18.7	
Bluegill	35.3	21.5	
Yellow Perch	35.3	4.4	
Black Bullhead	35.3	4.6	

* The study cites the 2 lb ai/imperial gallon. According to the LUIS report, the 2lb cation per gallon pertains to the 35.3 percent ai formulation. It is unclear as to what is the actual percentage formulation used.

** The study cites the percentage formulation as 19.8 percent cation and having 2 lb cation per gallon. According to the LUIS report, the 2 lb cation per gallon is similar to the 35.3 percent ai formulation (diquat dibromide is made up of about 53 percent cation).

*** Results based on 72 hour test rather than 96 hour test.

The results of the acute toxicity studies indicate that diquat dibromide is slightly to moderately toxic to both cold and warm water fish. The guideline requirement for acute toxicity testing of the technical on freshwater fish is fufilled. (MRID 00115858, 0027203, 00115572, 00138961, and 00003503)

(b) Fish Early Life Cycle Study

The MATC below is derived from the geometric mean of the fish early life cycle study which shows NOEL= 0.58 ppm and LOEL= 1.5 ppm of the Diquat Concentrate based on wet weight and length of the larvae. There are 50.9 percent cation in diquat dibromide in the formulation for this study.

Fish Early Life Cycle Findings			
Species	% Test Material (TGAI)	MATC in ppm cations	Conclusions
Channel Catfish	unknown	>1.0	NOEL = 0.58 ppm LOEL = 1.5 ppm
Fathead Minnow	41.4	0.197	

For hazard assessment, these data indicate that diquat dibromide ranges in toxicity to fish from slightly to moderately toxic. Data requirements for freshwater fish are fulfilled. Typically, toxicity testing is to be done with technical grade active ingredients, usually having relatively high percent purity. In the case of diquat dibromide, a test material containing 35 to 37percent represents, apparently, the highest purity obtainable. (MRID 090862, and 40380703)

(c) Freshwater Invertebrate Toxicity

In order to establish the toxicity to aquatic invertebrates, a 48-hour aquatic invertebrate acute toxicity test is required using the technical grade material on first instar *Daphnia magna* or early instar amphipods, stoneflies or mayflies; and because of persistence one aquatic invertebrate life cycle study.

Seven studies were evaluated under this topic. In the table below, the diquat cation will be used for risk assessment purposes for aquatic organisms since the availability of diquat dibromide is as a cation in aquatic environments. The value in ppm cation is extrapolated from the test values whether it be in diquat formulation, cation, or active ingredient. The acceptable toxicity studies for use in a hazard assessment are listed below:

Freshwater Invertebrate Toxicity Findings			
Species	% Test Material (TGAI)	EC_{50} or MATC ppm cation	Conclusions
*Daphnia magna**	46.6	EC_{50}= 1.03	Slightly to highly toxic
*Daphnia magna**	46.6	EC_{50}= 1.19	
*Daphnia magna**	35.2	EC_{50}= 0.77	
*Gammarus fasciatus**	35.3	EC_{50}= 18.7	
*Hyalella**	unknown	EC_{50}= 0.14	
Apple Snail*	35.3	EC_{50}= 0.34	
*Daphnia magna***	41.4	MATC = 0.044	

* Acute toxicity Study
* *Life Cycle Study

There is sufficient information to characterize diquat dibromide as slightly to highly toxic to to aquatic invertebrates. The guideline requirement is fulfilled. (MRID 235179, 00115576, 00003530, and 00115862)

(c) **Estuarine/Marine Toxicity**

Acute toxicity testing with estuarine and marine organisms is required when an end-use product is intended for direct application to the marine/estuarine environment or is expected to reach this environment in significant concentrations. The terrestrial nonfood use of diquat dibromide may result in exposure to the estuarine environment.

In order to establish the toxicity to estuarine and marine organisms, the following tests are required using the technical grade material: either a Mollusc 48-hour embryo larvae study using Pacific oyster, Eastern oyster, mussel (preferably *Mytilus edulis*) or Quahog (*Mercenaria*) or a Mollusc 96-hour Flow-Through Shell Deposition study using Pacific oyster or Eastern oyster; and a Shrimp 96-hour acute toxicity test using white, pink, brown, grass or mysid shrimp species; an estuarine fish (preferably silverside or sheepshead minnow).

Five studies were evaluated under this topic. In the table below, the diquat cation will be used for risk assessment purposes for aquatic organisms since the availability of diquat dibromide is as a cation in aquatic environments. The value in ppm cation is extrapolated from the test values whether it be in diquat formulation, cation, or active ingredient. The acceptable toxicity studies for use in a hazard assessment are listed below:

Estuarine/Marine Acute Toxicity Findings			
Species	**% Test Material (TGAI)**	**LC_{50} ppm cation**	**Conclusions**
Mysid Shrimp	41.1	0.42	slightly to highly toxic
Eastern Oyster	41.4	54.8	
Sheepshead Minnow	41.4	48	
Silver Salmon	unknown	—	
Striped Bass	35.3	43.2	

There is sufficient information to characterize diquat dibromide as slightly to highly toxic to estuarine species. The guideline requirement is fulfilled. (MRID 40315701, 40316001, 40316101, 090862, and 00028002)

(3) Terrestrial, Semi-Aquatic and Aquatic Plant Data

Terrestrial plant testing (seed germination, seedling emergence and vegetative vigor) is required for herbicides which have terrestrial nonfood/feed or aquatic nonfood (except residential) use patterns and which have endangered or threatened plant species associated with the site of application.

Aquatic Plants

Aquatic plant testing is required for any herbicide applied to terrestrial nonfood or aquatic nonfood (except residential). In order to establish the toxicity to aquatic plants, an aquatic plant growth study (123-2) comprising of *Selenastrum capricornutum, Lemna gibba, Skeletonema costatum, Anabaena flos-aquae*, and a freshwater diatom is required using the technical grade material.

Two aquatic plant studies were evaluated under this topic. In the table below, the diquat cation will be used for risk assessment purposes for plants since the availability and activity of diquat dibromide is as a cation with plants. The value in ppb cation is extrapolated from the test values whether it be in diquat formulation, cation, or active ingredient. The acceptable toxicity studies for use in a hazard assessment are listed below:

Nontarget Aquatic Plant Toxicity Findings				
Species	**% A.I.**	**Toxicity**		**Conclusions**
Tier I, several species of filamentous algae and aquatic vegetation	---	Controlled by 0.25 cation ppm of diquat		information insufficient to assess the toxicity, but sufficient to require Tier II testing
Tier II vascular plants: Giant Duckweed Water Hyancinth Azolla Hydrilla	 35.3	EC_{50} * 0.0036 0.0198 0.0277 N/A	EC_{50} ** 0.75 114.0 11.6 9.9	Vascular plant requirements (*Lemna gibba*) are satisfied, but *Skeletonema costatum, Anabaena flos-aquae, Selenastrum capricornutum*, and a freshwater diatom needs to be tested to satisfy the requirements under 123-2 and to provide a complete risk assessment of diquat to non-target aquatic plants.

* Foliar applied, lb cation/A   ** Rootzone, ppb cation

There are outstanding data requirements for aquatic plants. (MRID 40165103, 40165104, 40165105, and 41883002)

Terrestrial Plants

Three terrestrial plant studies were evaluated under this topic. In order to establish the toxicity to terrestrial plants, a germination, seedling emergence (123-1a) and vegetative vigor study (123-1b) is required. The acceptable toxicity studies for use in a hazard assessment are listed below:

Nontarget Terrestrial Plant Toxicity Findings			
Test and Species	% A.I.	EC_{25}	Conclusions
Seedling emergence & Germination (10 species)	--	>7.49 lbs ai/Acre	No effect to plants at 8.4 ai kg/ha or 7.49 lb ai/A*
Vegetative Vigor (corn, sweet corn, & wheat)	--	rates as low as 0.016 cation/A resulted in desiccation of certain plants	Tier II vegetative vigor testing needed
Vegetative Vigor, Sensitive species: Cotton Soybean Corn	35.3	0.00470 lb/A 0.00738 lb/A 0.01064 lb/A	Untreated seeds of wheat and sweet corn should be tested for tier II Vegetative Vigor.**

* Tier II seed emergence and seed germination studies do not need to be done.
** Only one grass species was tested. According to earlier study (40165102), sweet corn and wheat were found to be sensitive. Two more grass species should be tested to fulfill guidelines. If there are difficulties in finding untreated seeds of sweet corn or wheat, the treated seeds could be washed in methanol to remove most of the treatment and then tested after drying.

There are outstanding data requirements for terrestrial plants. (MRID 40165101, 40165102, and 41883001)

b. Ecological Effects Assessment

(1) Risk to Terrestrial Animals

Avian and mammalian species will be exposed to diquat dibromide through the consumption of vegetation containing residues. Below are the expected residues (ppm) on vegetation immediately after one application of diquat dibromide (based on Hoerger and Kenaga, 1972).

Plant category:......	Range shortgrass	long grass	leaves, leafy crop	forage, sm insects	seed pods, lrg insects
Application Rate in lb. cation per acre:					
0.8923 (Turf, golf course and ornamental)					
Maximum residue	214	98	111	52	11
Typical residue	112	82	31	29	2.7
0.5 (Alfalfa, carrot, clover, peeper, squash, potato, radish, turnip, soybean, and sorghum)					
Maximum residue	120	55	63	29	6
Typical residue	63	46	18	17	1.5
0.375 (Cucumber and tomato)					
Maximum residue	90	41	47	22	5
Typical residue	47	35	13	12	1
0.25 (Cantaloupe)					
Maximum residue	60	28	31	15	3
Typical residue	31	23	9	8	1

The maximum expected residues (ppm) on vegetation immediately after one application of 0.89 lb ai/A (based on Hoerger and Kenaga, 1972) would be 214 ppm on short grass or range grass. This exposure is characteristic of turf where short grasses predominate. The aquatic weed control use has higher application rates, however, direct treatment of avian and mammalian food items is not expected.

The criterion for the determination of hazard and presumption of unacceptable risk from exposure for acute avian and mammalian species is a value greater than or equal to 0.5 for the quotient of the preliminary estimated environmental concentration (EEC) divided by the lowest LD_{50} value for birds and mammals--this is known as the risk quotient (RQ).

Acute and Dietary RQ = EEC/LD_{50} or EEC/LC_{50} > or = 0.5 for birds and mammals

(a) Avian Acute Dietary Effects

Discussion of Acute Risk to Birds:

Residues found on dietary food items following diquat dibromide application may be compared to LC_{50} values to predict hazard.

The acute dietary toxicity data available for birds shows LC_{50}= 575 ppm ai for bobwhite. This is much higher than the highest exposure of 403 for short grass when diquat is applied to turf. The risk quotient derived by dividing the exposure (403 ppm) by the LC_{50} is 0.37. This does not exceed the LOC of 0.5, which, according to the new paradigm, if exceeded, indicates the potential for high acute risk. However, it does exceed the LOC triggering restricted use (0.2), and indicates a "may affect" for endangered bird species (0.1).

Assessment:

The following list provides an acute risk quotient for birds based on the maximum applied rates:

Use Site	RQ	High Risk LOC	Restricted LOC	Endangered LOC
Turf				
short grass	0.37	0.5	0.2	0.1
small insects	0.09			
Alfalfa, carrot, clover, pepper, squash, potato, radish, turnip, soybean, and sorghum.				
short grass	0.21			
leafy crop	0.11			
small insects	0.05			
Cucumber, tomato				
short grass	0.16			
leafy crop	0.08			
small insects	0.04			
Cantaloupe				
short grass	0.10			
leafy crop	0.05			
small insects	0.03			

The estimated residues on avian food items does not result in risk that exceeds the LOC for high acute risk. The LOC for restricted use has been exceeded for the turf use. Please see the endangered species section for further discussion concerning the LOC for endangered species.

(b) Avian Chronic Effects

Discussion of Chronic Risk to Birds:

The avian reproductive study found the NOEL to be 5 ppm cation and LOEL to be 25 ppm cation. These findings were based on number of eggs laid, hatching and 14-day old survival. The risk quotients indicate a chronic risk among birds including endangered species. Birds feeding on diquat-contaminated food items may experience reproductive problems. It is recognized that in some field crops such as alfalfa, clover and soybean, there may be few short grasses, so residues on leafy crops and insects may be more representative of actual exposure.

Assessment:

The NOEL from the mallard reproduction study shows 5 ppm cation. Risk quotients from maximum exposure and typical exposure exceed the chronic LOC (1).

Use Site	Chronic RQ Maximum	Typical
Turf		
short grass	42.8	22.3
small insect	10	5.9
Alfalfa, carrot, clover, pepper, squash, potato, radish, turnip, soybean, and sorghum.		
short grass	24	12.6
leafy crop	12.5	9.1
small insect	5.9	3.3
Cucumber, tomato		
short grass	18	9.5
leafy crop	9.5	6.9
small insect	4	2.4
Cantaloupe		
short grass	12	6.3
leafy crop	6.3	4.6
small insect	3	1.7

(c) Mammalian Acute Oral and Subacute Dietary Effects

Discussion of Overall Risk to Mammals:

Considering it's use patterns, its environmental fate characteristics and toxicity, diquat dibromide represents a relatively low risk to mammals. Effects, if they occur should not result in significant ecological damage.

Assessment:

According to the Toxicology Oneliner, the LD_{50} for rats was identified as 600 mg/kg for a formulation containing diquat dibromide. From that, an LD_{50} in mg diquat dibromide cation/kg was calculated to be 116[1]. From this LD_{50}, 1-day LC_{50}'s can be derived for various small mammals, depending on their body weight and how much they tend to eat per day. Small herbivores may consume approximately 16 percent to 20 percent of their body weight per day. Insectivorous, on the other hand, may consume up to 100 percent of their body weight per day. The following table indicates the range of 1-day LC_{50}'s that the LD_{50} may represent.

[1] This takes into account that the formulation was 19.3% cation. Calculation: 600 X 0.193 = 116 mg cation/kg.

	Body Weight	Food Consumed per day	1-day LC_{50}
Herbivore	26 g	4.3 g (16%)	701 ppm cation
Insectivore	5 g	5.5 g (110%)	105 ppm cation

Formula: 1-day LC_{50} = $\frac{LD_{50}\text{ mg/kg X Weight of animal (g)}}{\text{food consumed in a day (g)}}$

The following acute risk quotients for mammals have been calculated assuming the above toxicological characteristics:

Turf, ornamental	RQ	LOC for High Acute Risk	LOC for Restricted Use	LOC for Endangered Species
Herbivores (short grass)	0.30	0.5	0.2	0.1
Insectivorous (insects)	0.49			
Alfalfa, carrot, clover, pepper, squash, potato, radish, turnip, soybean, and sorghum.				
Herbivores (short grass)	0.17			
Herbivores (leafy crop)	0.09			
Insectivorous (insects)	0.28			
Cucumber, tomato				
Herbivores (short grass)	0.13			
Insectivorous (insects)	0.21			
Cantaloupe				
Herbivores (short grass)	0.08			
Insectivorous (insects)	0.14			

Chronic risk for mammals would be based on maximum and typical residues on small insects or leafy crops, except for the turf use, where short grasses would likely predominate. The 2-generation rat reproduction study showed the NOEL =80 ppm cation and the LOEL = 240 ppm cation.

	Chronic RQ from Maximum Residues (food item)	Chronic RQ from Typical Residues (food item)	LOC for Chronic Risk
Turf, ornamental			1.0
Herbivores (short grass)	2.7	1.4	
Insectivores (insects)	0.6	0.4	
Alfalfa, carrot, clover, pepper, squash, potato, radish, turnip, soybean, and sorghum.			
Herbivores (short grass)*	1.5	0.8	
Herbivores (leafy crop)	0.8	0.2	
Insectivores (insects)	0.4	0.2	
Cucumber, tomato			
Herbivores (short grass)	1.1	0.6	
Herbivores (leafy crop)	0.6	0.2	
Insectivores (insects)	0.3	0.2	
Cantaloupe			
Herbivores (short grass)	0.7	0.4	
Herbivores (leafy crop)	0.4	0.1	
Insectivores (insects)	0.2	0.1	

*It is recognized that there may be relatively few short grasses in alfalfa, clover, or soybean fields, or in some other vegetable growing fields.

Discussion of Acute Risk to Mammals

None of the acute risk quotients exceed the LOC for high acute risk. The LOC for restricted use is exceeded by all uses except cantaloupe. The LOC for endangered species has been exceeded by all use patterns and will be discussed in the endangered species section. Some additional factors influencing acute exposure are presented below, and reduce the certainty of the risk assessment conclusions.

1-Small herbivores such as mice actually feed on a variety of food items ranging from short grass to seeds and fruits. The residues on these other food items would be less, yielding lower risk quotients.

2-Small insectivores feed on insects in a variety of habitats, not just those one the surface exposed to direct spray. Insects that were underground, or otherwise protected during spray may have lower residue levels, also yielding lower risk quotients. Also, the estimated residues were for small insects. Large insects would have smaller residue levels.

3-The residues used in calculating the above risk quotients represented the maximum expected exposure levels. It should be noted that typical exposure levels would likely be less.

4-The entire risk assessment for mammals is based on one LD_{50} for laboratory rats. It is not known how sensitive wild mammals may be to diquat dibromide. If they are substantially more sensitive, they may be at greater risk than indicated by the risk quotients above.

5-The acute oral LD_{50} may not be the best indicator of actual toxicity of diquat dibromide as might occur when ingested as a dietary concentration. Diquat dibromide binds tightly to organic matter such as food items, and may not be as biologically available. Whereas, when intubated directly, as is done during the acute oral test, the test animal is more likely to receive the full impact of the test material.

6-The acute risk quotient for insecivores in turf and ornamental areas was 0.49, which is very close to equaling the LOC of 0.5.

Therefore, it is only with moderate certainty that OPP concludes that nonendangered mammals are not at acute risk from diquat dibromide. Based on risk to mammals, diquat dibromide does exceed the restricted use LOC for all uses except cantaloupe (application rate of 0.25 lb cation/acre).

Information that could reduce uncertainty in the acute risk assessment for mammals would be toxicity tests with wild mammals providing actual LC_{50} values. This testing is not required for risk assessment.

Discussion of Chronic Risk to Mammals

Using maximum and typical residues on food items for mammals, the risk quotients exceed the chronic LOC <u>for turf and ornamental use only.</u> However, other factors must be considered when considering the extent of risk and the probability that chronic risk will occur such as:

1- Diquat is very persistence in the environment with data from terrestrial Field Dissipation studies showing diquat does not degrade after 3 years.

2- However, small herbivores such as mice actually feed on a variety of food items ranging from short grass to seeds and fruits. These mammal species may move about, choosing a variety of food items, not just the food items with the maximum residues.

3- The RQ were derived using the No Effect Level (NOEL) of 80 ppm cation. The Lowest Effect Level (LOEL), where adverse effects were known to occur was at the extrapolated 240 ppm cation. It is not known at what concentration, between 80 and 240 ppm, adverse chronic effects may start to occur. Again, including the turf use, even maximum residues on food items did not exceed the 240 ppm.

4- Small insectivorous feed on insects in a variety of habitats, not just those who are on the surface exposed to direct spray. Insects that were underground, or otherwise protected during spray may have lower residue levels, also yielding lower risk quotients. Also, the estimated residues were for small insects. Large insects would have smaller residue levels.

These factors lead to a conclusion that while the possibility of chronic risk exists, the probability that it will occur may be relatively low. **The extent, or significance, of chronic impact to non-endangered mammals if it occurs, appears to be low.**

(d) Effects on Beneficial Insects

For beneficial insects, it appears that there will be minimal adverse effects (LD_{50} 100 and 47 μg/bee) because diquat dibromide is practically nontoxic to honey bees.

(2) Risk to Aquatic Animals

Discussion of risk:

While the possibility of acute or chronic risk to aquatic organisms exists, the probability that it will occur is relatively low. The extent, or significance, of risk to nonendangered aquatic organisms if it occurs, appears to be low.

Aquatic exposure

Refined EEC

An estimate of diquat runoff and its effect on surface water quality was evaluated using PRZM-EXAM models from a typical crop use on potatoes with data from a silt loam soil in Maine... This estimate is a worst case senario of the entire yearly application of 0.5 lb ai/A (cation ai/A) to highly eroded soil for 36 years. This assessment includes diquat adsorbed onto eroded soil particles as well as diquat in the runoff water. The Estimated Environmental Concentrations are 48.4 ppb cation (0.7934 lb cation/A) just after application and 43.6 ppb cation 90 days after application. Data from the Aquatic Dissipation study shows that diquat dissipates from the water column in Florida ponds with half-lives of 1-2 days. Since diquat bonds very tightly to organic matter and soil and the diquat is very stable (does not degrade); the diquat in the runoff would dissipate rapidly to the soil bottom and not be readily available to aquatic organisms.

The PRZM-EXAM model produced the following results showing annual average Environmental Exposure Concentration of diquat in Maine with 10 percent exceedance. The values are in cations ppb and the time period is that period after application.

Maximum	96 hour	21 days	60 days	90 days
48.4 ppb	47.8 ppb	45.1	45.3 ppb	43.6 ppb

Turf

Application on turf (0.8923 lb cation/A), is higher than the potato application mentioned above. However, the runoff is expected to be much less than the above described "worst case senario". Diquat binds very tightly to soil and organic matter and will not be dislodged to runoff. Soil in turf fields are tightly held in place by the fibrous root system of grasses. Therefore there is minimal soil runoff from turf fields and thereby minimal diquat runoff. The only exposure considered to be of significance from turf and ornamental use is that occurring from drift. It is assumed that 5 percent of that sprayed by air drifts to adjacent habitat. (0.8923 X 0.05 = 0.0446 lb cation loading per acre X 0.061 ppm = 0.003 ppm concentration in 6 feet of water).

Aquatic Weed Control

This assumes direct application to a water body 6 feet deep (4 lb cation per acre X 61 ppb=244 ppb)

Toxicity Values Used in Risk Quotient Calculation

Freshwater Fish	LC_{50}=13.9 ppm cation (bluegill)
Estuarine Fish	LC_{50}=48 ppm cation (sheepshead minnow)
Aquatic Invertebrate	EC_{50}=0.77 ppm cation (*Daphnia magna*)
Estuarine Invertebrate	EC_{50}=0.42 ppm cation (mysid shrimp)
Freshwater Fish	MATC=0.197 ppm cation (fathead minnow)
Aquatic Invertebrate	MATC=0.044 ppm cation (*Daphnia magna*)

Level's of Concern

	High Acute Risk	Risk triggering restricted use	Chronic Risk
LOC's	0.5	0.1	1

Acute Risk Quotient for Aquatic Organisms

Use Site	Use Rate Cation/acre	Method Appl.	Exposure (cation ppm)	Risk Quotients Fish	Aqu. Inv.	Est. Inv.
Terr. Crops	0.5	Ground	0.048	0.003	0.06	<u>0.1</u>
		Aerial	Drift less than from turf (below)			
Turf/Orn.	0.8923	Ground	Runoff minimal from this use site			
		Aerial	0.003	0.0002	0.0035	0.006
Aquatic Weed Control	4.0	Aerial	<u>0.244</u>	0.02	<u>0.3</u>	<u>0.6</u>

Chronic Risk Quotient for Aquatic Organisms

Use Site	Use Rate Cation/acre	Method Appl.	Exposure (cation ppm)	----Risk Quotients------- Fish	Aqu. Invertebrates
Terr. Crops	0.5	Ground	0.048	0.24	1.1
Turf/Orn.	0.8923	Aerial	0.003	0.01	0.07
Aquatic Weed Control	4.0	Aerial	0.244	1.24	5.5

Discussion of Risk to Aquatic Organisms

This discussion will be focused on nonendangered aquatic species. For a discussion on endangered species, please refer to the endangered species section.

Except for the aquatic weed control use which involves direct application to water, the acute LOC for acute risk to aquatic and estuarine organisms has not been exceeded. The acute LOC for high risk is exceeded for estuarine invertebrates but not fish and freshwater invertebrates, from aquatic weed control. Diquat is unlikely to result in fish kills from any of its uses.

The LOC for restricted use (0.1 for acute risk) is exceeded for crops treated at 0.5 lb ai/acre, and for aquatic weed control.

The chronic LOC has been exceeded for fish (aquatic weed control) and invertebrates (both terrestrial crops and aquatic weed control). However, other factors must be considered when considering the extent of risk and the probability that chronic risk will occur such as:

1-Diquat dibromide binds very strongly to clay and organic matter in the soil (KOC=100,000 in soil).. Diquat is not expected to be bioavailable to aquatic organisms once it is attached to plants or soil particles. Therefore, it may not be readily bioavailable to aquatic organisms as runoff from potato fields treated with diquat.

2- The aquatic dissipation study shows that diquat dissipates from the water column in Florida ponds with half-lives of 1-2 days. This amount of time is not sufficient for chronic exposure to take effect. The dissipation is believed to be caused by the bonding of the diquat to the soil and then settling down to the bottom of the pond or aquatic body. The label indicates that diquat should only be applied be clear water (not muddy) and under careful conditions as to not disturb the bottom sediments of the body of water.

3- The LC_{50} values of the aquatic organisms are from laboratory conditions, in which there are no soil particles or plant materials to bond. Therefore, the availability to aquatic organisms in the test system would be much higher than in an environmental setting where matter was availabe to "bind" with diquat dibromide.

These factors lead to a conclusion that while the possibility of acute or chronic risk exists, the probability that it will occur is relatively low. The extent, or significance, of risk to non-endangered aquatic organisms if it occurs, appears to be low.

(3) Risk to Terrestrial, Semi-Aquatic and Aquatic Plants

(a) Nontarget Terrestrial Plant Effects

Data from the seed germination and seedling emergence studies indicate that diquat is not expected to adversely affect terrestrial plants from runoff.

Vegetative vigor study did not have enough grass species tested and therefore complete data are not available to completely assess the risk to terrestrial plants. The available data do suggest that sweet corn and wheat may be sensitive to diquat; it is recommended that data from vegetative vigor tests on these species be obtained.

The available data do indicate that nearby nontarget crops or nontarget plants may be adversely affected from aerial drift applications from turf or aquatic weed control. Vegetative vigor testing with cotton (most sensitive species tested) yielded an EC_{25} of 0.0047 lb cation/A. The Risk Quotients for the various use sites are presented below. These risk quotients are compared with the LOC, which is 1 for both endangered and nonendangered plant species.

Aquatic Weed Control (Aerial)	Cantaloupe (Aerial)	Turf/ Ornamental (Aerial)	Crops treated at 0.5 lb cation/acre (Aerial)
42.5	2.7	9.5	5.3

Aerial application of diquat for crops treated at 0.5 lb cation/A, aquatic weed control, cantaloupe and turf/ornamental may result in risk that exceeds the level of concern for nontarget terrestrial plants or crops.

The effects to terrestrial plants that are suggested by the LOC exceedances would occur in areas immediately adjacent to the treated site. It is not known exactly how far hazardous spray drift may move, but it would likely be no more than several hundred feet.

(c) Nontarget Aquatic Plant Effects

Discussion of Risk to Nontarget Aquatic Plants

The possibility of acute risk exists from runoff, but the probability that it will occur is relatively low. However, the possibility of risk to nontarget aquatic plants from aerial application from all sites is relatively high. The data also suggest that exposure from drift settling on the foliage of aquatic plants represents a greater hazard than if the drift settles on the water first before exposure to the plants occur.

Exposure

Exposure to aquatic plants may occur through either runoff from terrestrial sites, or drift from aerial application. Of course, aquatic plants are directly exposed from the aquatic weed control use. However, since they are the "target pest" for that use, risk from such exposure is not estimated. Only risk caused by spray drift from aerial treatment for aquatic weed control is assessed.

Runoff exposure is from the refined EEC which yielded a concentration of 48.4 ppb in 2 meters of water resulting from runoff from a potato field treated with 0.5 lb ai/acre. See discussion above concerning this model.

Drift from aerial spray is assumed to be 5 percent. Exposure estimates follow:

Use Site	Application rate lb cation/acre	Exposure lb cation/acre
urf	0.8923	0.04462
rops	0.5	0.025
rops	0.25	0.0125
quatic weed control.	4.0	0.2

Data from the aquatic plant studies show that the most sensitive vascular plant tested is giant duckweed (*Spirodela punctata*) with an EC_{50}= 0.75 ppb cation when applied at the rootzone and an EC_{50}= 0.0036 lb cation/A when applied at the foliar level. The EFED is unable to make a complete risk assessment of aquatic plants at this time since data on algae and diatoms are unavailable at this time. Based on available data, the following risk quotients were calculated.

Risk Quotient for Non-target Aquatic Vascular Plants

Use Site	Use Rate Cation/acre	Method Application	Exposure in ppb or (lb/acre)* cation	Risk Quotient
Terr. Crops	0.5	Ground	48.4	967
Terr. Crops	0.5	Aerial	(0.025)	6.9
	0.25	Aerial	(0.0125)	3.5
Turf/Orn.	0.8923	Aerial	(0.04462)	12.4
Aqu. weed Control	4	Aerial	(0.2)	55.6

*Normally, exposure to aquatic plants is always estimated in an aquatic concentration, since typical test endpoints for aquatic plants are reported as an aquatic concentration (i.e. ppb). In this case, however, the test endpoints for the giant duckweed included an EC_{50} in lb cation/acre representing exposure that could occur from spray drift settling on the plant foliage. Since this yields higher risk quotients than those that would have been calculated from an aquatic concentration in ppb, this is the exposure value that will be used for risk assessment. For example, if 0.025 lb/acre (drift from Terr. Crops treated at 0.5 lb cation per acre) settled on a water body 6 feet deep, the resulting concentration would be 1.5 ppb. The risk quotient from dividing 1.5 ppb by 0.75 ppb (EC_{50} for giant duckweed) = 2. This is lower than the risk quotient reported (RQ=6.9).

Risk to aquatic plants: Using the aquatic environmental exposure concentrations, the risk quotient (967) exceeds the LOC for runoff from erodible potato fields in Maine, and drift from aerial application of turf/ornamentals fields, aerial application of potato, pepper, radish, turnip, sorghum, and soybean fields and aerial application for aquatic weed control. However, other factors must be considered when characterizing risk to aquatic plants such as:

1- Diquat dibromide binds very strongly to clay and organic matter in the soil (KOC=100,000 in soil). Diquat is not expected to be bioavailable to aquatic plants once it is attached to soil particles. Therefore, it may not be readily bioavailable to aquatic plants as runoff from potato fields treated with diquat.

2- The aquatic dissipation study shows that diquat dissipates from the water column in Florida ponds with half-lives of 1-2 days. The dissipation is believed to be caused by the bonding of the diquat to the soil and then settling down to the bottom of the pond or aquatic body. The label indicates that diquat should only be applied be clear water (not muddy) and under careful conditions as to not disturb the bottom sediments of the body of water.

3- The EC_{50} values of the aquatic plants are from laboratory conditions, in which there are no soil particles to bond. Therefore, the availablity to aquatic plants would be much higher than in an environmental setting.

These factors lead to a conclusion that while the possibility of acute risk exists from runoff, the probability that it will occur is relatively low. However, the possibility of risk to nontarget aquatic plants from aerial application from all sites is relatively high. The data also suggest that exposure from drift settling on the foliage of aquatic plants represents a greater hazard than if the drift settles on the water first before exposure to the plants occur. Elimination of aerial application can eliminate most of the risk to nontarget aquatic plants.

(4) Risk to Endangered Species

For endangered avian and mammalian species the risk quotient is a value greater than or equal to 0.1. For endangered aquatic vertebrate and invertebrate species, the risk quotient is 0.05.

RQ = EEC/LC$_{50}$ > or = 0.1 for endangered birds and mammals, the

RQ = EEC/LC$_{50}$ > or = 0.05 for endangered aquatic animals, and the

RQ = EEC/EC$_{25}$ and the EEC/EC$_{50}$ > or = 1 for terrestrial, semi-aquatic and aquatic plants.

The following table is a compilation of risk quotients for endangered species from previous risk assessments in this science chapter.

Organisms	Use Site	Acute Risk Quotient	Chronic Risk Quotient
The LOC for acute effects to birds and mammals is 0.1. The LOC for chronic effects is 1.			
MAMMALS	Turf,ornamental	0.49	2.7
	Alfalfa,clover, carrot, pepper, squash, potato, radish, turnip, soybean, sorghum	0.28	<1
	cucumber, tomato, watermelon	0.21	<1
	cantaloupe	0.14	<1
BIRDS	Turf,ornamental	0.37	22.3
	Alfalfa,clover, carrot, pepper, squash, potato, radish, turnip, soybean, sorghum	0.21	12.6
	cucumber,tomato, watermelon	0.16	9.5
	cantaloupe	0.1	6.3

Organisms	Use Site	Acute Risk Quotient	Chronic Risk Quotient
The acute LOC for acute effects to endangered aquatic organisms is 0.05. The LOC for chronic effects for endangered species is 1.			
FISH	aquatic weed control	<0.05	1.24
AQUATIC INVERTEBRATES	Alfalfa, clover, carrot, pepper, squash, potato, radish, turnip, soybean, sorghum	<0.05	1.1
	aquatic weed control	0.3	5.5
ESTUARINE	aquatic weed control	0.6	
	Alfalfa, clover, carrot, pepper, radish, potato, squash, turnip, soybean, sorghum	0.1	

Organisms	Use Site	Risk Quotient
The LOC for endangered plants is 1.		
PLANTS: AQUATIC	aerial application	
	turf/ornamentals	12.4
	cantaloupe	3.5
	aerial application for aquatic weed control	55.6
	crops treated at 0.5 lb/acre ground application	967
TERRESTRIAL	aerial application for	
	aquatic weed control	42.5
	turf/ornamental	9.5
	crops (0.5 lb/acre)	5.3
	cantaloupe	2.7

Levels of Concern have been exceeded for endangered species of mammals and birds from all terrestrial use sites.

Levels of Concern have been exceeded for endangered species of aquatic invertebrates, estuarine species, and fish from the use of diquat for aquatic weed control. It is recognized that in places where aquatic weed control is done year after year, endangered species may have already been eliminated. This cannot be assumed, however. Furthermore, the possibility for may affect exists if diquat dibromide were to be applied in new (previously untreated) aquatic ecosystems.

Although Levels of Concern have been exceeded for endangered species of aquatic and estuarine invertebrates and aquatic plants by runoff exposure from fields of alfalfa, clover, carrot, pepper, radish, potato, squash, turnip, soybean, or sorghum for endangered species of aquatic organisms; there is a high degree of uncertainty that endangered species in these habitats may actually be affected by runoff. The risk quotient was based on exposure provided by OPP's EEC model based on erodible potato fields in Maine. However, other environmental fate data, which the model does not take into account, indicate that the diquat that moves with the water will actually become biologically unavailable quickly as it becomes tied up by soil and organic particles. This reduces, significantly, the possiblity of acute effects, and makes chronic exposure extremely unlikely. Therefore, it is unlikley, in spite of the relatively large risk quotient, that endangered aquatic organisms (fish, invertebrates or plants) would be affected from exposure due to runoff alone.

Endangered species of aquatic plants may be affected from drift coming from aerial application of all terrestrial use sites and from aerial application of aquatic weed control. Endangered species of aquatic plants in close proximity to aquatic weed control sites that use diquat may be affected.

Endangered species of terrestrial plants may be affected by drift from aquatic weed control or turf/ornamental use sites only.

However, the Endangered Species Protection Program is expected to become final in 1994. Limitations in the use of diquat dibromide will be required to protect endangered and threatened species, but these limitations have not been defined and may be formulation specific. EPA anticipates that a consultation with the Fish and Wildlife Service will be conducted in accordance with the species-based priority approach described in the Program. After completion of consultation, registrants will be informed if any required label modifications are necessary. Such modifications would most likely consist of the generic label statement referring pesticide users to use limitations contained in county Bulletins.