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

OFFICE OF
PESTICIDES AND TOXIC SUBSTANCES

MAR 11 1988

MEMORANDUM

SUBJECT: Carbaryl Final Registration Standard and Tolerance Reassessment (FRSTR)

FROM: Leslie Touart, Fisheries Biologist
Ecological Effects Branch
Hazard Evaluation Division (TS-769)

THRU: Otto Gutenson, Acting RS Coordinator
Ecological Effects Branch
Hazard Evaluation Division (TS-769)

THRU: Henry T. Craven, Acting Chief
Ecological Effects Branch
Hazard Evaluation Division (TS-769)

TO: Dennis Edwards (PM-12)
Registration Division (TS-767)

Attached to this cover memorandum are the Topical Summaries, Disciplinary Review and Generic Data Requirements for the Ecological Effects Branch Chapter of the Carbaryl FRSTR.

cc: J. Heckman, MSS (memorandum only)
K. Barbehenn, SIS coordinator

CARBARYL

Ecological Effects Chapter
(Revised)

INTRODUCTION

The Ecological Effects Chapter for the initial Carbaryl Science Chapter was completed July 22, 1982. Of the data required in the initial standard, studies in all required categories have been provided, albeit only six were fully acceptable. Therefore, 12 of these studies remain outstanding as follows:

STUDY TYPE	TEST MATERIAL
Warmwater fish acute	Sevin-4-oil
Coldwater fish acute	Sevin-4-oil
Aquatic invertebrate acute	Sevin-4-oil
Aquatic invertebrate acute	Sevin XLR
Estuarine fish acute	technical
Estuarine crustacean acute	technical
Estuarine mollusc acute	technical
Warmwater fish acute	alpha-napthol
Coldwater fish acute	alpha-napthol
Aquatic invertebrate acute	alpha-napthol
Estuarine fish acute	alpha-napthol
Estuarine crustacean acute	alpha-napthol

The use of carbaryl to control burrowing shrimp in oyster beds was not considered in the previous standard and will require additional field testing to support. Aquatic field testing can now be required for several uses based on new information received as a result of requirements from the previous standard. Also, phytotoxicity testing is now required and was not included in the earlier standard.

The following studies received an abbreviated review.

MRID

131008
144766
144767

TOPICAL SUMMARIES

Effects on Birds

Twelve studies in nine citations were received and evaluated under this topic. These studies were used in performing a hazard assessment.

Author	MRID#
Bart *	0503018
Buckner *	05019256
Hill *	00028757
Moulding *	TOUCAR01
Richmond *	TOUCAR02
Tucker *	TOUCAR03
Univ. of Maine *	TOUCAR04
Fletcher	161500
Fletcher	160044

* These studies were evaluated in the previous registration standard.

In order to establish the toxicity of carbaryl to birds, the minimum data required on the technical material are:

- An avian single-dose LD50 test with either one species of waterfowl, preferably the mallard, or one species of upland gamebird, preferably bobwhite (section 71-1); and

- Two avian dietary LC50 tests, one with a species of waterfowl, preferably the mallard, and one with a species of upland gamebird, preferably the bobwhite (section 71-2).

Avian Acute Oral Toxicity - Technical

The acceptable acute oral toxicity studies on carbaryl are listed below.

Species	Test Material	Results	Author	Date	MRID	Fulfills Req.
Mallard	100%	LD50>2179 mg/kg	Tucker	1970	TOUCAR03	yes
Ring-necked pheasant	95%	LD50>2000 mg/kg	Tucker	1970	TOUCAR03	yes

Avian Dietary Toxicity - Technical

The acceptable avian dietary toxicity studies on technical carbaryl are listed below.

Species	Test Material	Results	Author	Date	MRID	Fulfills Req.
Mallard	99.8%	LC50>5000 ppm	Hill	1975	28757	yes
Japanese quail	99.8%	LC50>5000 ppm	Hill	1975	28757	no 1/
Bobwhite	99.8%	LC50>5000 ppm	Hill	1975	28757	yes
Ring-necked pheasant	99.8%	LC50>5000 ppm	Hill	1975	28757	yes

1/ Inappropriate species.

The guideline requirements for acute avian toxicity testing have been fulfilled. These test results show that carbaryl is practically non-toxic to birds.

Avian Reproduction Studies - Technical Carbaryl

Avian reproduction studies may be required (section 71-4). Carbaryl is used repeatedly in several major uses (i.e., corn, forests, etc.) which subject birds to repeated and/or continuous exposure. The following studies were submitted.

Species	Test Material	Results	Author	Date	MRID	Fulfills Req.
Bobwhite	99.9%	NOEL=>3000 ppm	Fletcher	1986	160044	yes
Mallard	99.9%	NOEL=300 ppm LEL= 1000 ppm	Fletcher	1986	161500	yes

The guideline requirements for chronic avian toxicity testing have been fulfilled. The results of these tests are based on eggs laid, eggs set, viable embryos, hatchability, 14-day survival and eggs cracked. Mallard ducks are chronically sensitive to carbaryl at constant concentrations above 300 ppm.

Field Testing

Avian field testing may be required depending on the results of the avian toxicity studies and available fate and exposure information. Also, though unusual and rare, field testing may be required if toxicity information on other organisms and related fate and exposure information indicate that indirect effects to birds may be expected. Four field tests with birds were reviewed under the earlier standard which address these requirements. All four studies were forest monitoring studies as follows:

Author (MRID)	Location	Use Rate	Results	Fulfill Requirements
Moulding (TOUCAR01)	New Jersey	1 lb.a.i./ acre (x2) 80% WP	Bird population adversely affected. Population reduced to 55% from control.	No 1/
Bart (0503018)	New York	1 lb.a.i./ acre Sevin-4-oil	No adverse effects detected.	No 1/
Richmond (TOUCAR02)	Oregon	2 lb.a.i./ acre Sevin-4-oil	No adverse effects detected.	No 1/
Univ. of Maine (TOUCAR04)	Maine	3/4 lb.a.i./ acre Sevin-4-oil	Bird population adversely affected. Immediate post-spray reduction in warblers with gradual recovery, slight weight reduction in black ducklings and chickadee nestlings.	No 1/

1/ These studies may contribute to fulfillment of field testing requirements in combination with an additional test or tests. These tests are deficient in scope and are insufficiently quantitative in addressing risks.

Precautionary Labeling

Based on the available information, no toxicity labeling for birds is needed.

Effects on Freshwater Fish

Thirty-three studies in seventeen citations were received and evaluated under this topic. These studies were used in performing a hazard assessment.

Author	MRID#
Carlson *	TOUCAR05
Johnson *	GS028026
McCann *	42381
McCann *	59202
McCann *	43115
McCann *	43116
Sanborn *	5015248
US-FWS *	49128
Univ. of Maine *	TOUCAR04
Knott *	116416
Knott *	116420
Sousa	151519
Sousa	151417
Sousa	151541
Sousa	151542
Suprenant	164305
Suprenant	164307

* These studies were evaluated in the previous registration standard.

Fish Acute Toxicity Tests - Technical

The minimum data required for establishing the acute toxicity of carbaryl to fish are the results from two 96-hour studies with the technical product. One with coldwater species, preferably rainbow trout, the other with a warm water species, preferably bluegill sunfish (section 72-1). The acceptable fish studies are listed below.

Species	Test Material	Results	Author	Date	MRID	Fulfills Req.
Coho salmon	99.5%	LC50=4.34 ppm	Johnson	1980	GS028026	no 1/
Chinook salmon	"	LC50=2.4 ppm	"	"	"	no 1/
Cuthroat trout	"	LC50=7.1 ppm	"	"	"	no 1/
Atlantic salmon	"	LC50=4.5 ppm	"	"	"	no 1/
Brown trout	"	LC50=6.3 ppm	"	"	"	no 1/
Brook trout	"	LC50=2.1 ppm	"	"	"	yes
Lake trout	"	LC50=0.69 ppm	"	"	"	yes
Goldfish	"	LC50=13.2 ppm	"	"	"	no 2/

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Species	Test Material	Results	Author	Date	MRID	Fulfills Req.
Carp	99.5%	LC50=5.28 ppm	Johnson	1980	GS028026	no 2/
Fathead minnow	"	LC50=14.6 ppm	"	"	"	no 1/
Black bullhead	"	LC50=20 ppm	"	"	"	no 1/
Channel catfish	"	LC50=15.8 ppm	"	"	"	no 1/
Green sunfish	"	LC50=11.2 ppm	"	"	"	yes
Largemouth bass	"	LC50=6.4 ppm	"	"	"	yes
Black crappie	"	LC50=2.6 ppm	"	"	"	yes
Yellow perch	"	LC50=5.1 ppm	"	"	"	yes
Rainbow trout	99.5%	LC50=1.95 ppm	Johnson	1980	GS028026	yes
Rainbow trout	tech.	LC50=14 ppm (48 hr)	McCann	1968	43116	no 3/
Bluegill sunfish	99.5%	LC50=6.76 ppm	Johnson	1980	GS028026	yes
Bluegill sunfish	tech.	LC50=14 ppm (48 hr)	McCann	1969	43115	no 3/

1/ Not a preferred test species.
2/ Unacceptable test species.
3/ Inappropriate test duration.

These studies fulfill the guideline requirement for fish acute toxicity tests for carbaryl with technical material. They show that technical carbaryl is highly toxic to coldwater fish and moderately toxic to warmwater fish.

Fish Acute Toxicity Tests - Formulations

Formulated product studies may be requested (section 70-3). Forest and rice uses allow for direct application to water or direct contamination of aquatic habitat. Testing with both coldwater and warmwater fish is required using formulations registered for forest and/or rice uses; including formulations of the following products -- Sevin XLR Plus, Sevin 4F, Sevin 50W, Sevin 80S and Sevin-4-oil. The following tests partially fulfill the requirements for such testing.

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Species	Test Material	Results	Author	Date	MRID	Fulfills Req.
Rainbow trout	44 % a.i. (Sevin XLR)	LC50=1.4 ppm	Sousa	1985	151519	yes
Bluegill sunfish	44% a.i. (Sevin XLR)	LC50=9.8 ppm	Sousa	1985	151417	yes
Rainbow trout	49% a.i. (Sevin-4-oil)	LC50=4.5 ppm	Johnson	1980	GS028026	yes
Rainbow trout	49% a.i. (Sevin-4-oil)	LC50=3.8 ppm	Knott	1970	116420	yes
Bluegill sunfish	49% a.i. (Sevin-4-oil)	LC50=39 ppm	Johnson	1980	GS028026	yes
Bluegill sunfish	49% a.i. (Sevin-4-oil)	LC50=3.7 ppm	Knott	1970	116416	no 1/
Bluegill sunfish	5% a.i. (Sevin 5% Garden Dust)	LC50=290 ppm	McCann	1968	42381	yes
Bluegill sunfish	30% a.i. (unknown)	LC50=49 ppm	McCann	1970	59202	yes

1/ Concentrations of carbaryl were not measured and precipitate was noted.

These studies show that 44 and 49% a.i. formulations are moderately toxic to fish. They would fulfill the requirements for tests with these formulations.

Fish Acute Toxicity Tests - Degradate

Acute fish studies using a degradate of a pesticide active ingredient may be required (section 70-3). Such studies are required because alpha-napthol, the primary degradate of carbaryl, is relatively persistent in water (1/2-life > 4 days). The following are acceptable fish acute toxicity tests.

Species	Test Material	Results	Author	Date	MRID	Fulfills Req.
Bluegill sunfish	100% (alpha-napthol)	LC50=0.75 ppm	Suprenant	1986	164305	no 1/
Rainbow trout	100% (alpha-napthol)	LC50=1.8 ppm	Suprenant	1986	164307	no 1/

1/ The studies failed to adequately maintain and measure the

exposure concentrations.

These tests show that alpha-napthol, the primary degradate of carbaryl is highly toxic to fish.

Fish Reproductive Tests - Technical Carbaryl

Fish reproductive studies may be required (section 72.5). Carbaryl is registered for several outdoor uses involving multiple applications and it is likely to reach aquatic habitats because of its widespread use, therefore, a fish reproductive study is required. The acceptable study is listed below.

Species	Test Material	Results	Author	Date	MRID	Fulfills Req.
Fathead minnow	99%	MATC>0.21<0.68 ppm	Carlson	1972	TOUCAR05	yes

The MATC is based on survival, growth and reproduction parameters.

Field Studies

Field studies may also be required to determine exposure or effects to fish (section 72-7). Based on the toxicity of carbaryl, both acute and chronic effects may be expected under typical use conditions. Therefore, aquatic field testing may be required. Two studies were reviewed which relate to these requirements. Both studies were forest monitoring studies with the Sevin-4-oil formulated product. The results of these studies are as follows:

Author (MRID)	Location	Use Rate	Results
US-FWS (49128)	Maine	1 lb. a.i./ acre	No observed mortalities, sublethal effects noted (AChE inhibited 10 to 28%).
Univ. of Maine (TOUCAR04)	Maine	3/4 lb. a.i./ acre	No observed adverse effect.

Neither study fully satisfies the requirements for field testing to determine hazard to fishes. The studies may be used in conjunction with other tests to fulfill these requirements. The tests generally lacked sufficient scope to allow quantitative assessments of potential risks.

Precautionary labeling

The following toxicity statement is required:

"This pesticide is toxic to fish."

Effects on Aquatic Invertebrates

Eighteen studies in seven citations were reviewed and used to perform a risk assessment on aquatic invertebrates.

Author	MRID#
Johnson *	GS028026
Sanborn *	5015248
Univ. of Maine *	TOUCAR04
Nicholson	150538
Nicholson	150540
Suprenant	150901
Suprenant	164310

* These studies were evaluated in the previous registration standard.

Acute Aquatic Invertebrate Testing - Technical

The minimum data requirement for establishing the acute toxicity of carbaryl to aquatic invertebrates is the result from one 48-hour (or 96-hour) acute toxicity test with the technical product (section 72-2). Acceptable tests are listed below.

Species	Test Material	Results	Author	Date	MRID	Fulfills Req.
Daphnia pulex	99.5%	EC50=6.4 ppb	Johnson	1980	GS028026	no 1/
Simocephalus	"	EC50=7.6 ppb	"	"	"	yes
Cypridopsis	"	EC50=115 ppb	"	"	"	no 1/
Asellus	"	LC50=280 ppb	"	"	"	no 1/
Gammarus lacustris	"	LC50=22 ppb	"	"	"	yes
Gammarus fasciatus	"	LC50=26 ppb	"	"	"	yes
Procambarus	"	LC50=1900 ppb	"	"	"	no 1/
Palaemonetes	"	LC50=5.6 ppb	"	"	"	no 1/
Pteronarcella	"	LC50=1.7 ppb	"	"	"	yes
Pteronarlys	"	LC50=4.8 ppb	"	"	"	yes
Claassenia	"	LC50=5.6 ppb	"	"	"	no 1/
Skwala	"	LC50=3.6 ppb	"	"	"	no 1/

EC50 - 48hr test LC50 - 96hr test

1/ Not preferred test species and/or test conditions deviate from accepted guidelines (e.g., temperature too low).

These studies fulfill the requirements for an acute toxicity test with aquatic invertebrates and show that carbaryl is very highly toxic to this group.

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Acute Aquatic Invertebrate Testing - Formulation

Formulated product studies may be requested (section 70-3). Forest and rice uses allow for direct application to water or direct contamination of aquatic habitat. Testing with aquatic invertebrates is required using formulations registered for forest and/or rice uses; including formulations of the following products -- Sevin XLR Plus, Sevin 4F, Sevin 50W, Sevin 80S and Sevin-4-oil. The following tests partially fulfill the requirements for such testing.

Species	Test Material	Results	Author	Date	MRID	Fulfills Req.
Daphnia magna	49% a.i. (Sevin-4-oil)	EC50=7.1 ppb	Nicholson	1985	150538	no 1/
Daphnia magna	44% a.i. (Sevin XLR)	EC50=13 ppb	Nicholson	1985	150540	no 1/

1/ The studies failed to adequately maintain and measure the exposure concentrations.

Acute Aquatic Invertebrate Testing - Degradate

Acute aquatic invertebrate studies using a degradate of a pesticide active ingredient may be required (section 70-3). Such studies are required because alpha-napthol, primary degradate of carbaryl, is relatively persistent in water. A partially acceptable aquatic invertebrate test with alpha-napthol is presented below.

Species	Test Material	Results	Author	Date	MRID	Fulfills Req.
Daphnia magna	100% (alpha-napthol)	EC50=0.7 ppm	Suprenant	1986	164310	no 1/

1/ The study failed to adequately maintain and measure the exposure concentrations.

This study does not fulfill the requirement for an acute aquatic invertebrate toxicity test with alpha-napthol, primary degradate of carbaryl. It shows alpha-napthol to be highly toxic to Daphnia magna.

Reproductive Aquatic Invertebrate Testing - Technical

Reproductive testing with aquatic invertebrates may be required (section 72-4). Since carbaryl is registered for uses involving multiple treatments, has been demonstrated to be very

highly acutely toxic and is expected to reach the aquatic environment from its registered uses, aquatic invertebrate reproductive testing was required. The following test was considered acceptable.

Species	Test Material	Results	Author	Date	MRID	Fulfills Req.
Daphnia magna	99%	MATC>1.5<3.3 ppb	Suprenant	1985	150901	yes

This MATC is based on significant reduction of offspring; reported concentrations are calculated based on the measured concentrations.

Field Studies

Field testing for effects to aquatic invertebrates may be required (section 72-7). Such testing is required for carbaryl and one study was reviewed in the earlier standard (Univ. of Maine, 1981; TOUCAR04). The test was partially acceptable and showed that, when Sevin-4-oil is used at 3/4 lb. a.i./acre in a Maine forest, carbaryl may persist in water and substrate of ponds greater than 138 days after application. Maximum residues of 254 ppb in water and 4.86 ppm in sediment were found. Also, an immediate post-treatment reduction of several invertebrate groups was noted.

A terrestrial-aquatic model ecosystem study (Sanborn, 1974; 5015248) indicated that technical carbaryl did not significantly persist or accumulate in water or invertebrate organisms. However, no Guidelines requirement is satisfied by this study.

Precautionary Labeling

The available data indicate that a precautionary statement for aquatic invertebrates is required.

"This pesticide is extremely toxic to freshwater invertebrates."

Effects on Estuarine and Marine Organisms

Eleven studies in nine citations were reviewed and used to perform the hazard assessment on marine and estuarine organisms.

Author	MRID#
Butler *	48317
Davis *	25816
Tagatz *	503001
Sousa	150539
Suprenant	148221
Hoberg	150544
Suprenant	164306
Suprenant	164308
Suprenant	164309

* These studies were evaluated in the previous registration standard.

Acute Toxicity Tests - Technical

Toxicity testing with estuarine and marine organisms may be requested (section 72-3). Since carbaryl is registered for use on crops which are near estuaries (i.e., rice, corn, citrus, etc.), these studies were requested. The requirements under this category include a 96-hour LC50 for an estuarine fish, a 96-hour LC50 for a crustacean and either a 48-hour embryo-larvae study or a 96-hour shell deposition study with oysters. The following studies are acceptable.

Species	Test Material	Results	Author	Date	MRID	Fulfills Req.
Sheepshead minnow	99%	96-hr LC50=2.2ppm	Sousa	1985	150539	no 1/
Eastern oyster	99%	48-hr EC50=2.7ppm	Suprenant	1985	148221	yes
Mysid	99%	96-hr LC50=6.7ppb	Hoberg	1985	150544	no 2/
Brown shrimp	Tech.	48-hr EC50=2.5ppb	Butler	1963	48317	no /3
Blue crab	"	48-hr ED50=550ppb	"	"	"	no /3
White mullet	"	48-hr TLM=2.5ppm	"	"	"	no /3
Longnose killifish	"	48-hr TLM=1.75ppm	"	"	"	no /3

1/ Test concentrations were not measured and precipitate observed.
2/ Test concentrations were not adequately maintained or measured.
3/ Duration of test inappropriate.

Butler (1963; 48317) demonstrated that 2 ppm of technical carbaryl reduced oyster shell growth by 14% at 27ppt salinity and 29 degrees C and 19% at 17ppt and 20 degrees C.

These data do not fulfill the requirements for acute estuarine tests with carbaryl. They tentatively show that carbaryl is very highly toxic to crustaceans and moderately toxic to fish and mollusks.

Acute Toxicity Tests - Degradate

Degradate testing with estuarine or marine species may be required (section 70-3). Such studies are required because alpha-napthol, primary degradate of carbaryl, is readily formed and is relatively persistent in saline water. Estuarine and marine testing with alpha-napthol is presented below.

Species	Test Material	Results	Author	Date	MRID	Fulfills Req.
Sheepshead minnow	100% (alpha-napthol)	LC50=1.8 ppm 48hr	Suprenant	1986	164306	no 1/
Eastern oyster	100%	EC50=2.1 ppm	Suprenant	1986	164308	yes
Mysid	100%	LC50=0.2 ppm	Suprenant	1986	164309	no 1/

1/ Test concentrations were not adequately maintained or measured.

These data fulfill the requirements for oyster testing and partially fulfill the requirements for estuarine/marine fish and crustacean testing. They tentatively demonstrate that alpha-napthol, degradate of carbaryl, is moderately toxic to estuarine/marine fish and oysters and highly toxic to crustaceans.

Precautionary Labeling

The data tentatively support the following warning: "This pesticide is extremely toxic to marine/estuarine invertebrates."

Plant Protection Testing

No studies were received under this topic. To determine toxicity of carbaryl to plants, the following studies are required.

122-2: Aquatic plant growth

These tests are required for terrestrial nonfood aquatic food uses including forests, rice and oyster-bed uses.

Higher tier testing may be required depending on the results of the lower tier tests.

DISCIPLINARY REVIEW

I Ecological Effects Profile

A Technical Carbaryl

1. Avian Studies

Two studies show that carbaryl is practically nontoxic to birds. An acute oral study (Tucker and Crabtree, 1970, TOUCAR03) resulted in an LD50 of >2179 mg/kg for mallards and >2000 mg/kg for ring-necked pheasants. An avian dietary study (Hill et al., 1975) demonstrates an LC50 of >5000 ppm for both mallards and bobwhite quail.

Two one-generation reproductive studies (Fletcher, 1986, 160044 and 161500), one with bobwhite quail and one with mallards, resulted in NOEL's of >3000 ppm (highest level tested) and 300 ppm, respectively.

2. Aquatic Studies

One study (Johnson and Finley, 1980, GS028026) shows that carbaryl is highly toxic to coldwater fish (96hr LC50=0.69 ppm for lake trout) and moderatlely toxic to warmwater fish (96hr LC50=6.76 ppm for bluegill sunfish).

A full life-cycle reproductive test with fathead minnows (Carlson, 1972, TOUCAR05) provided an MATC of >0.21<0.68 ppm.

One study (Johnson and Finley, 1980, GS028026) demonstrates that carbaryl is very highly toxic to aquatic invertebrates with an LC50 of 1.7 ppb to Pteronarcella. A life cycle test with Daphnia magna resulted in an MATC of >1.5<3.3 ppb (Suprenant, 1985, 150901).

3. Estuarine Studies

One test tentatively shows that technical carbaryl is very highly toxic to crustaceans with an LC50 of 6.7 ppb. Two tests tentatively show that carbaryl is moderately toxic to estuarine fish and oysters with a 96hr LC50 of 1.75 ppm (Butler, 1963, 48317, longnose killifish) and a 48hr EC50 of 2.7 ppm (Suprenant, 1985, 148221, Eastern oyster), respectively.

4. Mammal Data

The acute rat oral LD50 of > 500 mg/kg indicates that carbaryl is moderately toxic to mammals.

B Degradate, Alpha-Napthol

Aquatic Testing

Two tests tentatively show that alpha-napthol is highly toxic to fish with LC50's of 0.75 ppm and 1.8 ppm for bluegill (Suprenant, 1986, 164305) and for rainbow trout (Suprenant, 1986, 164307) respectively. Alpha-napthol, tentatively, is highly toxic to Daphnia magna with an EC50 of 0.7 ppm (Suprenant, 1986, 164310). One study demonstrates that alpha-napthol is moderately toxic to estuarine/marine molluscs with a 48hr EC50 of 2.1 ppm (Suprenant, 1986, 164308). Two studies tentatively demonstrate that alpha-napthol is moderately toxic to sheepshead minnow with an LC50 of 1.8 ppm (Suprenant, 1986, 164306) and very highly toxis to estuarine/marine crustaceans with an LC50 of 0.2 ppm (Suprenant, 1986, 164309).

C Formulated Product Testing

SEVIN XLR

Two tests demonstrate that the Sevin XLR formulation (44% a.i.) is moderately toxic to fish. The LC50 of Sevin XLR was 1.4 ppm for rainbow trout (Sousa, 1985, 151519) and 9.8 ppm for bluegill sunfish (Sousa, 1985, 151417). The Sevin XLR formulation (44% a.i.) is very highly toxic to aquatic invertebrates. The reported EC50 of Sevin XLR to Daphnia magna was 13 ppb (Nicholson, 1985, 150540).

SEVIN-4-OIL

The LC50 of Sevin-4-oil was 2.5 ppm for rainbow trout (Johnson, 1980, GS028026) and 39 ppm for bluegill sunfish (Johnson, 1980, GS028026). The EC50 of Seven-4-oil to Daphnia magna was 7.1 ppb (Nicholson, 1985, 150538).

Four studies were available which addressed the hazard of Sevin-4-oil to non-target organisms from a formulated product of carbaryl in forest uses. Two studies (Bart, 1979, 0503018; Richmond, TOUCAR02) investigated non-target effects of Sevin-4-oil to avian wildlife in New York and Oregon, respectively. No adverse effects were noted at an application rate up to 2 lbs. a.i./acre. One study (Univ. of Maine, 1981, TOUCAR04) investigated the hazard of carbaryl (Sevin-4-oil) to birds, fish and aquatic invertebrates in a forest. At an application rate of 3/4 lb. a.i./acre, avian and aquatic invertebrate populations were adversely affected but finfish were not affected. Immediate postspray reductions to warblers with only slight recovery with time were recorded. Black ducklings and chickadee nestlings exhibited a slight weight reduction. Several aquatic invertebrate groups were reduced immediately after treatment. One fish monitoring study (U. S. Fish and Wildlife Service, 1976, 49128) reported no mortalities but some acetylcholinesterase inhibition (10-28%) to fish in forests receiving 1 lb. a.i./acre

in Maine.
SEVIN 80S

One study (Moulding, 1976, TOUCAR01) investigated an 80% a.i. Wettable Powder formulation at 1 lb. a.i./acre applied twice to a large mixed-hardwood forest tract in New Jersey. The study investigated only effects to avian wildlife and reported that the total bird population in the treated area was reduced up to 55% from control areas. Additionally, one year later the bird population was 45% reduced from the previous year.

II Uses

Carbaryl is a broad spectrum carbamate insecticide with some acaricidal (mites/ticks), molluscicidal (slugs/snails) and plant regulatory activity. Carbaryl is one of the most widely used pesticides for insect control on a multitude of sites. It is estimated that over 9 million pounds of carbaryl active ingredient are used in the U. S. with approximately 30 percent comprised of home and garden uses. Carbaryl end-use formulations include baits, dusts, granulars (pelleted/tableted), wettable powders, impregnated materials, flowable concentrates, ready-to-use liquids and pressurized liquids.

A Use Sites

Terrestrial, food uses: alfalfa, almonds, apples, apricots, asparagus, bananas, beans, garden beets, birdsfoot trefoil, blackberries, blueberries, boysenberries, broccoli, brussels sprouts, cabbage, carrots, cauliflower, celery, cherries, chestnuts, chinese cabbage, citrus fruits, clover, collards, corn, cotton, cowpeas, cranberries, cucumbers, dandelions, dewberries, eggplant, endive, filberts, flax, grapes, grass, horseradish, kale, kohlrabi, lentils, lettuce, loganberries, sugar maple, melons, millet, mustard greens, nectarines, okra, olives, parsley, parsnips, peaches, peanuts, pears, peas, pecans, peppers, pistachio nuts, plums, potatoes, prickly pear cactus, pumpkins, radishes, raspberries, rutabagas, salsify, sorghum, soybeans, spinach, squash, strawberries, sugar beets, sunflowers, sweet potatoes, swiss chard, tomatoes, turnips, walnuts and wheat.

Terrestrial, non-food uses: ornamental trees, ornamental woody shrubs, ornamental herbaceous plants, lawns and turf, uncultivated non-agricultural areas, recreational areas and parks, plague reservoir host animal premises and tobacco.

Greenhouse, non-food use: ornamental plants.

Domestic, outdoor use: ornamental trees, ornamental woody shrubs, ornamental herbaceous plants, lawns and turf, pet sleeping quarters, domestic dwellings and garbage cans.

Aquatic, food use: rice and oysters (Special Local Need use only).

Forests use: Christmas tree plantations, forest trees, shelterbelt plantings, recreational areas and parks.

Indoor use: dogs and pets, poultry and horses, poultry houses, barns, domestic dwellings, recreational areas, commercial and industrial and institutional, food marketing and storage and distribution, food processing plants and eating establishments.

B Discussion of Uses

According to the Preliminary Quantitative Use Assessment, October, 1987, the primary usage of carbaryl is for agricultural uses (36% - including sweet corn, field corn, wheat, pecans, tomatoes, peanuts, soybeans, potatoes, etc.), home and garden uses (30%), livestock uses (20%), forest uses (9%) and industrial/commercial uses (2%).

III Environmental Fate Information

Information presented in the original standard and presented here indicate that available data are insufficient to fully assess the environmental fate of carbaryl. Carbaryl is expected to be stable under acidic conditions but decomposes under alkaline conditions. Photolysis varies with the seasons of the year. Preliminary data indicate that there may be a potential for carbaryl to accumulate in catfish, crayfish, snails, duckweed and algae.

IV Hazard Assessment

A Discussion

The available information indicates that carbaryl:

1. Is extremely toxic to aquatic invertebrates;
2. Is highly toxic to fish; and
3. Is moderately to practically nontoxic to birds and mammals.

Furthermore, the data show that alpha-napthol is:

1. Highly toxic to the aquatic organisms tested.

Carbaryl is registered for numerous outdoor uses, including major agricultural crops such as corn, soybeans and cotton and non-agricultural uses such as forests. Many uses recommend or allow repeat applications. Exposure to non-target organisms can result from residues of direct applications, spray drift from treated areas and runoff from treated areas. Such exposures would be both acute and chronic. Due to the absence of appropriate environmental fate and some non-target organism toxicity data, a full Ecological Effects Hazard Assessment cannot be completed at this time.

The primary agricultural uses for carbaryl include wheat, corn, peanuts, sweet corn, soybeans, and tomatoes with application rates typically between 1/2 to 2 lbs. a.i./acre (corn uses permit up to 6.4 lbs. a.i./acre), with treatment intervals between 1 day and 7 days and up to 0 days pre-harvest interval. Forest uses allow applications of from 1/2 lb. a.i./acre up to 2 lb. a.i./acre. Rice uses permit applications from 1 to 2 lbs. a.i./acre. One Special Local Need (Sec 24(c)) use on oyster beds allows up to 10 lbs. a.i./acre to be applied directly to estuarine mud flats.

B Terrestrial

Three rates mentioned above (1, 2, and 6.4 lbs. a.i.per acre) will be used to estimate exposure on terrestrial food items.

The following table shows the maximum and typical residues expected on various types of terrestrial food items.

	short grass	long grass	leafy crops	insects forage	seed pods	fruit
1 lbs. ai/acre						
maximum	240	110	125	58	12	7
typical	125	92	35	33	3	4.7
2 lbs. ai/acre						
maximum	480	220	250	116	24	14
typical	250	184	70	66	14	6
6.4 lbs. ai/acre						
maximum	1536	704	800	371	77	45
typical	938	589	224	211	19	30

These residues are substantially lower than the avian LC50's (>5000 ppm for mallard and bobwhite. With an LD50 of 500 mg/kg (rat), these residues are unlikely to exceed acute effect levels for mammals. Therefore, no acute effects are expected to terrestrial nontarget organisms. Further, these residues are generally lower than the avian reproductive NOEL of 300 ppm (reported for mallards which would not pose a chronic hazard to birds except for those instances when high rates on corn to control cutworms (up tp 6.4 lbs.a.i./acre) are used or repeat applications at short intervals result in accumulated residues. The reproductive effects seen at concentrations above 300 ppm, although statistically siginificant, were marginal and occurred at the 1000 ppm and 3000 ppm treatment levels. It can be concluded that carbaryl is not likely to result in any serious direct acute or chronic risk to terrestrial organisms.

Terrestrial wildlife, however, may be indirectly affected from large-scale or widespread carbaryl usage by the reduction of food sources and will be discussed below.

C Aquatic

The available information indicates that although carbaryl is only moderately to highly toxic to finfish it is very highly toxic to aquatic invertebrates. Also, the primary degradate (alpha-napthol) is highly toxic to finfish and invertebrates. The use of carbaryl may seriously affect aquatic organisms, especially for those uses which allow for direct exposure of water (i.e., forests, rice, mosquito control). This contention is heavily supported by field monitoring studies which have demonstrated substantial reductions to aquatic invertebrates in forest uses. One study (Univ. of Maine, 1981, TOUCAR04) reported maximum residues in the water of 254 ppb after an application of only 0.75 lbs. a.i./acre (2 lbs. a.i./acre permitted on label for some forest uses) and measurable concentrations persisted for greater than 138 days. The measured concentrations exceeded the laboratory derived LC50 values for most aquatic invertebrates. Additionally, agricultural uses may allow for acute and chronic effects based on roughly calculated exposure predictions. A 1 lb. a.i./acre treatment will typically result in a maximum expected exposure from runoff of 73.4 ppb [Based on a 30 acre field draining into a 6 acre*feet pond with 2% pesticide loss in runoff, the resultant loading is dissolved completely in the water column with no partitioning to sediment]. Spray drift would also result in concentrations as high as 73.4 ppb [Based on 5% drift loss and 2 lb.a.i./acre application rate]. These concentrations exceed laboratory demonstrated effect concentrations and indicate potential serious adverse effects are likely. Additional environmental fate information and aquatic field testing information are necessary to determine the probability and magnitude of such an unwanted occurrence.

The use of carbaryl in estuaries to control burrowing shrimp in oyster beds may result in undesirable effects to non-target organisms. The application rate of 10 lbs. a.i./acre, which is required to control the burrowing shrimp, is sufficient to affect a much larger area than the treated site alone. If evenly dispersed throughout an estuarine system 10 lbs. of carbaryl would exceed toxic levels for certain sensitive invertebrates in a volume equal to 1000 acre*feet (concentration = 3.7 ppb). When applied to bare beds at ebb tide, carbaryl would not be evenly distributed. Much of the application would be bound to the mud substrate and persist for up to 6 weeks, at decreasing concentrations (Karinen et al., 1967). When water contacts the treated bed, carbaryl will be extracted out of the sediment and dispersed throughout the aqueous medium. Also, since estuarine water has a pH which is generally around 8, carbaryl will rapidly degrade into alpha-napthol. Macroinvertebrates and small fishes would be affected by an application only within the first few days immediately following treatment. This conclusion is based on available information demonstrating that less than 1% of the applied carbaryl is available to the water column at 4 days post-application (Karinen et al., 1967). The effects to these animals can be expected in an area an order of magnitude larger

than the treated area, in other words, an application to 1 acre would substantially affect 10 acres. This conclusion considers 0.1 lb a.i. available and evenly distributed in the water column. An area roughly equivalent to 10 acre*feet would obtain a concentration of 3.7 ppb which exceeds 1/2 the LC50 of the most sensitive estuarine invertebrate tested (mysid LC50=6.7 ppb). Smaller organisms, in the plankton and benthos, could be heavily affected in the general surrounding area. The effects seen in the microfauna would be over a somewhat longer period than that observed for the macrofauna.

Chronic exposure to carbaryl is not expected from the use on oyster beds. The degradation characteristics of carbaryl and dilution from tidal exchange preclude any long term exposures. Nevertheless, long term effects may be expected. These long term effects would not be due to a chronic toxicity of carbaryl but rather a long term loss of a portion of the biological component of the estuary. Successive treatments over a period of years would successively remove a portion of the benthic and planktonic communities. Whether or not the estuary is resilient enough to absorb these losses without permanent alterations to its stability is questionable. Conceivably, the species diversity and quantitative structure could be altered, eventually adversely affecting commercially valuable species such as Dungeness crab and salmon. A monitoring program should be established to observe if any changes in the structure of the benthic and planktonic communites result from the use of carbaryl.

Because carbaryl is very highly toxic to aquatic invertebrates and terrestrial invertebrates, indirect effects to finfish and terrestrial vertebrates may be expected. Field studies in forests have reported such indirct effects on avifauna, especially waterfowl which are dependent upon aquatic invertebrates for nestling recruitment. To illustrate the concern for indirect effects, consider waterfowl in the prairie pothole region of the U. S. (North Dakota, South Dakota, Minnesota and Montana). Carbaryl is used heavily on large acreage crops grown in the prairie pothole region including wheat, sunflowers, corn, etc.). Waterfowl in this region account for over 50% of the North American production of waterfowl. Many species of dabbling ducks are heavily dependent on aquatic invertebrates, with 70 to 99% of their diet consisting of aquatic invertebrates abundant in the permanent and temporary ponds known collectively as the prairie potholes. These potholes inundate the agricultural areas of the region. Pesticides applied to crops in the area will directly expose the potholes. Reductions in invertebrates would substantially reduce the recruitment of new waterfowl and reductions in the pothole region could result in severe population reductions of several waterfowl species on a National level. Likewise, reductions of aquatic invertebrates in other habitats may pose serious risks to terrestrial and aquatic vertebrates dependent upon them with farreaching (e.g., national) ramifications.

A terrestrial field study is required to address this particular risk to waterfowl recruitment which may result from heavy agricultural uses in the prairie pothole region. This requirement is deemed necessary to determine if even transient reductions of invertebrates which occur at a time crucial for offspring recruitment will adversely affect such recruitment.

D Summary of Hazard

Adverse effects to aquatic invertebrate organisms are fully expected with indirect threats to fish and terrestrial wildlife likely. Additional information in the form of field testing is required to clarify the potential risks.

V Endangered Species

A Triggers

The endangered species triggers are as follows:

Group		Trigger
Birds		300 ppm (avian rep. NOEL)
Fish		210 ppb (fish rep. NOEL)
	(or)	35 ppb (1/20th fish LC50)
Aquatic Inv.		0.1 ppb (1/20th aq. invertebrate LC50)
Mollusks		130 ppb (1/20th oyster EC50)

B Exposure

As previously discussed, the expected exposures based on an incomplete environmental fate database are generally less than 300 ppm for terrestrial food items and up to 254 ppb for aquatic habitat. Therefore, triggers established for endangered and threatened aquatic fauna are exceeded.

C Previous Opinions

Carbaryl has been previously considered by the U.S. Fish and Wildlife Service (FWS) Office of Endangered Species and included in the cluster opinions on forests, rangeland and/or pastureland, agricultural crops and mosquitoe uses. Specific recommendations were issued in PR Notice 87-4 and PR Notice 87-5. The registrant will be notified of labeling requirements upon implementation of these cluster opinions.

D Discussion

Essentially all major uses of carbaryl have been addressed in one or more biological opinions from FWS. The conclusions from these opinions have been used to determine hazard to endangered species. It is unlikely that the uses for which opinions were not available, i.e. ornamentals, greenhouse, livestock, industrial/commercial, etc., would affect endangered

species.

Endangered bird species that could be affected indirectly through severe reduction of their food supply which were not addressed in the cluster opinions include the Piping plover and the Interior least tern. It is not possible to complete an assessment of hazard to them until aquatic field testing and environmental fate information are available. When the aquatic field studies have been completed and outstanding environmental fate informartion is available, the evaluation will be completed.

The EEB will initiate consultation with the USFWS when adequate data have been provided.

VI Precautionary Labeling

A. Manufacturing Use

"This pesticide is toxic to fish and extremely toxic to freshwater and estuarine invertebrates. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or public waters unless this product is specifically identified and addressed in an NPDES permit. Do not discharge effluent containing this product to sewer systems without previously notifying the sewage treatment plant authority. For guidance, contact your State Water Board or Regional Office of the EPA."

B. End-Use Products

1. Non-aquatic use sites:

"This pesticide is toxic to fish and extremely toxic to freshwater and estuarine invertebrates. Drift and runoff from treated areas may be hazardous to aquatic organisms in neighboring areas. Do not apply directly to water or wetlands (swamps, bogs, marshes, and potholes). Do not contaminate water when disposing of equipment washwaters."

2. Aquatic use sites (including rice, oyster beds, etc.):

"This pesticide is toxic to fish and extremely toxic to freshwater and estuarine invertebrates. Drift and runoff may be hazardous to aquatic organisms in neighboring areas. Do not contaminate untreated water when disposing of equipment washwaters. Discharge from rice fields may kill freshwater and estuarine organisms."

For rice uses, the following statement should be included under Use Directions:

"CAUTION: May kill shrimp and crabs. Do not use in areas where these are important resources. Do not use on rice fields in which crayfish and/or catfish farming are included in the

cultural practice."

3. Forest use sites

"This pesticide is toxic to fish and extremely toxic to aquatic invertebrates. Do not apply directly to water or wetlands (swamps, bogs, marshes, and potholes), except under the forest canopy. Drift and runoff from treated areas may be hazardous to aquatic organisms in neighboring areas. Do not contaminate water when disposing of equipment washwaters."

VII CLASSIFICATION

Major outdoor uses (i.e., corn, soybeans, rice, forests, etc.) exceed restricted use triggers (EEC > 1/5 LC50 for most sensitive species) for aquatic invertebrates. Therefore, all carbaryl products labeled for agricultural uses (except home gardens) and forest uses must classified for Restricted Use.

VIII DATA REQUIREMENTS

The required data are provided in Table A, attached.

IX LITERATURE CITED

Karinen, J. F., J. G. Lamberton, N. E. Stewart and L. C. Terriere. 1967. Persistence of carbaryl in the marine estuarine environment. Chemical and biological stability in aquarium systems. J. Agr. Food Chem. 15(1):148-156.

TABLE A
Generic Data Requirements for Carbaryl

Data Requirement	Composition 1/	Use Pattern 2/	Does EPA have data to satisfy this requirement? (Yes, No or partially)	Bibliographic Citation	Must additional data be submitted under FIFRA Section 3(c)(2)(B)?
§158.145 Wildlife and Aquatic organisms					
Avian and Mammalian Testing					
71-1 - Avian Oral LD_{50}	TGAI	A,B,C,G,H	Yes	TOUCAR03	No
71-2 - Avian Dietary LC_{50}					
a - waterfowl	TGAI	A,B,C,G,H	Yes	28757	No
b - upland game	TGAI	A,B,C,G,H	Yes	28757	No
71-3 - Wild Mammal Toxicity	TGAI	A,B,C,G,H	No		No
71-4 - Avian Reproduction	TGAI	A,B,C,G,H	Yes	160044 161500	No
71-5 - Simulated and Actual Field Testing - Mammals and Birds	TGAI	A,B,C,G,H	Partially	503018 TOUCAR01 TOUCAR02 TOUCAR04	Yes 3/ (3 y)

TABLE A (continued)
Generic Data Requirements for Carbaryl

Data Requirement	Composition 1/	Use Pattern 2/	Does EPA have data to satisfy this requirement? (Yes, No or partially)	Bibliographic Citation	Must additional data be submitted under FIFRA Section 3(c)(2)(B)?
Aquatic Organism Testing					
72-1 - Freshwater Fish LC_{50}					
a- warmwater	TGAI	A,B,C,G,H	Yes	GS028026 43115	No
Sevin XLR 44%ai	TEP	C,G	Yes	151417	No
Sevin-4-oil 49%ai	TEP	C,G	Yes	GS028026	No
Sevin 4F 50%ai Sevin 50W 50%ai Sevin 80S 80%ai	TEP	C,G	No		Yes 4/ (9 m)
	Degradate	C,G	No		Yes 5/ (9 m)
b- coldwater	TGAI	A,B,C,G,H	Yes	GS028026 43116	No
Sevin XLR 44%ai	TEP	C,G	Yes	151519	No
Seven-4-oil 49%ai	TEP	C,G	Yes	GS028026 116420	No
Sevin 4F 50%ai Sevin 50W 50%ai Sevin 80S 80%ai	TEP	C,G	No		Yes 4/ (9 m)
	Degradate	C,G	No		Yes 5/ (9 m)

TABLE A (continued)
Generic Data Requirements for Carbaryl

Data Requirement	Composition 1/	Use Pattern 2/	Does EPA have data to satisfy this requirement? (Yes, No or partially)	Bibliographic Citation	Must additional data be submitted under FIFRA Section 3(c)(2)(B)?
72-2 - Freshwater Invertebrate Acute EC_{50}	TGAI	A,B,C,G,H	Yes	GS028026	No
	TEP 12/	C,G	No		Yes4/ (9 m)
	Degradate	A,B,C,G,H	No		Yes5/ (9 m)
72-3 - Estuarine/Marine Organism Acute EC_{50}					
a- finfish	TGAI	A,B,C,G	No		Yes6/ (1 y)
	TEP 12/	C	No		Yes7/ (1 y)
	Degradate	A,B,C,G	No		Yes5/ (1 y)
b- crustacean	TGAI	A,B,C,G	No		Yes6/ (1 y)
	TEP 12/	C	No		Yes7/ (1 y)
	Degradate	A,B,C,G	No		Yes5/ (1 y)
c- oyster	TGAI	A,B,C,G	Yes	148221	No
	TEP 12/	C	No		Yes7/ (1 y)
	Degradate	A,B,C,G	Yes	164308	No

TABLE A (continued)
Generic Data Requirements for Carbaryl

Data Requirement	Composition 1/	Use Pattern 2/	Does EPA have data to satisfy this requirement? (Yes, No or partially)	Bibliographic Citation	Must additional data be submitted under FIFRA Section 3(c)(2)(B)?
72-4 - Fish Early-Life Stage and Aquatic Invertebrate Life-Cycle	TGAI	A,B,C,G,H	Yes	TOUCAR05 150901	No
72-5 - Aquatic Organism Accumulation	TGAI	C,G	No		Yes 8/ (9 m)
72-6 - Life-Cycle Tests with Fish	TGAI	C,G	Yes	TOUCAR05	No
72-7 - Simulated or Actual Field Testing - Aquatic	TEP	A,C,G	Partially	49128 TOUCAR04	Yes 9/ (3 y)
§158.150 Plant Protection Testing					
Tier I:					
122-1 - Seed Germination/					
Seedling Emergence	TGAI	B,C,G	No		No 10/
Vegetative Vigor	TGAI	B,C,G	No		No 10/
122-2 - Aquatic Plant Growth	TGAI	B,C,G	No		Yes 11/ (9 m)
Tier II:					
123-1 - Seed Germination/					
Seedling Emergence	TGAI	B,C,G	No		No 10/
Vegetative Vigor	TGAI	B,C,G	No		No 10/
123-2 - Aquatic Plant Growth	TGAI	B,C,G	No		Reserved 11/
Tier III:					
124-1 - Terrestrial Field	TGAI	B,C,G	No		No 10/
124-2 - Aquatic Field	TGAI	B,C,G	No		Reserved 11/

1/ Composition: TGAI = Technical grade of the active ingredient; PAI = Pure active ingredient; TEP = Typical end-use product; Degradate = alpha-napthol.

2/ The use patterns are coded as follows: A=Terrestrial, Food Crop; B=Terrestrial, Non-Food Crop; C=Aquatic, Food Crop; D=Aquatic, Non-Food Crop; E=Greenhouse, Food Crop; F=Greenhouse, Non-Food Crop; G=Forestry; H=Domestic Outdoor; I=Indoor.

3/ Avian and mammalian field testing is required to ascertain the indirect hazard of reductions in invertebrate populations to terrestrial vertebrates dependent upon them. The test should investigate population recruitment of an appropriate species (e.g., bluewinged teals) in an appropriate habitat (e.g., prairie pothole region). The EEB recommends that the registrant submit a protocol for evaluation before initiating the study.

4/ Required for formulated products used in forests and/or aquatic food uses.

5/ Required for the primary degradate alpha-napthol.

6/ Required for corn, soybeans, cotton, rice, citrus, sorghum, forests, mosquito control, cranberry and oyster bed uses. The requirement for chronic toxicity testing with estuarine organisms is currently reserved pending the results of the remaining acute tests.

7/ Required for formulated products used in rice, oyster beds and cranberries.

8/ Required for aquatic food and forest uses.

9/ Hazard assessment for most outdoor uses indicates a high risk to aquatic invertebrates. A comprehensive aquatic field study to quantify effects on aquatic organisms is needed for major agricultural uses (i.e., corn, soybeans, wheat), forest uses, mosquito control uses, and aquatic food crop uses to determine if the hazard indicated by available laboratory and field evidence is ecologically significant. The EEB recommends that a protocol for conducting this study be submitted prior to initiation of the field work. A guidance document outlining acceptable methods for conducting an aquatic mesocosm test (Touart, 1988, NTIS) can be consulted in designing an appropriate comprehensive test. A mesocosm test is recommended because it is believed to be extrapolatable to the variety of carbaryl uses. Additionally, the Special Local Need registration of carbaryl for use in oyster beds requires a special monitoring study to assess long term ramifications and exposure of carbaryl exposure in an estuary. The EEB recommends that a protocol for conducting this monitoring study be submitted prior to initiation of the field work.

10/ These tests are not required since carbaryl is registered for use on most vegetables and ornamental plants.

11/ Required for all aquatic food and forest uses, higher tier testing is reserved pending receipt of the lower tier tests.

12/ Typical end-use products including Sevin XLR 44%ai, Sevin-4-oil 49%ai, Sevin 4F 50%ai, Sevin 50W 50%ai and Sevin 80S 80%ai.