Smith River Flood Plain

Pesticide Aquatic Ecological Exposure Assessment

Part I: Pesticide Usage In Del Norte County and Smith River Flood Plain Lily Bulb Production Area

Part II: Generic Estimated Environmental Concentration Tier 1 Screening

Prepared for:
The Smith River Project †

Prepared by:
The Center for Ethics and Toxics
Britt Bailey, M.A. & Marc Lappé, Ph.D. in partnership with Georgiana Hale† and Greg King†

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PART I: Pesticide Usage in the Smith River Flood Plain's Lily Bulb Production Area

1. Executive Summary

The Smith River flood plain located within Del Norte County is an ecologically diverse area in a remote region of Northern California. Del Norte County is not considered a productive agricultural economy in terms of its market value or its agricultural inputs including chemicals. The Smith River is California's only major undammed river, and is mostly pristine due to a lack of harmful inputs. Due to the intensive cultivation of lily bulbs within this relatively small though environmentally significant area, a two-part study of the scale and rate of pesticide usage was undertaken to ascertain, 1) the level and intensity of pesticide use, and 2) the risks the pesticides pose to humans and endangered species.

In this study, pesticide usage was compared to that of major California agricultural counties, Tulare and Kings. While Del Norte County uses approximately 200,000 pounds of pesticides per year as compared to 17 million pounds and 5 million pounds in Tulare and Kings respectively, the intensity of use in Del Norte County is nearly double in select active ingredients per treated acre. Upon further investigation of the rate and scale of pesticide use in Del Norte County, it was found that virtually all of the pesticide concentration is occurring within the approximately 11-square-mile area of the Smith River flood plain. The

second part of this study discusses the potential ecological impact to endangered aquatic organisms from agricultural chemicals used in the Smith River flood plain and entering the estuary as non-point source pollutants.

We found that pesticide use in Del Norte County, as measured by application rates, exceeded that of two major agricultural counties. This level of use exceeded the federal government's established level of concern for endangered aquatic organisms for four of five pesticides studied.

2. Background: Characterization of the Smith River Flood Plain

The Smith River Flood Plain is located in northern California's Del Norte County, a county consisting of 1,003 square miles with a 2001 population of 27,882.[1] Del Norte's two major economies include fishing and lily bulb production. The fishing industry provides 39.2 million pounds of fish and approximately $17 million in revenue. The lily bulb production industry occurs in an 11-square-mile area identified as the Smith River Flood Plain (SMFP), where 90% of the United States lily bulbs are cultivated. The crop returns nearly $20 million annually.

The lily bulb growing region of the Smith River exists largely within the broad and shallow estuary which includes in-reaching sloughs. The estuary is a biologically rich and fragile habitat for thousands of organisms, and is the gateway for endangered aquatic animals including the anadromous populations of coho and Chinook salmon, and steelhead trout.

A key question is the degree and extent of the possible threat to the rich biological health of the Smith River estuary posed by the concentrated and intense use of nearly 50 various agricultural chemicals used on nearly 1,000 acres of lily bulb fields. Some of these chemicals are known to contaminate groundwater, are highly toxic to fish, and are probable human carcinogens. Each year nearly 200,000 pounds of chemicals are used in and around the approximately 11-square-mile area of the Smith River estuary.

3. Experimental Design

We tested the hypothesis that pesticide application rates were comparable to that of two randomly selected well known agriculture producing counties: Tulare and Kings. Tulare County, located in California's Central Valley, is one of the most productive agricultural counties in California. In terms of value of production, it is second only to Fresno County. Like Del Norte County, a majority of Tulare's land area is owned by government (52 percent, mostly in foothill and mountain areas). The leading industry is food and related products, followed distantly by printing and publishing, lumber and wood products, fabricated metal products, and electronic and other electric equipment. Agricultural products include milk, oranges, grapes, cattle and calves, cotton lint and seed, and others. The county includes an area of 4,863 square miles and is the second-leading producer of agricultural commodities in the United States.

Kings County, another well known intensive agricultural county, has 87.2 percent of its land area in farms.[2] The county's leading industry is food and kindred products. The dominant agricultural products are cotton/cottonseed and milk, followed distantly by cattle and calves, turkeys, grapes, peaches, and other products. Agricultural production in Kings County ranks 12th among California counties and 16th among U.S. counties. The county is 1,390 square miles and has nearly 900,000 total acres in cultivation.

Kings and Tulare represent two of only a handful of California counties responsible for most of the state's reported agricultural pesticide use. Tulare is ranked seventh in total reported pesticide use at 18.3 million pounds and Kings is ranked twelfth with pesticide use at approximately 5.1 million pounds.[3] Del Norte County, in contrast, reports pesticide use at approximately 200,000- 250,000 pounds per year and is ranked thirty-fourth in overall use. We tested general equivalence of use by comparing application rates of selected active ingredients per acre treated in each of the three counties.

4. Methods

In order to measure the intensity of use within the three counties, we selected nine pesticides used in all identified counties for thorough review for the 5 year period of 1996-2000. The selected pesticides outlined in Table 1 were chosen based on toxicity category, level of use, potential to contaminate groundwater, and toxicity to fish. The nine identified chemicals include three fungicides, one insecticide, one

herbicide, and four nematocides. Four of the chemicals are B2 carcinogens, three are known groundwater contaminants, and four are known to be highly toxic to fish. (See Appendix A for toxicological profiles of the selected chemicals.)

To determine the intensity of pesticide use, or application rate, we divided the pounds of active ingredient used by the total acres treated per acre of crop planted. This definition excludes pesticides used in processing or post-harvest fumigation. The total pounds of active ingredient and the amount of acres treated were provided by the California Department of Pesticide Regulation *Pesticide Use Report Database*. All records marked as outliers by the Department of Pesticide Regulation were excluded from the data set before analysis.

Table 1: Selected Chemicals used in Del Norte County and the Smith River Flood Plain identified for thorough environmental health assessment.

Identified Chemicals for Study	Category	Toxicity Classification
1,3-D	Nematocide/Fumigant	B2 (probable human carcinogen)
Metam Sodium	Nematocide/Fumigant	B2 (probable human carcinogen)
Chorothalonil	Fungicide	B2 (probable human carcinogen), Potential Groundwater Contaminant
Carbofuran	Insecticide	Class I (highly toxic), Potential Groundwater Contaminant
Diuron	Herbicide	Class III (slightly toxic), Groundwater Contaminant
Disulfoton	Insecticide	Class I (highly toxic)
PCNB	Fungicide	Class III (slightly toxic)
Chloropicrin	Fungicide/Fumigant	Class I (highly toxic), Potential Groundwater Contaminant
Methyl Bromide	Nematocide/Fumigant	B2 (probable human carcinogen)

5.(A) Results: Usage and Comparisons by County

Figure 1 provides an analysis by county of pesticide use intensity for the nine selected chemicals. The rates of application per acre of pesticide used per county are presented for five consecutive years. It can be seen that in virtually every category tested, the application rates in Del Norte County exceed the rates of pesticide application in Tulare and Kings counties, especially for the soil fumigants 1,3-D and Methyl Bromide. Figure 1 also shows that virtually all of the chemicals applied in Del Norte County are applied in the Smith River flood plain.

Figures 2 through 10 depict the application rates per selected chemical. With the exception of chlorothalonil, PCNB in 1996, and methyl bromide in 1997, all of the reviewed pesticides have higher application rates in Del Norte County than do the same pesticides in the two agricultural "high-use" counties.

5.(B) Results: Contribution of Smith River Flood Plain Pesticide Use to Total Usage in Del Norte County

Because lily bulb production constitutes the bulk of agricultural activity within Del Norte County, we investigated the proportion to which the selected pesticides used in Del Norte County were being used in the concentrated area of the Smith River Estuary. The pounds of pesticides were calculated by obtaining the pesticide use in one square mile areas (see Figures 11-15) by MTRS (Meridian Township Range Section). For each of the five years, the MTRS's in lily bulb production

changes moderately. For example, in 1996 MTRS #18NO1W28 was not listed as being in production for purposes of pesticide use, though in 1997 this area was treated with pesticides for the production of lily bulbs. For this reason, the "treated" acreage was adjusted accordingly when computing the application rate. During the five-year period, there were no less than 9 square miles in production and no more than 11 square miles. Total pesticide use was heaviest for fumigants (1,3-D, methyl bromide, and metam sodium).

As shown in Figure 1, Del Norte County in general, has a higher rate of pesticide application than that of high use counties, Tulare and Kings. Figures 16-24 show the chemical use contributing to the high application rates in Del Norte County. These figures demonstrate graphically how much of the total chemical use in Del Norte County can be attributed to the Smith River flood plain. Overall, our findings show that pesticide use in the Smith River flood plain represents nearly all of the pesticide use for Del Norte County as a whole. Our findings indicate the scale and rate of pesticide use in the Smith River flood plain exceeds that of at least two of the most intensely developed agricultural regions in the State.

6. Discussion:

While Del Norte County is not considered a prominent agricultural county within California, it is home to the largest lily bulb growing region in the United States. This industry appears to be highly pesticide dependent, using more pesticides per acre than comparable agricultural activities within two other counties. The

extremely high use of pesticides in the Smith River flood plain creates general concern for the ecosystem in and around the lily bulb cultivation. This concern extends to those residents living in the area as well as farmworkers. Because pesticide use is concentrated within an 11 square mile area of the ecologically sensitive Smith River estuary, such use raises the issue of a possible biohazard to aquatic species that live in or traverse the estuary. This possibility was tested in Part II of this report which examines the risk posed to endangered species by the pesticides used in the Smith River flood plain.

7. Recommendations

To follow-up the high-risk of potential ecological impact from the high rate of pesticide use in the Smith River estuary, we proposed a Tier I estimation of risk to aquatic species. In this study, the pesticide concentrations expected from exposure were compared to concentrations known to be toxic to sensitive organisms.

In addition, we recommend a complete human health assessment commencing with a drinking water assessment due to the fact that many of the nearby residents draw residential water from deep and shallow wells.

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[3] DPR Pesticide Use data, 1991-1998.

PART II: Tier I Aquatic Risk Assessment for Endangered Species within Smith River Floodplain

1. Executive Summary

To assess potential ecological impacts from the high rate of pesticide use in the Smith River floodplain, we conducted a Tier I estimation of risk to aquatic endangered species. The risk estimation focused on possible effects to species listed as endangered and threatened under the Federal Endangered Species Act listed Central California Coast ESU Steelhead, California Coastal ESU Chinook, Southern Oregon/Northern California ESU Coho. A model, GENEEC (Generic Estimated Environmental Concentration) was used as the exposure estimation tool. With GENEEC, we were able to ascertain whether or not a particular intensity of pesticide product's use presented a likely environmental or ecological harm to such species.

Five pesticides used in the Smith River flood plain were selected based on their high relative toxicity and assessed using the GENEEC model. A calculated "risk quotient" was then compared to established levels of concern (LOCs) to determine if a given pesticide posed a significant risk. Of the five chemicals selected for review (Chlorothalonil, Carbofuran, Diuron, Disulfoton, and Pentachloronitrobenzene [PCNB]), four of the five exceeded or met the established levels of concern for endangered aquatic organisms.

Because the species selected for study are federally listed as threatened and endangered under the Endangered Species Act, ecological mitigation and regulatory action to reduce risk-generating pesticide usage is necessary. At a minimum, we believe a higher and more complex level of investigation for those chemicals that failed Tier 1 is warranted. Other selected soil fumigants not suitable for the GENEEC model should also be reviewed by appropriate governmental agencies to assess the potential effects to the salmonid recovery efforts.

2. Background

Under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), the Toxic Substance Control Act (TSCA), and the Clean Water Act (CWA), the US Environmental Protection Agency (EPA) is charged with determining if the manufacture, use, or disposal of a chemical will present an unreasonable risk of harm to the environment. In addition, the Endangered Species Act (ESA) requires an estimation of the "take" of individuals to determine if the loss of the individuals might adversely affect a population of an endangered or threatened (listed) species. "Taking" as a principle is broadly construed as an action that affects habitat required for the continued existence of species. If sufficiently severe, habitat modification may be shown to be harmful to the entire species even though no individual deaths need to be cited.[1]

The Smith River is considered a State Reference Stream for salmonid populations due to its relatively healthy fish populations. It is home to Central Coast

Coho, northern California Steelhead, and the California Coastal Chinook. The Smith River is considered one of California's healthier rivers based on minor resource extraction and agricultural use occurring near its streams, thus ensuring low human impact. The Upper and Middle Smith River subwatersheds have been targeted as high priorities for watershed restoration. The Upper and Middle Smith River comprise a "key watershed," meaning it is an area important for maintaining and recovering habitat for at risk fish stocks, specifically salmonid populations and other resident species.

The Smith River estuary is as especially and equally important to the recovery efforts of salmon as its upland streams. Estuaries generally are rearing, refuge and feeding grounds for salmon. Juvenile salmon experience the highest growth rates of their lives while in estuaries and near-shore waters. Juvenile salmon move to estuaries for weeks or months to grow and adapt to salt water before moving out to sea. The estuary is the location where salmon transform from a freshwater to a saltwater fish. This process, called smoltification, is especially sensitive to chemical disruption. Smoltification involves alterations and developmental changes to body chemistry, appearance, and behavior that are easily disrupted by toxic chemicals.[2] Degradation to the quality of water within the estuary is a significant barrier for the continued survival and recovery of salmon.[3]

Studies involving the effects of pesticides on salmon show that juvenile salmon may suffer adverse effects from passing through polluted estuaries and near-shore areas. Human produced pollutants can cause immune dysfunction, increased susceptibility to disease and impaired growth and development in fish.[4, 5] Ecological impacts of some pesticides to non-target organisms, such as the effect of the carbamate pesticide carbofuron in male salmon, can lead to a significantly reduced ability to respond to priming pheromones, a scent released when a female is ovulating.[6] Low level concentrations of fungicides have also been shown to cause death in juvenile salmon.[7]

While the inland reaches of the Smith River may be relatively untouched and constitute a healthy habitat for recovering salmonids, the chemical activity surrounding the estuary is of particular ecologic concern. Based on these concerns, intensity of pesticide use, and its concentration within an 11 square mile area, the Smith River flood plain was evaluated in a Tier 1 ecological assessment. This assessment estimated the potential adverse effects to endangered aquatic organisms, specifically salmon, within the Smith River estuary from calculated pesticide usage in the surrounding flood plain.

Selected pesticides of concern both toxicologically (See Appendix A) and based on rate of use were chosen for aquatic Tier I assessment. The same chemicals were analyzed as presented in Part I of the report (see Table 1.). Because the most

suitable aquatic risk assessment tool is not appropriate for tracking soil fumigants, risk estimation was conducted on selected *non-soil* fumigants.[8*]

Identified Chemicals for Study	Category	Toxicity Classification
Chorothalonil	**Fungicide**	**B2 (probable human carcinogen), Potential Groundwater Contaminant**
Carbofuran	**Insecticide**	**Class I (highly toxic), Potential Groundwater Contaminant**
Diuron	**Herbicide**	**Class III (slightly toxic), Groundwater Contaminant**
Disulfoton	**Insecticide**	**Class I (highly toxic)**
PCNB	**Fungicide**	**Class III (slightly toxic)**

Figure 1: Selected Pesticides for Aquatic Risk Assessment

3. Methods

A. *Generic Estimated Environmental Concentration (GENEEC)*

The Tier I tool used in evaluating the potential aquatic risk from pesticides was the Generic Estimated Environmental Concentration (GENEEC 2.0) used by the Environmental Fate and Effects Division (EFED) within the Environmental Protection Agency. GENEEC calculates acute as well as longer-term estimated environmental concentration (EEC) values. As a model, GENEEC incorporates estimates of the reduction in dissolved pesticide concentration due to adsorption of the chemicals to soil or sediment, incorporation, degradation in soil before wash off

[*] Actual measured residues of soil fumigants may be a better indicator of exposure and risk from the soil fumigants than are estimates. In the near future, the Endangered Species Protection Program within the EPA will require protection of endangered and threatened species from the adverse use of soil fumigants.

to a water body, direct deposition of spray drift into the water body, and degradation of the pesticide within the water body.[9] A pesticide concentration from normal use (exposure) is compared to concentrations known to be toxic from laboratory tests (hazard). The exposure/hazard ratio is used as an indication of potential ecological risk to non-target species in the environment. The model is conservative in its nature and therefore may underestimate actual exposure.[10]

GENEEC was developed in response to the EPA's Environmental Fate and Effects Division's need to have a standard aquatic environment in which all chemicals could be assessed and compared. A "standard agricultural field-farm pond scenario" was selected for all aquatic exposure assessments. This standard pond scenario assumes that rainfall onto a treated, 10-hectare agricultural field causes pesticide–laden runoff into a one-hectare, 20,000-cubic-meter volume, two-meter-deep body of water. Although this scenario was designed to predict pesticide concentrations in the standard farm pond, it has been shown to be a good predictor of upper level pesticide concentrations in small but ecologically important upland streams.[11] While the EPA does not currently have a specific approach developed for modeling risk estimations for estuarine species, agency experts have concluded pesticide effects data in estuaries can be evaluated using GENEEC at the Tier 1 screening level.[12]

B. ***Exposure and Risk Assessment for Aquatic Organisms***

Risk characterization integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. The means of this integration is called the "quotient method." Risk quotients (RQs) are calculated by dividing exposure estimates (EEC) by acute and chronic ecotoxicity values (LC_{50}).

RQ = EXPOSURE/HAZARD

Risk Quotients are then compared to EPA established levels of concern (LOCs). Levels of concern were set by the Office of Pesticide Programs and discussed in the Standard Evaluation Procedure for Ecological Risk Assessment (EPA/540/09-86/167, 1986). The levels of concern are used to analyze potential risk to non-target organisms and the need to consider regulatory action. They currently address the following risk presumption categories: (1) "acute high" –potential for acute risk is high; regulatory action may be warranted in addition to restricted use classification, (2) "acute restricted use"— the potential for acute risk is high, but may be mitigated through restricted use classification, (3) "acute endangered species"— endangered species may be adversely affected, and (4) "chronic risk" – the potential for chronic risk is high and regulatory action may be warranted. We decided the most suitable target was 3).

The ecotoxicity test values (measurement endpoints) used in the acute and chronic risk quotients are derived from required studies. An example of an ecotoxicity value derived from short-term laboratory studies that assess acute effects

is the LC_{50}, the lethal concentration measured in mg/Liter at which 1/2 of the test population do not survive.

Risk presumptions and the corresponding Risk Quotients and Levels of Concern fo Aquatic Animals are tabulated below:

Risk Presumptions for Aquatic Animals

Risk Presumption	RQ	LOC
Acute Risk	**EEC[1]/LC50 or EC50**	**0.5**
Acute Restricted Use	**EEC/LC50 or EC50**	**0.1**
Acute Endangered Species	**EEC/LC50 or EC50**	**0.05**
Chronic Risk	**EEC/ NOAEC**	**1**

[1] **EEC = (ppm or ppb) in water**

C. ***Smith River Flood Plain Aquatic Ecological Exposure Assessment***

The Generic Estimated Environmental Concentration (GENEEC 2.0) was used to measure ecologically relevant endpoints on endangered salmonid species within

the Smith River Floodplain. Surrogate organisms typically tested in laboratory toxicity assessments allow for generalizations regarding the protection afforded the Endangered Species Act listed species. Rainbow trout, a species typically used in pesticide registration or water quality derivation, was used as the standard surrogate species whose toxicity tests have been found likely to be protective of most listed aquatic fish species.[13]

A calculated risk quotient was compared to the toxicological endpoint (LC50) for Rainbow Trout. The risk quotient (RQ) represents the ratio of the Estimated Environmental Concentration of a particular chemical to the toxicity test effect. The risk quotient was then compared to the level of concern for acute endangered species.

Since Tier 1 screening is intended to be protective, the risk quotient was based on peak Environmental Estimation Concentration. An acute risk quotient was generated based on the peak Environmental Estimation Concentration (EEC) divided by the LC50. This equation describes risk as a quotient of the concentration of toxicant likely to occur in estuarine areas adjacent to pesticide applications as estimated by the GENEEC model, to the acute marine/estuarine fish. The pond values are used as a rough approximation of pesticide concentrations in the estuarine environment. The result is an expression of acute risk to marine/estuarine fish in terms of concentration exposed to concentration tested. Figures 25-29 present the inputs for each chemical and the resulting risk quotients (RQs). The risk

water flow. To compensate in part for dilution effects, we chose conservative estimates of factors that err on the side of underestimating the toxic contribution of the chemicals in this case.

Other inputs required to estimate environmental concentration include:

1. Application rate: Application rates were calculated using available data provided by the California Department of Pesticide Regulation by Meridian Township Range Section for all areas in use.

2. K_{oc}: The carbon normalized soil/water equilibrium coefficient. This environmental fate value represents a pesticide's ability to attach to soil.

3. Solubility in Water: An important physical property in determining the concentration of a pesticide in water.[15]

4. Photolysis 1/2 life: This input is defined as the time it takes for _ of the pesticide's chemical bonds to be broken by light energy, usually assumed to be the UV region of sunlight.

5. Aerobic Soil _ Life: The time required for _ of the pesticide residue to lose its identity whether through dissipation, decomposition, or metabolic alteration in soil.

4. Results:

To assess whether there is an ecological concern from the pesticides used in the surrounding Smith River flood plain, risk quotient values were compared to the Level of Concern (LOCs) for endangered aquatic organisms. The GENEEC generated risk quotients or indicators of risk are shown for the five pesticides in the

non-soil fumigant category in Figure 30, which depicts the risk quotients in comparison to the level of concern. Based on a one-time application as entered into the GENEEC model, the resulting risk quotients exceed or meet the levels of concern for four of the five pesticides analyzed for each year between 1996 and 2000.

5. Discussion

Our findings of intensive pesticide use and its proximity to endangered salmonids prompted a Tier 1 aquatic risk estimation for five chemicals, carbofuran, chlorothalonil, diurin, disulfoton, and pentachloronitrobenzene. The Tier 1 assessment yielded risk quotients that exceeded or met EPA established levels of concern set for endangered aquatic organisms for four of the five chemicals examined for all years studied but one when a single pesticide, chlorothalonil did not meet the criteria

Overall, the GENEEC model is a good estimate of risk although it is still under evaluation at the federal level. The model only addresses one scenario — a one-time run-off event. It does not capture the cumulative risk of multiple applications nor the use of multiple chemicals within the particular area such as the Smith River floodplain.

GENEEC also fails to factor in site-specific considerations such as water temperature, pH, changes in precipitation, and climate. Toxicologically, GENEEC does not account for degradates of chemicals or its breakdown products. Inert

ingredients are also not considered. Volatilization and the effects of accumulation of chemicals, for example a persistent chemical like PCNB, is not captured when estimating risk.

The GENEEC model does not factor overall species distribution or density, or account for the numbers of organisms actually exposed, or the concentration and duration of exposure. Using an endpoint such as an LC_{50} may underestimate risk to endangered aquatic organisms from a regulatory standpoint. The lethality to even one organism (salmonids in this case) would violate the Endangered Species Act. Additional safety factors for the toxic endpoint may better correspond to protection policies. Furthermore, the risk quotient does not provide a definitive value for the amount of pesticide that will be available to fish or aquatic invertebrates. The actual amount of pesticide available will vary depending on application method, configuration and calibration of equipment, and specific field conditions.

6. Conclusion

This analysis provides clear and compelling evidence suggesting endangered and threatened species, particularly salmonids, are at an elevated risk of harm from existing agricultural pesticide practices on the Smith River flood plain. Specifically, based on the high level of concern values, the current intensity of pesticide activity within the 11-square-mile lily bulb cultivation region can reasonably be expected to endanger the health of recovering salmon species that use the estuary surrounding the flood plain as rearing and smoltification grounds.

7. Recommendations

Based on the findings of the Tier 1 assessment, the following recommendations are indicated:

1. **Because the species selected for study are federally listed as endangered and threatened under the Endangered Species Act, ecological mitigation and regulatory action is necessary.**
2. **A higher, more complex assessment (e.g.Tier 2) should be conducted for those chemicals that did not pass the first screening.**
3. **An independent review team should conduct a Tier 2 ecological assessment that would include actual residue testing in the estuary and critical run-off points, as well as a cumulative risk assessment of the chemicals exceeding the level of concern.**
4. **The further application of chemicals for lily bulb cultivation surrounding the Smith River estuary should only be conducted under the advisement of the EPA in consultation with the US Fish and Wildlife Service and the National Marine Fisheries Service.**
5. **Because the Smith River estuary is a significant recovery area for endangered salmonids, and a Tier 1 assessment yielded risks in excess of the levels of concern, all measures should be taken to reduce the intensity of pesticide use within the area and begin mandatory substitutions of less**

toxic materials including chemicals which are not toxic to fish and are not known to contaminate groundwater.

6. **The Environmental Protection Agency should develop a conservation and mitigation program for endangered aquatic organisms within the Smith River estuary considering acute, chronic, and sublethal effects of pesticides, degradates, and inerts on all of the life stages of endangered and threatened species.**

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Glossary of Terms

Acres treated—The actual amount of acres that are treated with a chemical versus the amount available for planting

Active ingredient—The chemical in a pesticide formulation that produces the pesticidal effect in the target species

Application rate- The pounds of active ingredient applied to acres per acre of crop treate

B2 Carcinogen- A list of chemicals are evaluated by the Environmental Protection Agency for carcinogenic potential. Those chemicals known to cause cancer in animals but not yet definitively shown to cause cancer in humans are called "probable human carcinogens. This is also known as a B2 carcinogen

EEC—An Estimated Environmental Concentration of active ingredient

LC50—The lethal concentration of a given active ingredient of a chemical needed to extinguish _ of the test population. Usually provided in milligrams/liter

GENEEC—An aquatic exposure estimation tool developed by the Environmental Fate and Effects Division of the Environmental Protection Agency. The model calculates a Generic Estimated Environmental Concentration

Koc—The carbon normalized soil/water equilibrium coefficient. This value represents a pesticide's ability to attach to soil

Level of Concern—Values established by the Environmental Protection Agency which provide criteria used to indicate potential risk to non-target organisms and the need to consider regulatory action

Non-point source pollutant—Pollution from sources that are diffuse which does not have any single point of origin or discharge, such as pollutants generally carried off land by run-off

Risk Quotient (RQ) – A value representing the ratio of the Estimated Environmental Concentration of a particular chemical to the toxicity test effect (in this case the LC50). The equation describes the chemicals likeliness of occurrence in water

Tier 1—The first of a series of screening tools providing an assessment of whether acute or chronic concentrations may be of concern to an ecosystem

Water solubility—The maximum concentration of a chemical that dissolves in pure wate at a specific temperature and pH

Appendix A: Smith River Floodplain Pesticide Toxicological Assessment

Chemical/ CAS#	**Category**	**Half –life**	**MCL**	**RfD** Mg/kg/day	**LD_{50}** Mg/kg	**LC_{50} (A)** mg/L	**LC_{50} (B)** Mg/L
1,3-D 542-75-6	B2	3->69 days	5ppb	**.0025**	640	3.9	1.8 (bluegill)
Metam Sodium [TF] **137-42-8**	**B2, Class I**	N/a	400 ppb	285	N/a	N/a	N/a
Chlorothalonil [TF] **1897-45-6**	B2, Class II, OC	**200 days**	.5[b]	**.015**	10,000	**.25**[c]	**.25 (rainbow trout)**
Carbofuran [GW] **1563-66-2**	**Class I, CB**	**30-120 days**	.04	**.005**	**5-13**	1.3	1.3 (rainbow trout)
Diuron [GW] **330-54-1**	Class III	**30 days- 3 years**	N/A	**.002**	3400	3.5	1-2.5 (aquatic inv.)
Disulfoton [TF, GW] **298-04-4**	**Class I, OP**	30 –90 days	N/A	**.00004**	**1.9-2.5**	1.85	**.038** (bluegill)
PCNB [TF, GW]	Class III, OC	**>365 days**	N/A	**.003**	1650	.55	.55 (rainbow trout)
Chloropicrin 76-06-2	**Class I**	4 days	N/A	N/A	N/a	**.0165**	**.105** (bluegill)
Methyl Bromide 74-83-9	**B2,Class I**	30-60 days	N/A	**.0014**	214	11	11

Bold indicates toxicological criteria of high environmental and human health concern.

LC_{50} (A) = Salmonid most comparable species, Rainbow Trout 96 hour

LC_{50} (B) = Most sensitive species

[GW] = high potential for groundwater contamination

[TF] = May contaminate surface water, highly toxic to fish

[B] Health advisory

[C] fish are noticeably affected when levels are low (less than 1mg/L)

2000

	T	K	DN	SRFP	T	K	DN	SMFP	T	K	DN	SRFP	T	K	DN	SRFP	T	K	DN	SRFP
1,3-D	263	92	331	332	259	121	330	331	255	87	322	320	334	104	333	330	253	90	321	320
Chloropicrin	5	2	40	40	7	3	32	34	3	2	16	17	2	10	26	28	4	30	42	47
Metam Sodium	60	42	291	307	95	67	308	307	69	116	316	316	70	78	324	329	80	67	318	318
Chlorothalonil	2	2	1	.96	2	1	1	1	2	2	1	1	2	2	1	1	2	2	1	1
Carbofuran	1.1	1	2.7	2.8	1	n/a	2	2	.5	.5	2	2.2	.3	.3	3	3	.5	.3	2	1.5
Diuron	2	1	2	1.4	1	.5	1	1.26	1	1	1	1.3	1	.3	1	1	1	1	1	1
Disulfoton	1	1	7	7.5	1	1	7	7.2	1	1	7	6.6	1	1	7	7.26	1	1	8	8
Pentachloro-nitrobenzene	[T]57	[T]1	.5	6.8	[T]n/a	[T]6	14	10.6	1	[T]1	8	7.6	1	2	11	15	1	[T]1	[T]12	12.5
Methyl Bromide	279	167	323	324	312	193	264	256	56	179	270	259	169	223	297	292	150	232	294	300

Figure 1: Pounds of Active Ingredient Per Treated Acre by County/Area & Year (1996-2000)

<u>Counties</u>:
T= Tulare
K=Kings
DN= Del Norte
SMFP = Smith River flood plain

[T]Unit type provided in Tons of Commodity Treated, line(s) omitted in calculation

Figure 2: 1,3-D Pounds Active Ingredient Per Acre Treated 1996-2000

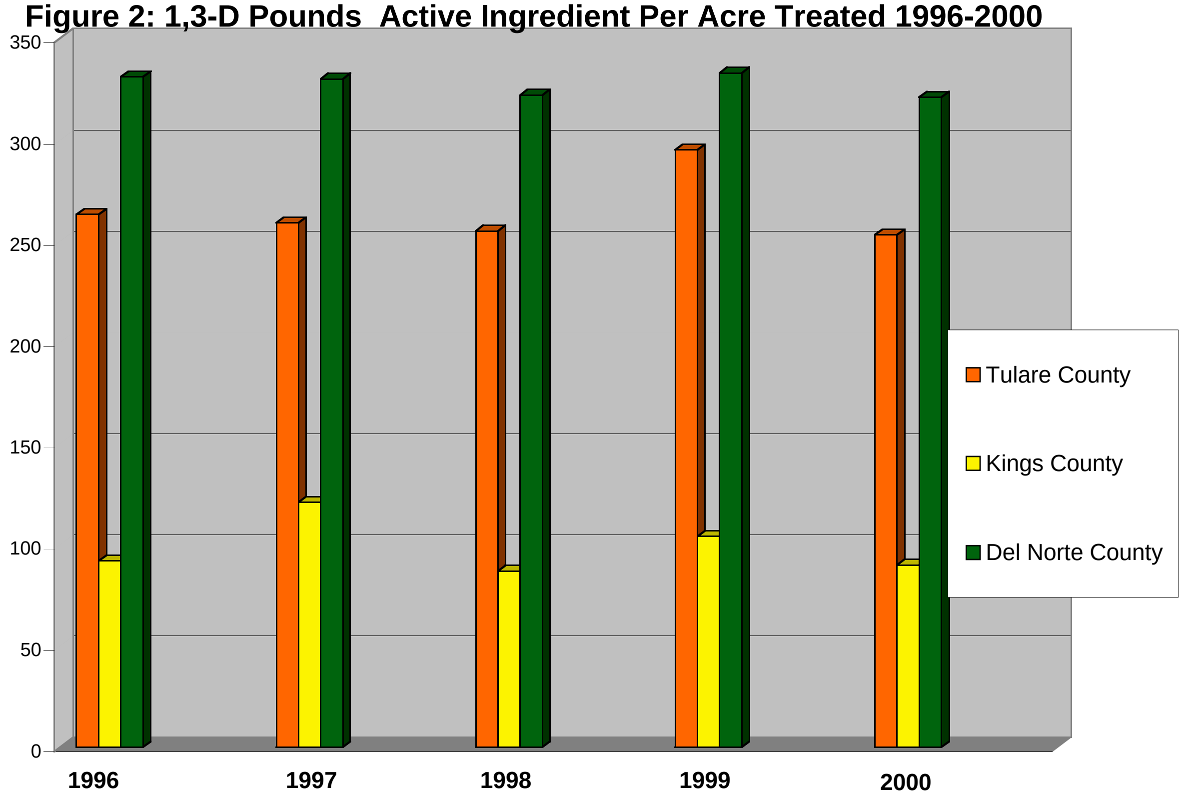


Figure 3: Chloropicrin Pounds Active Ingredient Per Acre Treated, 1996-2000

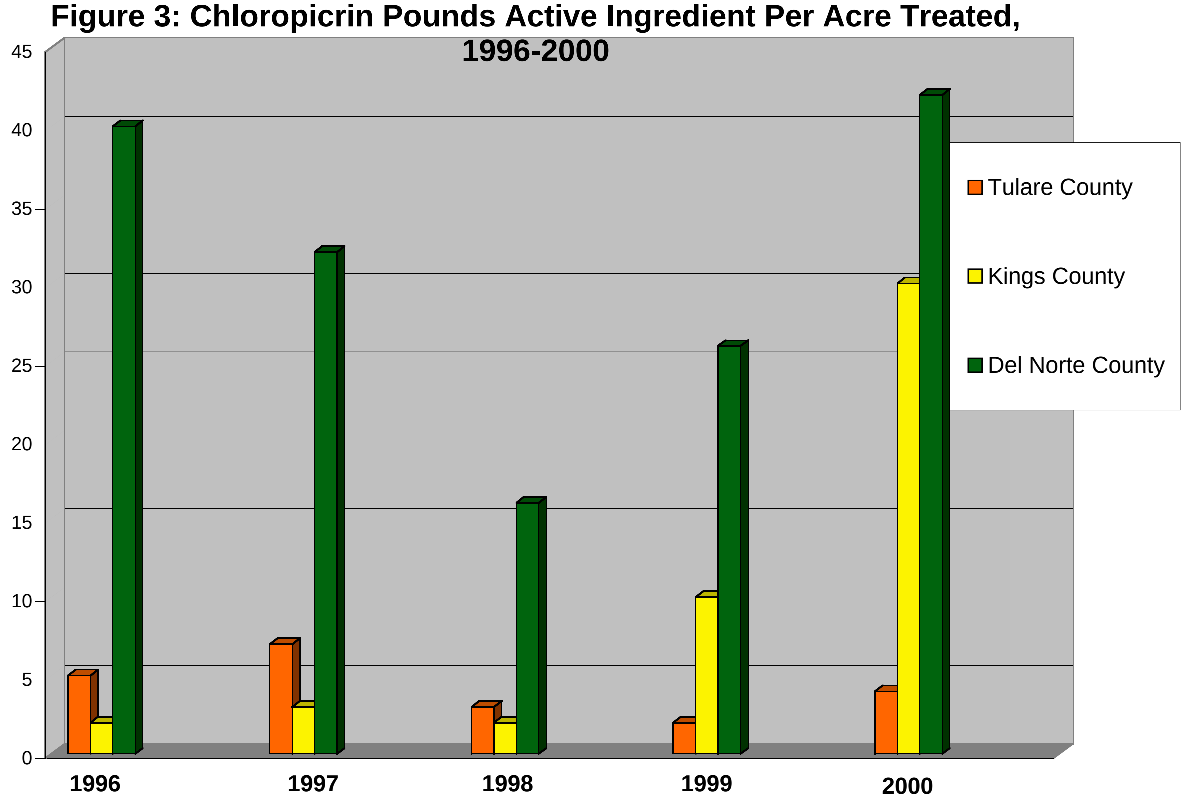


Figure 4: Metam Sodium; Pounds Active Ingredient Per Acre Treated, 1996-2000

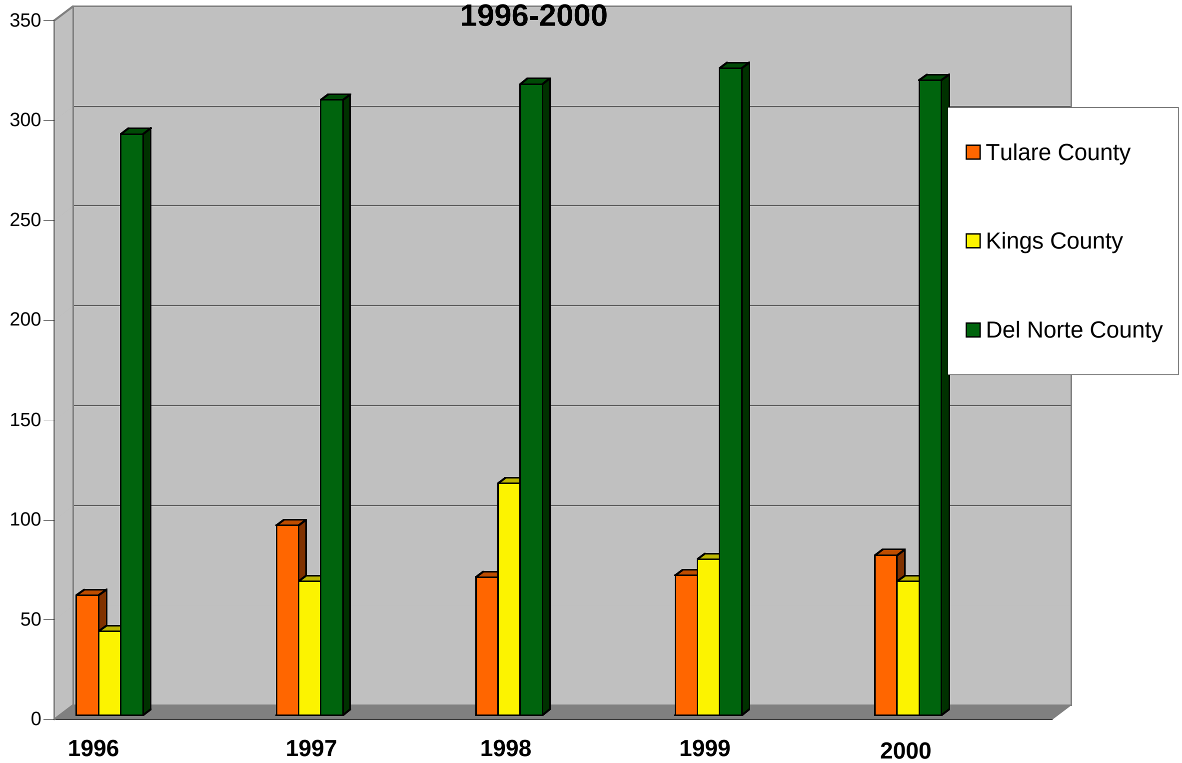


Figure 5: Chlorothalonil Pounds Active Ingredient Per Acre Treated, 1996-2000

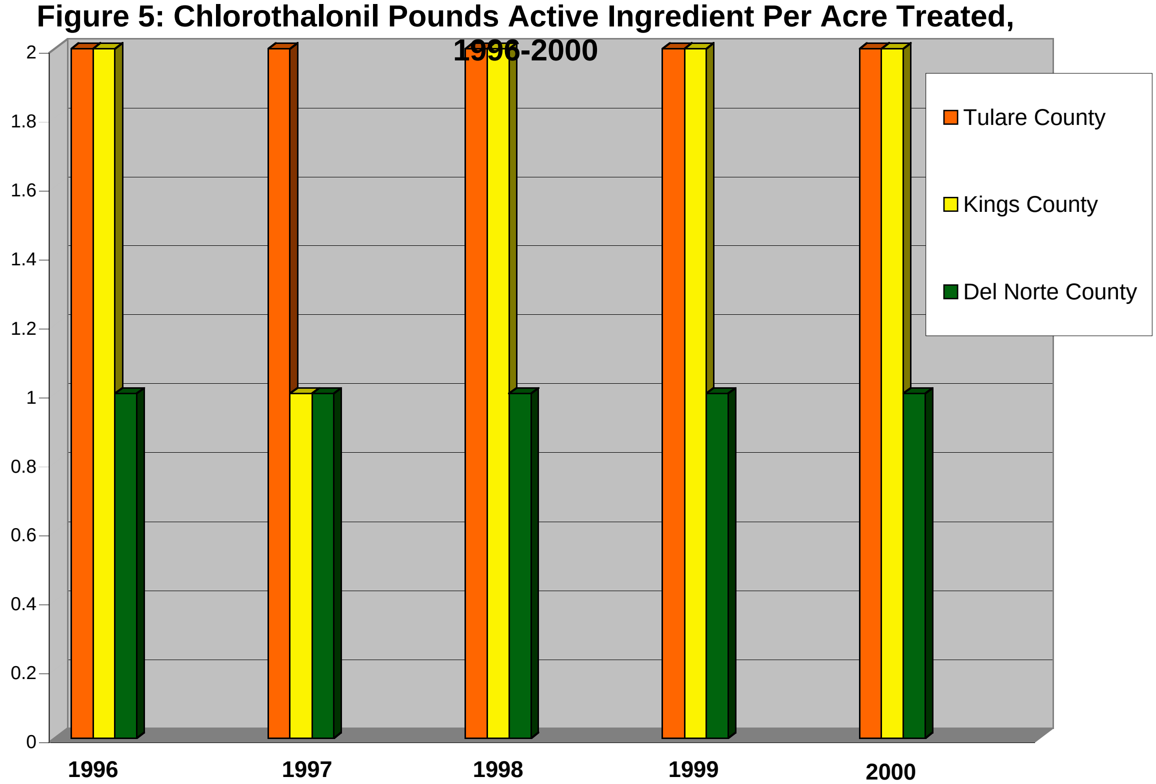


Figure 6: Carbofuran Pounds Active Ingredient Per Acre Treated, 1996-2000

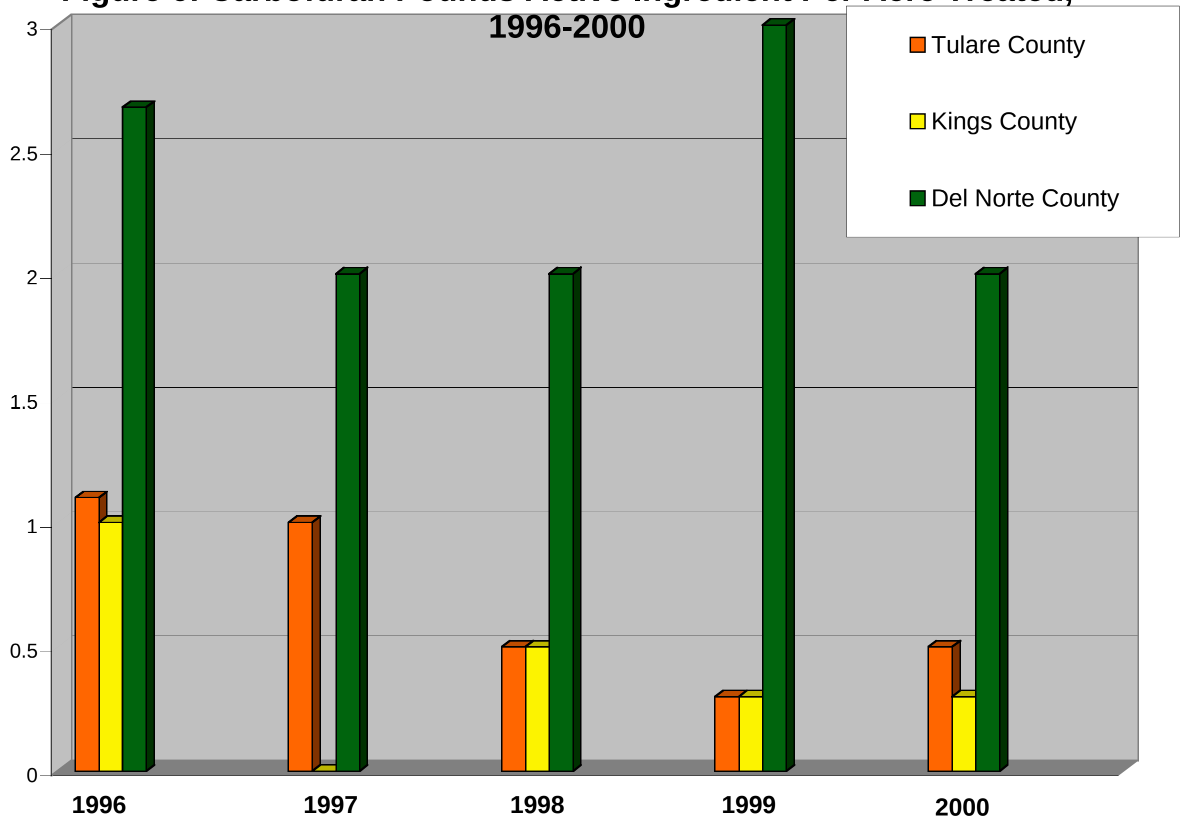


Figure 7: Diuron Pounds Active Ingredient Per Acre Treated, 1996-2000

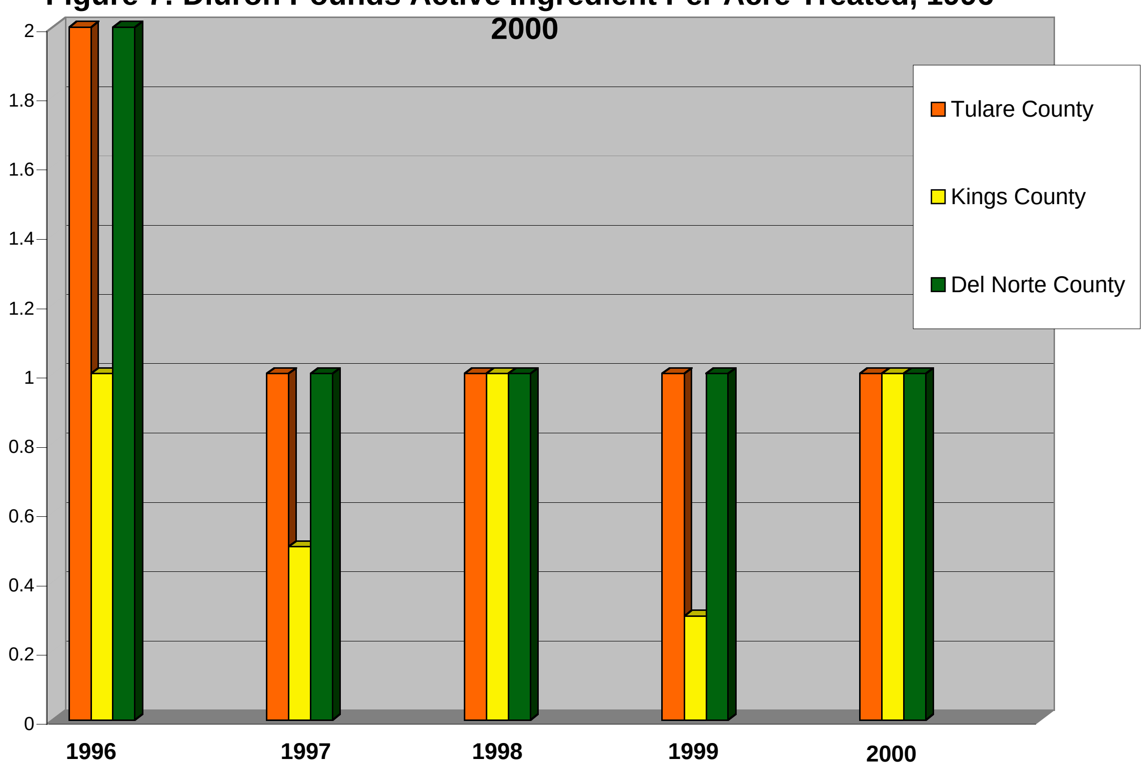


Figure 8: Disulfoton Pounds Active Ingredient Per Treated Acre, 1996-2000

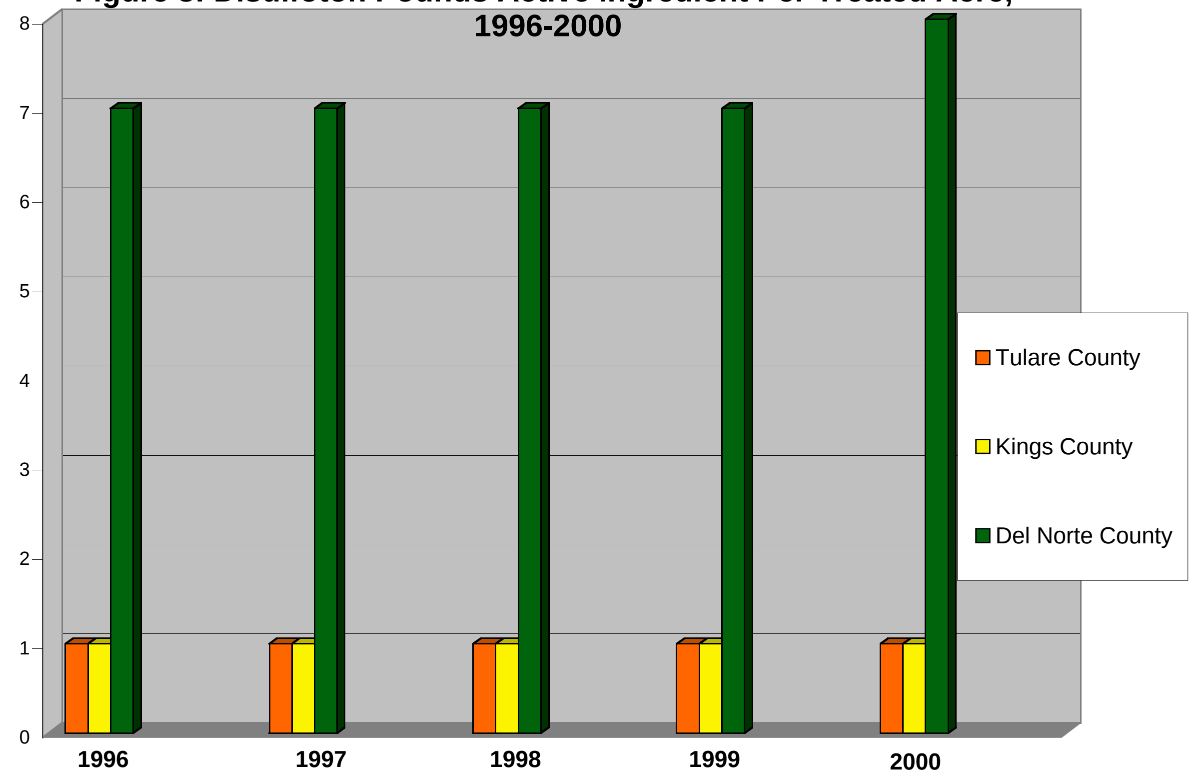


Figure 9: PCNB Pounds Active Ingredient Per Acre, 1996-2000

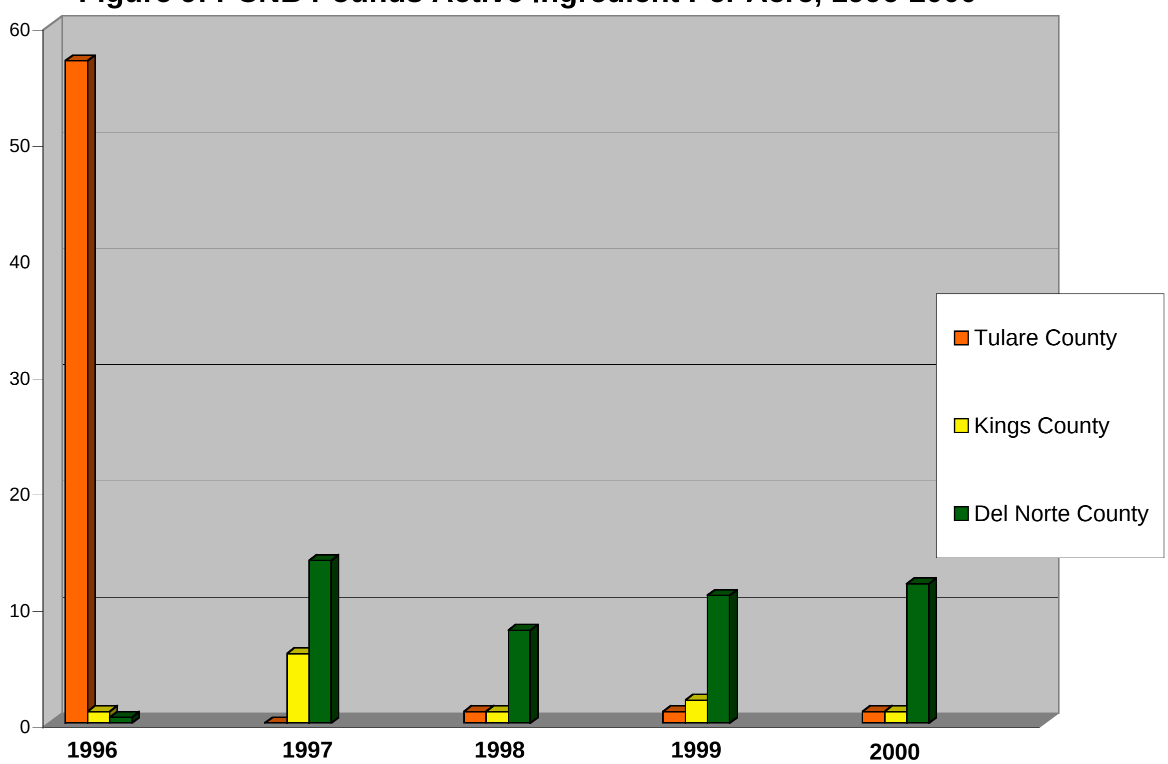


Figure 10: Methyl Bromide Pounds Active Ingredient Per Acre Treated, 1996-2000

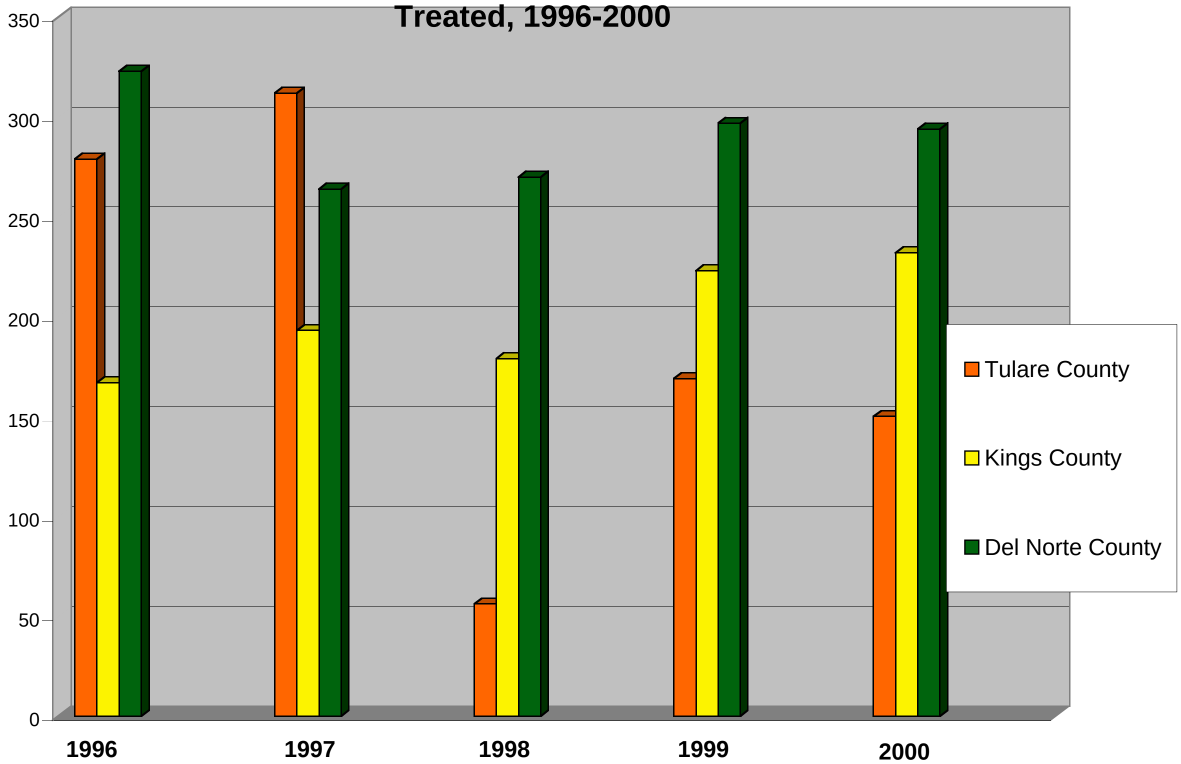


Figure 11: 1996 Pounds of Chemical Used, Smith River Flood Plain

MTRS									
	1,3-D	Metam Sodium	Chlorothalonil	Carbofuran	Diuron	Disulfoton	Pentachloro-nitrobenzene	Chloropicrin	Methyl Bromide
17NO1W01	3328	9306	N/A	N/A	91	N/A	N/A	N/A	N/A
17N01W02	N/A	8175	822	237	63	N/A	N/A	411	1244
17N01W03	N/A	N/A	113	N/A	17	N/A	N/A	N/A	N/A
18N01W21	N/A	13,832	1070	231	180	N/A	N/A	204	5659
18N01W22	N/A	6825	2794	747	241	N/A	N/A	872	5371
18N01W23	N/A	2932	142	57	15	N/A	N/A	N/A	N/A
18N01W26	N/A	10,066	884	359	193	127	N/A	425	6439
18N01W27	1892	20,625	1825	615	270	N/A	65	2140	9394
18N01W35	N/A	4594	1100	69	181	N/A	N/A	695	7085
TOTAL	5220	76,355	8750	2315	1241	127	65	4747	35,192

Figure 12: 1997 Pounds of Chemical Used, Smith River Flood Plain

MTRS									
	1,3-D	Metam Sodium	Chlorothalonil	Carbofuran	Diuron	Disulfoton	Pentachloro-nitrobenzene	Chloropicrin	Methyl Bromide
17NO1W01	N/A	3209	763	98	47	N/A	N/A	N/A	N/A
17N01W02	N/A	5685	726	154	54	N/A	N/A	266	1578
17N01W03	N/A	N/A	1343	N/A	62	N/A	146	1264	2590
17N01W11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
18N01W21	2152	23,630	1156	289	209	N/A	N/A	12	2426
18N01W22	4456	7112	874	185	195	179	N/A	1563	15,519
18N01W23	N/A	N/A	275	29	7	N/A	N/A	N/A	N/A
18N01W26	N/A	10,380	727	169	140	48	N/A	917	9444
18N01W27	1527	23,063	1362	247	192	N/A	52	1969	6593
18N01W28	N/A	N/A	455	N/A	39	8	N/A	N/A	N/A
18N01W35	1821	7062	935	83	158	N/A	N/A	38	7623
TOTAL	9956	80,141	8616	1254	1103	235	198	6029	45,803

Figure 13: 1998 Pounds of Chemical Used, Smith River Flood Plain

MTRS	1,3-D	Metam Sodium	Chlorothalonil	Carbofuran	Diuron	Disulfoton	Pentachloro-nitrobenzene	Chloropicrin	Methyl Bromide
17NO1W01	N/A	N/A	169	21	36	90	N/A	20	3990
17N01W02	936	11,261	410	80	143	36	N/A	10	2069
17N01W03	N/A	N/A	1364	N/A	66	N/A	180	1468	3008
18N01W21	N/A	19,548	2311	263	333	42	N/A	24	4728
18N01W22	2398	8657	1243	157	203	N/A	N/A	386	4412
18N01W23	N/A	N/A	N/A	N/A	12	N/A	N/A	N/A	N/A
18N01W26	10,437	11,341	1003	134	174	125	N/A	277	6277
18N01W27	9487	18,433	1744	200	399	140	24	549	8280
18N01W28	N/A	N/A	73	4	10	N/A	N/A	N/A	N/A
18N01W35	7432	8759	1135	91	142	N/A	N/A	49	9790
TOTAL	30,690	77,999	9452	950	1518	433	204	2783	42,554

Figure 14: 1999 Pounds of Chemical Used, Smith River Flood Plain

MTRS									
	1,3-D	Metam Sodium	Chlorothalonil	Carbofuran	Diuron	Disulfoton	Pentachloro-nitrobenzene	Chloropicrin	Methyl Bromide
17NO1W01	N/A	2438	97	N/A	35	N/A	N/A	N/A	N/A
17N01W02	1735	14,563	1041	262	103	46	N/A	1878	1059
17N01W03	N/A	N/A	1944	N/A	53	N/A	240	2863	5866
17N01W11	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17N01W12	N/A	N/A	46	N/A	N/A	N/A	N/A	N/A	N/A
18N01W21	N/A	18,177	1391	205	204	161	N/A	16	3244
18N01W22	6916	7135	724	95	225	374	N/A	87	17,338
18N01W23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
18N01W26	5689	11,798	564	54	155	295	N/A	401	8887
18N01W27	8694	19,378	2234	726	262	380	43	261	12,785
18N01W35	7906	7928	980	N/A	141	465	N/A	1255	13,326
TOTAL	31,020	81,417	9021	1342	1178	1721	283	6761	62,505

Figure 15: 2000 Pounds of Product Used, Smith River Flood Plain

MTRS	1,3-D	Metam Sodium	Chlorothalonil	Carbofuran	Diuron	Disulfoton	Pentachloro-nitrobenzene	Chloropicrin	Methyl Bromide
17NO1W01	2749	2565	82	23	48	161	N/A	1	211
17N01W02	2192	3207	632	171	134	259	N/A	799	2130
17N01W03	N/A	N/A	1421	N/A	56	N/A	217	5147	5147
17N01W12	N/A	1924	81	N/A	N/A	N/A	N/A	2403	516
18N01W21	9781	13,465	857	211	319	638	N/A	8	1635
18N01W22	9785	15,317	1385	113	174	142	N/A	40	7946
18NO1W23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
18N01W26	9255	7785	600	132	237	450	N/A	815	13,750
18N01W27	14,383	337	1278	196	321	746	22	256	6763
18N01W28	N/A	N/A	N/A	N/A	9	N/A	N/A	N/A	N/A
18N01W35	1959	5771	1082	9	99	407	N/A	64	12,767
TOTAL	50,104	50,371	7418	855	1397	2803	239	9533	50,865

Figure 16: 1,3-D Pound Usage, Contribution of Use in the Smith River Flood Plain to Total for Del Norte County

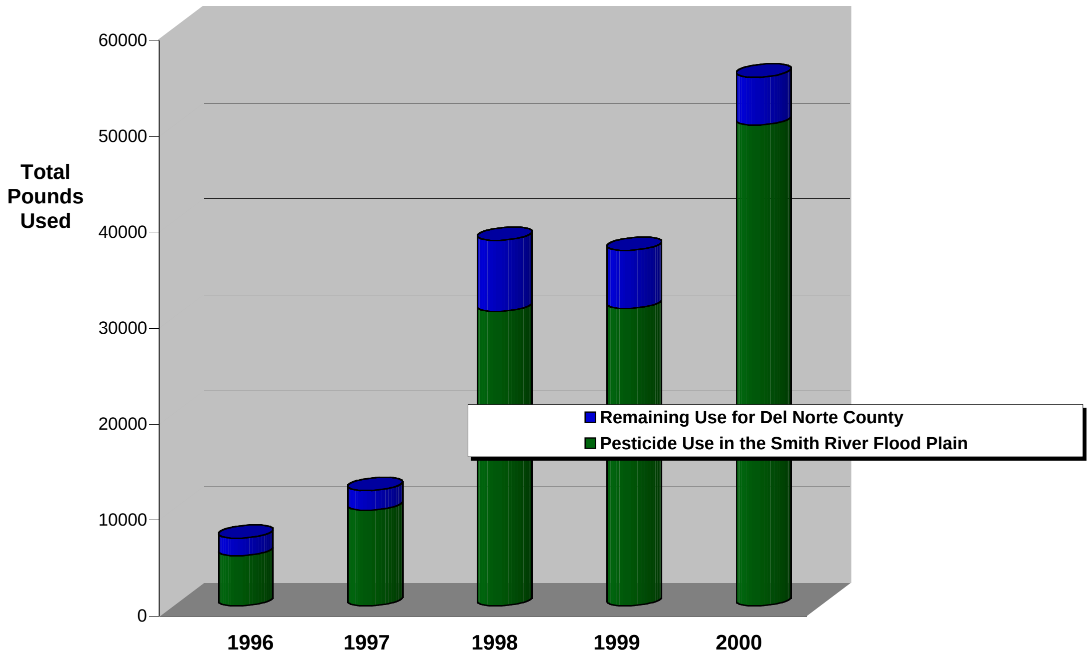


Figure 17: Chloropicrin Pound Usage, Contribution of Use in the Smith River Flood Plain to the Total for Del Norte County

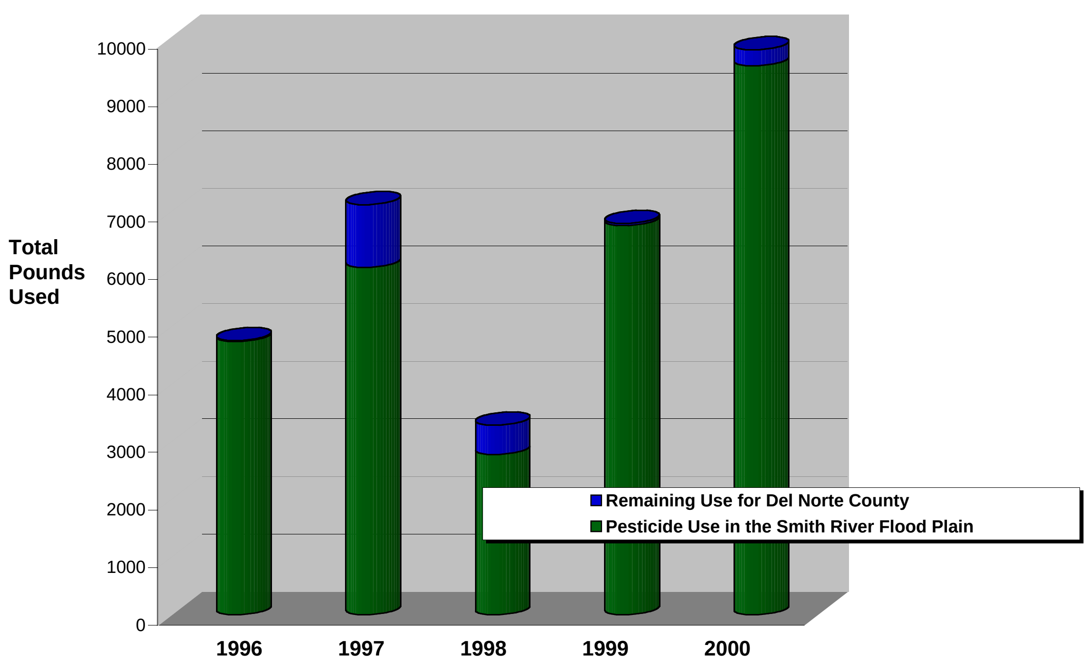


Figure 18: Metam Sodium Pound Usage, Contribution of Use in the Smith River Flood Plain to Total for Del Norte County

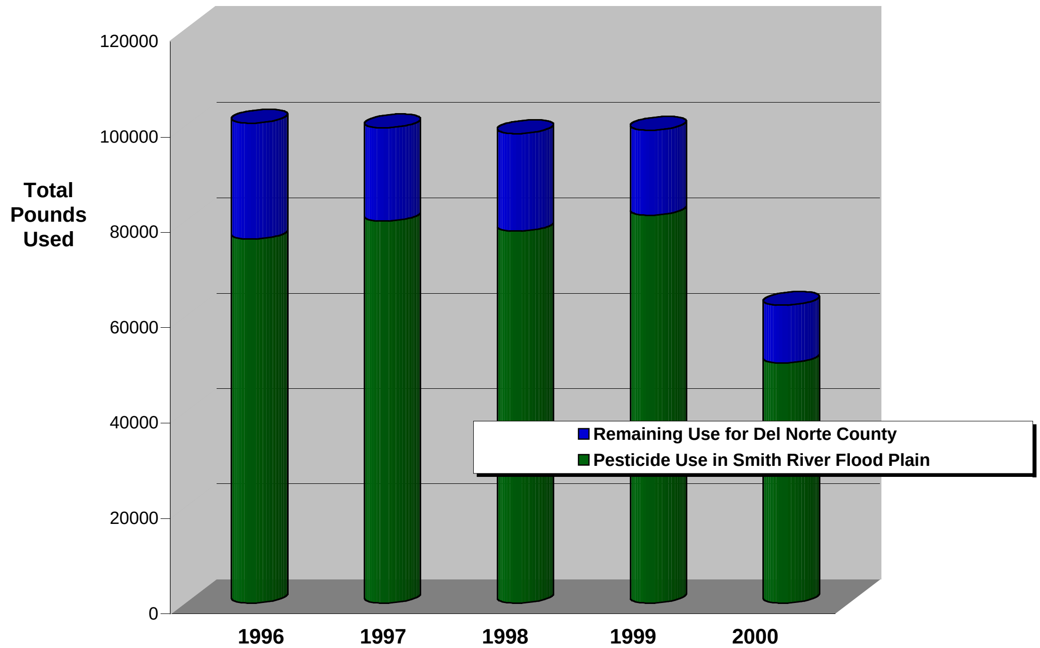


Figure 19:Chlorothalonil Pound Usage, Contribution of use in the Smith River Flood Plain to Total for Del Norte County

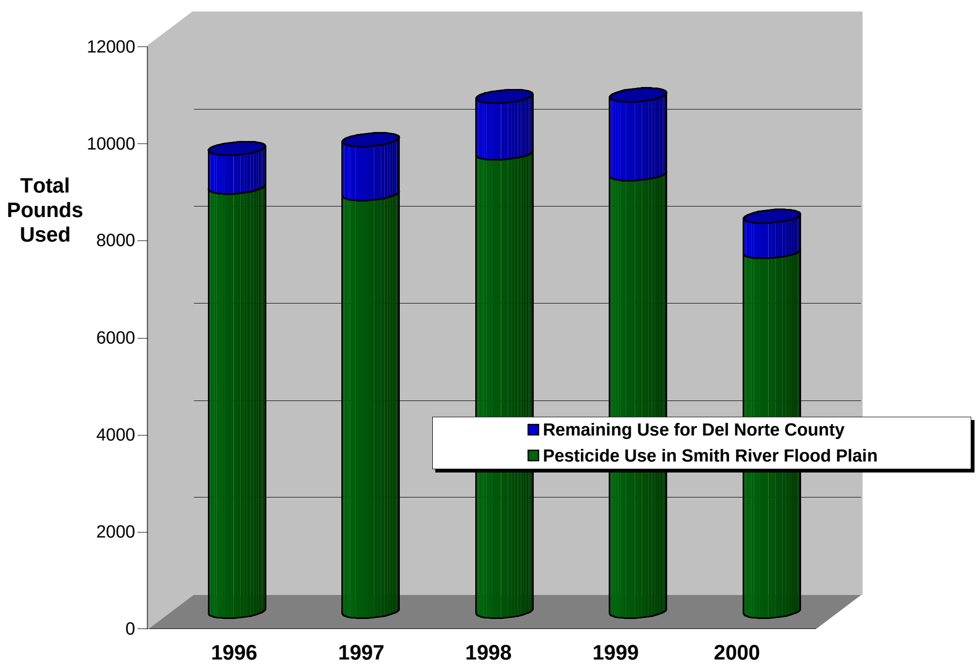


Figure 20: Carbofuran Pound Usage, Contribution of use in Smith River Flood Plain to the Total for Del Norte County

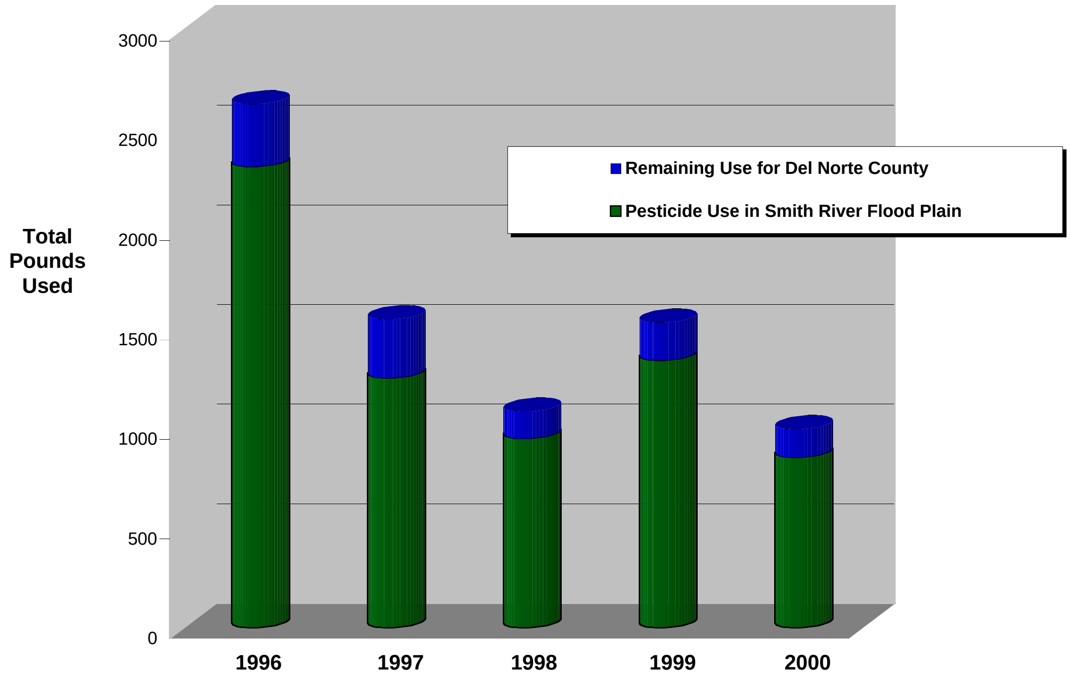


Figure 21: Diuron Pound Usage, Contribution of use in the Smith River Flood Plain to the Total for Del Norte County

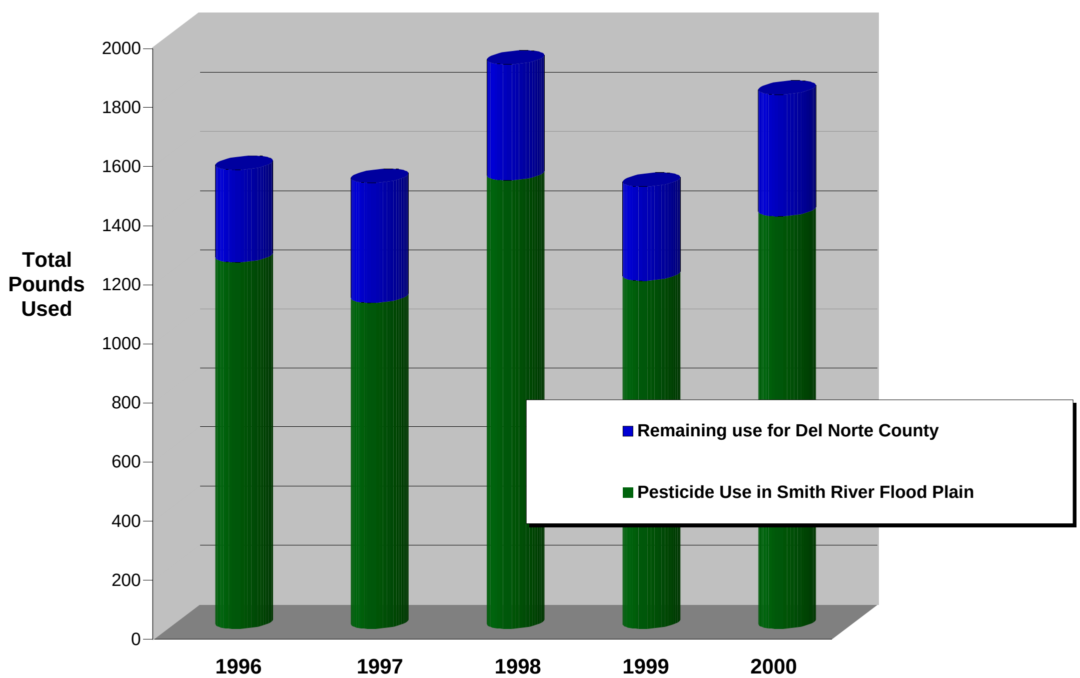


Figure 22: Disulfoton Pound Usage, Contribution of Use in the Smith River Flood Plain to Total for Del Norte County

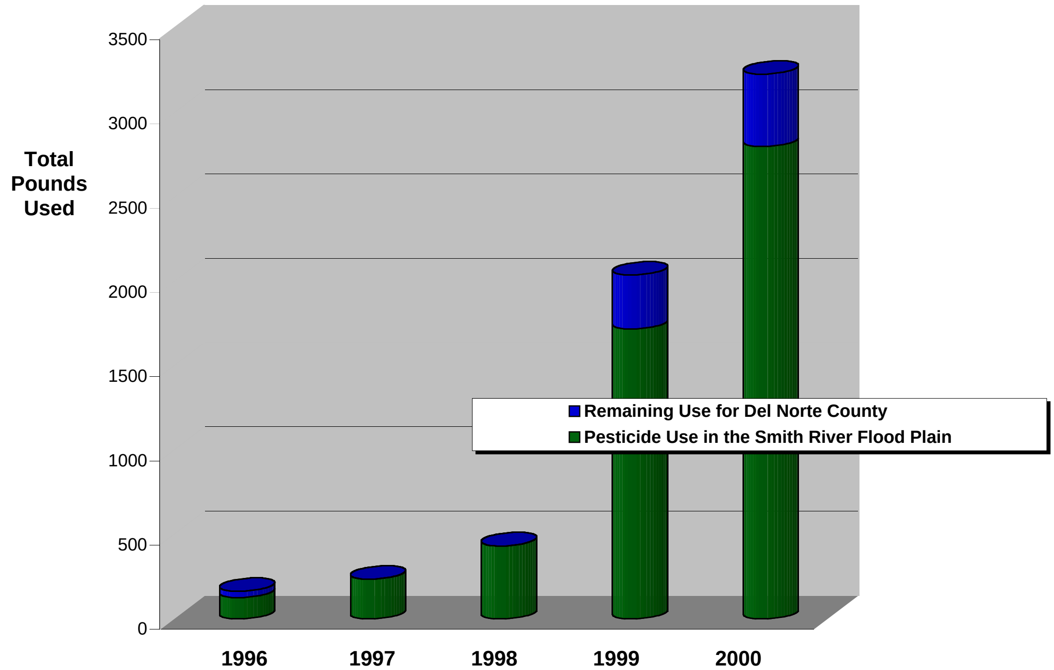


Figure 23: Pentachloronitrobenzene (PCNB) Pound Usage, Contribution of Use in the Smith River Flood Plain to Total for Del Norte County

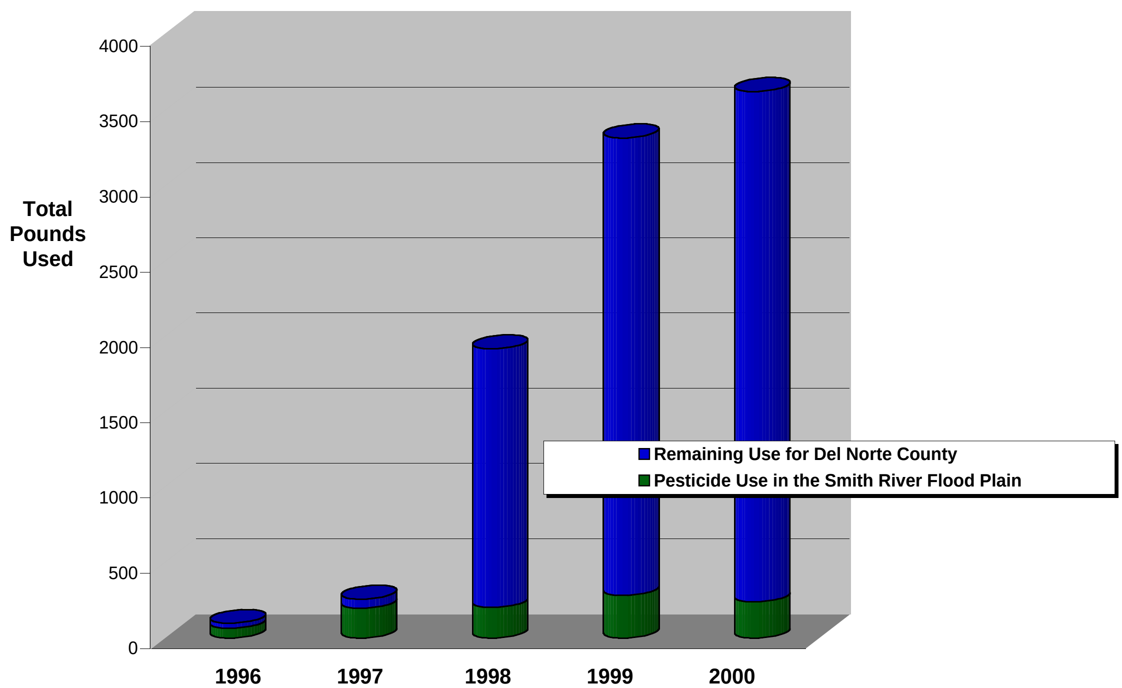
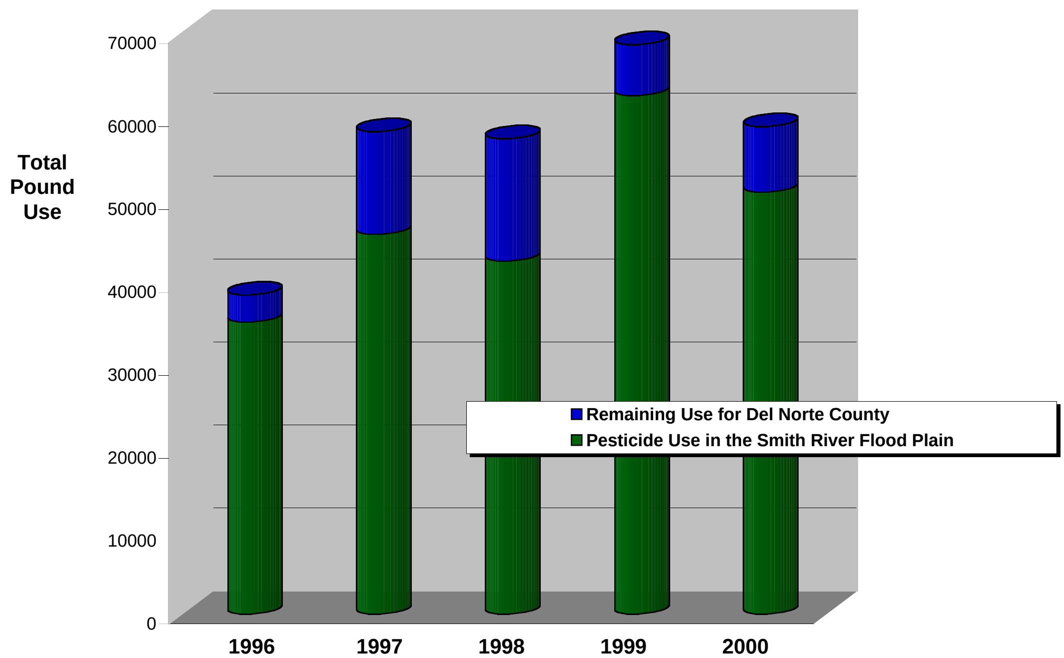


Figure 24: Methyl Bromide Pound Usage, Contribution of Use in the Smith River Flood Plain to the Total for Del Norte County



Chemical	Pounds Chemical Used	Acres Treated	Average Application Rate	Koc/ Kd	Photolysis _ Life/ Days	Aerobic Soil _ Life/days	Water Solubility Mg/L	Peak EEC (ppm)	LC_{50} Rainbow Trout, mg/liter	Acute Risk Quotient EEC/LC_{50}
Chlorothalonil	8749	9141	.96	1800	.01	60	.6	.012	.25	.05
Carbofuran	2315	828	2.8	29.3	.25	42	320	.144	1.3	.111
Diuron	1241	918	1.4	383	60	330	36.4	.047	3.5	.014
Disulfoton	127	17	7.5	740	.25	21	25	.182	1.85	.098
PCNB	65	9.48	6.8	20,000	3	434	.44	.031	.55	.056

Figure 25: 1996 Tier I Calculations for Acute Risk Quotients (RQ)

Bold indicates levels are above the Level of Concern (LOC) for Acute Endangered Aquatic Animals (.05 ppm)

Chemical	Pounds Chemical Used	Acres Treated	Average Application Rate	Koc/ Kd	Photolysis _ Life/Days	Aerobic Soil _ Life/days	Water Solubility Mg/L	Peak EEC (ppm)	LC_{50} Rainbow Trout Mg/L	Acute Risk Quotient EEC/LC_{50}
Chlorothalonil	8615	8035	1.07	1800	.01	60	.6	.003	.25	.012
Carbofuran	1254	658	2	29.3	.25	42	320	.103	1.3	.079
Diuron	1103	869	1.26	383	60	330	36.4	.042	3.5	.012
Disulfoton	235	32.4	7.25	740	.25	21	25	.175	1.85	.095
PCNB	199	18.7	10.6	20,000	3	434	.44	.049	.55	.089

Figure 26: 1997 Tier I Calculations for Acute Risk Quotients

Bold indicates levels are above the Level of Concern (LOC) for Acute Endangered Aquatic Animals (.05 ppm)

Chemical	Pounds Chemical Used	Acres Treated	Average Application Rate	Koc/ Kd	Photolysis _ Life/Days	Aerobic Soil _ Life/days	Water Solubility Mg/L	Peak EEC (ppm)	LC_{50} Rainbow Trout Mg/L	Acute Risk Quotient EEC/LC_{50}
Chlorothalonil	**9451**	**9712**	**1**	**1800**	**.01**	**60**	**.6**	**.013**	**.25**	**.052**
Carbofuran	**950**	**422**	**2.25**	**29.3**	**.25**	**42**	**320**	**.116**	**1.3**	**.089**
Diuron	**1518**	**1171**	**1.3**	**383**	**60**	**330**	**36.4**	**.044**	**3.5**	**.013**
Disulfoton	**433**	**64.9**	**6.67**	**740**	**.25**	**21**	**25**	**.161**	**1.85**	**.087**
PCNB	**204**	**27**	**7.61**	**20,000**	**3**	**434**	**.44**	**.035**	**.55**	**.064**

Figure 27: 1998 Tier I Calculations for Acute Risk Quotients (RQ)

Bold indicates levels are above the Level of Concern (LOC) for Acute Endangered Aquatic Animals (.05 ppm)

Chemical	Pounds Chemical Used	Acres Treated	Average Application Rate	Koc/ Kd	Photolysis _ Life/Days	Aerobic Soil _ Life/days	Water Solubility Mg/L	Peak EEC (ppm)	LC_{50} Rainbow Trout Mg/liter	Acute Risk Quotient EEC/LC_{50}
Chlorothalonil	8991	8750	1.03	1800	.01	60	.6	.013	.25	.052
Carbofuran	1342	422	3.2	29.3	.25	42	320	.165	1.3	.127
Diuron	1178	1147	1.027	383	60	330	36.4	.035	3.5	.01
Disulfoton	1721	237	7.26	740	.25	21	25	.176	1.85	.095
PCNB	283	25	15	20,000	3	434	.44	.068	.55	.123

Figure 28: 1999 Tier I Calculations for Acute Risk Quotients (RQ)

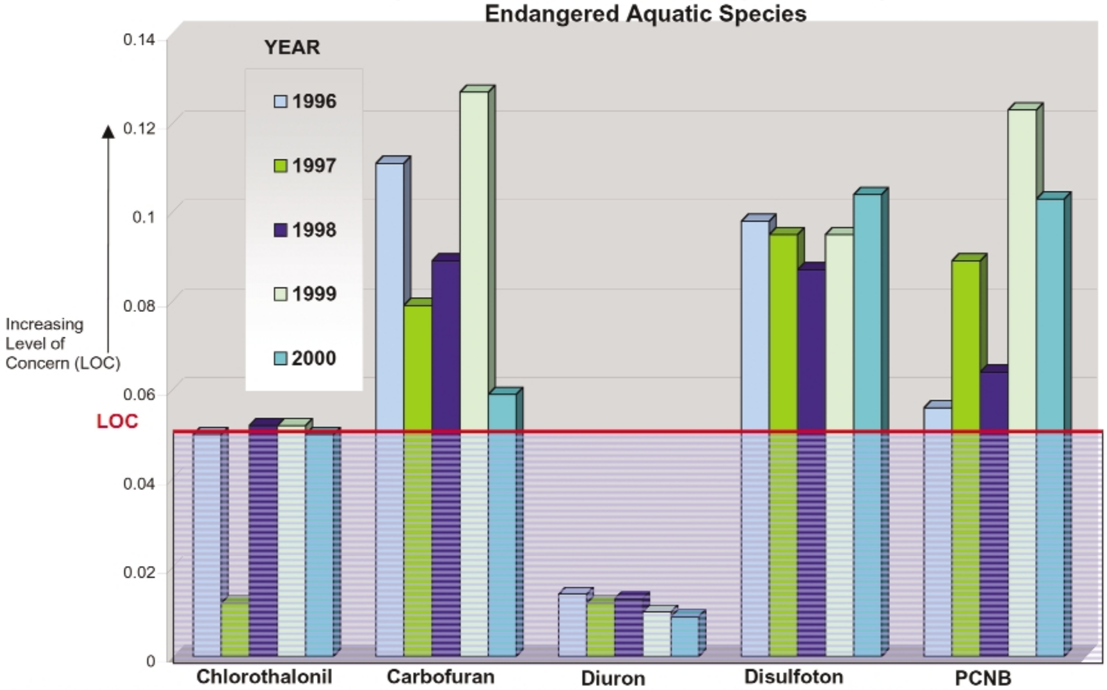
Bold indicates levels are above the Level of Concern (LOC) for Acute Endangered Aquatic Animals (.05 ppm)

Chemical	Pounds Chemical Used	Acres Treated	Average Application Rate	Koc/Kd	Photolysis _Life/ Days	Aerobic Soil _ Life/days	Water Solubility Mg/L	Peak EEC (ppm)	LC_{50} Rainbow Trout Mg/Liter	Acute Risk Quotient EEC/LC_{50}
Chlorothalonil	7647	7417	.97	1800	.01	60	.6	.012	.25	.05
Carbofuran	855	537	1.5	29.3	.25	42	320	.077	1.3	.059
Diuron	1397	1166	1	383	60	330	36.4	.034	3.5	.009
Disulfoton	2803	347	8	740	.25	21	25	.194	1.85	.104
PCNB	239	19	12.5	20,000	3	434	.44	.057	.55	.103

Figure 29: 2000 Tier I Calculations for Acute Risk Quotients(RQ)

Bold indicates levels are above the Level of Concern (LOC) for Acute Endangered Aquatic Animals (.05 ppm)

Figure 30: Level of Concern (LOC)* for Toxicity to Endangered Aquatic Species



*EPA Established Level of Concern based on Standard Evaluation Procedure for Ecological Risk Assessment, # 540/09-86/167,1986