Appendix H. Lake Davis, CA, Rotenone Application

The information contained in this summary was provided by the California Department of Fish and Game (California Department of Fish and Game, 1999). In October 1997, the California Department of Fish and Game treated Lake Davis in Plumas County, California, with rotenone to eliminate introduced Northern pike (*Esox lucius*) that was considered a predatory fish, potentially threatening indigenous salmonids and other threatened and endangered fish species in the Sacramento-San Joaquin Delta (personal communication: Brian Finlayson, California Department of Fish and Game 2005). Located at an elevation of 5,775 ft above mean sea level, Lake Davis is a 4,026 acre (1,619 ha) impoundment of Big Grizzly Creek, a tributary to the Middle Fork Feather River. The reservoir has a maximum depth of 108 ft (33 m) and a mean depth of 20.5 ft (6.3 m) (Lee, 2001). The reservoir is classified as meso-eutrophic based on growing season inorganic nitrogen concentration (Lee, 2001).

From October 15 - 16, 1997, the Lake Davis and its tributaries (Grizzly, Freeman and Cow Creeks) were treated with two formulations of rotenone, *i.e.*, 64,000 lbs of powdered ProNoxfish (7.1% a.i.; EPA Registration No. 432-829) and 15,785 gallons of a synergized liquid formulation Nusyn-Noxfish (2.5% a.i.; EPA Registration No. 432-550) to maintain a desired treatment concentration. The liquid formulation used piperonyl butoxide as a synergist.

Rotenone concentrations were measured within and surrounding the treatment area. The data suggest that initially rotenone was not equally distributed through the water column; this is consistent with the reservoir having an average depth of roughly 20 feet. The deepest portion of the reservoir initially had the lowest concentration of rotenone but as time progressed, concentrations became relatively evenly distributed throughout the reservoir. Rotenone concentrations declined to roughly 50% of peak by five days post-treatment and were below levels of detection by 48 days post-treatment.

Maximum mean rotenone concentrations in the deepest portion of the reservoir near the dam did not demonstrate the extent of decline seen in other areas of the reservoir. Rather, rotenone concentrations remained relatively constant from 1 to 13 days post-treatment. However, like other areas in the reservoir, rotenone residues dropped below levels of detection by 39 days post-treatment.

As rotenone concentrations declined in the reservoir between days 1 to 39 post-treatment, the concentration of rotenone's primary degradate, rotenolone, increased from days 1 to 13 post-treatment. Concentrations of rotenolone started to decline by Day 20 post-treatment.

One of the greatest sources of controversy regarding Lake Davis treatment with rotenone involved the inerts associated with the formulated product. **Table I.1** lists inerts measured in the formulated product; although trichloroethylene was reported to be of particular concern, it was measured at concentrations well below other volatile organic compounds. Trimethylbenzene and xylene were the volatile organic compounds measured in the highest concentrations; trimethylbenzene was highest at 3 days post-treatment. By 5 days post-treatment, all of the monitored volatile organic compounds had fallen below detection limits.

Table I.1. List of inerts associated with formulated rotenone applied to Lake Davis, California, October 15 - 16, 1997 (Source: California Department of Fish and Game, 1999).	
Chemical Class	**Chemical**
Volatile Organic Compounds	
	Trichloroethylene
	Xylene
	Toluene
Semi-volatile Organic Compounds	
	2-methyl naphthalene
	1-methyl naphthalene
	Naphthalene
	ethyl benzene
Nonvolatile Organic Compounds	
	piperonyl butoxide
	benzoic acid

Based on analyses of the formulated product prior to application, naphthalene made up a large percentage of the semi-volatile organic compounds and was still being detected in the reservoir several weeks post-treatment. The semi-volatile compound 2-methyl naphthalene was highest the day after treatment. Even by 6 days post-treatment, 2-methyl naphthalene concentrations were detected.

Piperonyl butoxide was the synergist used in the liquid formulation. Residues of the synergist were still detected roughly four months after application of the rotenone. Concentrations of piperonyl butoxide declined to below the level of detection by after about 7 months post treatement.

Potassium permanganate ($KMnO_4$) was used to detoxify the rotenone in the outflow through Grizzly Valley dam into Big Grizzly Creek. Rotenone concentrations at the potassium permanganate treatment site (rotenone detoxification area) on Big Grizzly Creek peaked three days post-treatment. Rotenone was detected at the detoxification station up until mid November. Downstream of the detoxification station, rotenone residues dropped to below levels of detection until late October when residues were again detected for three consecutive days. According to the report, the spike in rotenone at this time and location resulted from insufficient potassium permanganate being added to deactivate the rotenone.

Rotenone concentrations in the sediment (•g/kg dry weight) peaked 14 days post-treatment then declined rapidly to below the level of detection by 33 days post-treatment. Residues of rotenolone were similarly detected in sediment until 33 days post-treatment after which time rotenolone concentrations dropped below levels of detection.

Similar to water column, 2-methyl naphthalene represented the highest mean concentrations of semi-volatile organic contaminants measured in sediment; residues in sediment dropped below the level of detection by thirteen days post-treatment. Residues of naphthalene spiked one day after treatment however, detectable residues persisted through 20 days post-treatment. Concentrations of 1-methyl naphthalene were roughly similar one and six days post-treatment but like the other semi-volatile organic chemicals, shortly dropped below levels of detection.

By October 24, 1997, the California Department of Pesticide Regulation (DPR) and the county agricultural commissioner had received 16 pesticide illness reports from people in the vicinity of the treatment area. According to a press release from the California Environmental Protection Agency (http://www.calepa.ca.gov/PressRoom/Releases/1997/lakedavis.htm) DPR toxicologists conducted a preliminary analysis of the amount of rotenone detected in the air and determined that A*there was over a thousand-fold difference between the lowest level of the formulated product (Nusyn-Noxfish) that caused effects in animal studies and the amount of active ingredient rotenone detected in air sampling. It is unlikely that the levels of rotenone that people were exposed to would result in illnesses. Toxicologists at Cal/EPA's Office of Environmental Health Hazard Assessment concurred with this assessment.* Although trichloroethylene residues (500 •g/L) were detected in Big Grizzly Creek below the dam, these residues were well below the California Occupational Safety and Health workplace exposure limit it 100,000 •g/L (California Environmental Protection Agency. 1997).

Because of the movement of rotenone outside of the intended treatment area and its release in to Big Grizzly Creek, the California Central Valley Regional Water Quality Control Board issued a Anotice of violation@ against the California Department of Fish and Game for violating a condition of a waste discharge requirement (California Environmental Protection Agency).

In spite of efforts to eliminate Northern pike with rotenone, pike were not eliminated and have subsequently re-established themselves in the reservoir. Discussions with local stakeholders are continuing.