Fires and Fire Retardants

Over the years, numerous fires (500+) have occurred on the refuge. The primary contaminant concerns from fires are the production of polycyclic aromatic hydrocarbons (PAHs) from the incomplete combustion of organic material (trees, grass, etc.) and the use of fire retardant chemicals to suppress fires.

Most of the fires on the KNWR were small and usually started by campfires. However, in 1969 two major fires (10 total for the year) burned significant portions of the refuge. The Russian River fire started at a campfire on June 14, 1969 and burned 2,300 refuge acres until it was declared out on July 25, 1969. Over 1,000 men and nearly $1 million were used to suppress this fire. The 1969 Refuge Narrative did not indicate if fire retardant chemicals were used to combat this fire.

The 1969 Swanson River fire burned 83,000 refuge acres. Over 4,000 men and $20 million were used to combat the fire. Additionally, about one million gallons of the fire retardant Phoschek were applied aerially to suppress the fire.

The other major fire, the Swanson River fire, started on August 3, 1969 from a campfire on the bank of the Swanson River. The fire burned 83,000 refuge acres, and over 4,000 men and $20 million were used to combat the fire. Nearly one million gallons of the fire retardant Phoschek (also known as Phoscheck or Phos-chek) were applied aerially to suppress the fire. The MSDS for Phos-Chek® Fire Retardant Grades D-75F and D-75R is contained in Appendix K. Toxicity information for phos-check will be discussed later in this section; however, the grade of phos-chek applied at the Swanson River Fire was not documented. Pictures in the 1969 Narrative show standing pools of phoschek near Mosquito Lake from the Swanson River Fire. The narrative also documents a fish die-off in Swanson River during the fire. On December 21, 1999, one of the biologists who was at the scene of the fire and die-off event, David Watsjold, presented his recollection of the events:

> *I clearly recall the great Swanson River fire of 1969. After the fire was brought under control, Larry Engel and I got into a canoe near the oil field road and went down the river to Cook Inlet. The fire burned very hot on both sides of the river in several areas, and there was virtually no vegetation along the riverbanks. There was extensive use of fire retardants on this fire, and it was evident along the river. It was obvious that some amount of retardant went directly into the river. We had no fish sampling gear with us; we didn't have much in those days. The fire occurred during the peak of the adult coho salmon return. I can distinctly remember that we saw a large number (hundreds) of dead adult coho salmon in the area of the burn and below it. We did not see any small juveniles as they were probably not visible or there was not much rearing going on in the lower river. No adults were collected to determine death, and I don't think we knew at the time what effects retardant had on fish.*

Table 2. 96-hour LC50[a] (mg/L) of Fire-Trol LCG-R and Phos-Chek D75-F to Five Life Stages of Rainbow Trout (Oncorhynchus mykiss) Exposed in ASTM[b] Soft (42 mg/L $CaCO_3$) and Hard Water (163 mg/L $CaCO_3$) at 12±1°C.

Chemical	*Water type*	*Egg*	*Embryo-larvae*	*Swim-up fry*	*60 dph[c]*	*90 dph*
Fire-Trol LCG-R	Soft	>10,000 A	>3,600[e] B	910 C (722-1,115)	1,080 CD (880-1,353)	1,413 D* (1,105-1,724)
	Hard	>10,000 A	2,642[e] B (2,117-3,249)	872 C (685-1,066)	1,413 D (1,105-1,724)	1,006[d] C* (780-1,300)
Phos-Chek D75-F	Soft	>1,700 A	266[e] B (213-327)	279[d] B (216-360)	234 B (191-291)	218[d] B (170-280)
	Hard	>3,600 A	235[e] B (183-287)	218[d] B (170-280)	218[d] B (170-280)	218[d] B (170-280)

[a]LC50 = lethal concentration at which 50% of the sample size experiences lethality. [b]ASTM = American Society for Testing and Materials. Asterisks denote a significant difference (p<0.05) in toxicity of test formulations between soft and hard water. Common uppercase letters denote no significant difference (p<0.05) among life stages within a test formulation and water quality. [c]dph = days posthatch. [d]No partial kills; 95% confidence interval: lower limit = highest test concentration with 0% mortality, upper limit = lowest test concentration with 100% mortality. [e]Test were started with true sac-fry.

In general, fire retardants currently are not used on National Wildlife Refuges in Alaska unless the fire may spread and threaten a resource designated for fire protection. The fire retardant currently approved for aerially application in Alaska is Fire-Trol LCG-R (Appendix L). According to a study conducted by Gaikowski et al. (1996), Fire-Trol LCG-R is less toxic than Phos-Check D75-F. The 96-hour median lethal concentrations (LC50s) for Fire-Trol LCG-R and Phos-Chek D75-F at various life stages for rainbow trout are displayed in Table 2 .

The recommended field mixtures for Fire-Trol LCG-R and Phos-Chek D75-F are 1 gal/4.5 gal (270,400 mg/L) and 1.20 lb/gal (143,800 mg/L), respectively (Gaikowski et al. 1996). Application at these field concentrations may result in lethal concentrations in aquatic environments; field concentrations can be much higher than acute toxicity values (Table 2) (Gaikowski et al. 1996). For example, one drop of Phos-Chek D75-F would have to be diluted 515- to 660-fold (depending on water hardness) to reach a concentration near the 96-hour LC50 (Gaikowski et al. 1996).

Summary: Fires and Fire Retardants

Currently, fire retardants are not routinely used on KNWR, and because phos-chek readily degrades in the environment, residual impacts from historic fire retardant use are unlikely.