Evaluation of Human and Ecological Risk
For Borax Stump Treatments
Sugarberry Project Silviculture Appendix K
3/20/07

PRODUCT SUMMARY

Borax ($Na_2 B_4 O_7\ 10H_2O$ sodium tetraborate decahydrate) is used as a registered pesticide (fungicide) EPA Reg. No. 2935-501, EPA Est. No. 66196-CA-01 **(**WILBUR-ELLIS SPORAX®). For prevention of Heterobasidion annosum (annosus) root disease, borax is applied to freshly-cut stump surfaces at a rate of one pound per 50 square feet of stump surface. This is equivalent to one pound of borax on 60 twelve-inch stumps (Sporax label, Wilbur-Ellis Company). Borax as used in forestry is identical to the material sold throughout North America as a household-cleaning agent (Dost 1996 page 1). Sporax® does not have any inert ingredients. No contaminants have been identified in Sporax (Pesticide Fact Sheet).

HAZARDS

Humans

Acute (short-term) Hazards

Borax is a low oral and dermal toxicity pesticide in Class III, but it carries a DANGER signal word, due to the fact that it is a severe eye irritant. Primary body entry routes are through eyes and damaged skin. Immediate or acute health hazards from overexposure may be judged by comparing borax's toxicities with standard toxicity ranges. The higher the number in the chart, the less toxic the material is to test animals.

TOXICITY

TOXICITY	CLASS	Units	Dermal LD 50 mg/kg	Oral LD 50 mg/kg
DANGER	I		200	<50
WARNING	II		200-2,000	50-500
CAUTION	III		2,000-20,000	500-5,000
BORAX			>2,000	>6,000

Accidental ingestion of borax may include nausea, vomiting, diarrhea, and abdominal pain. Intact skin is a barrier to absorption of borax. Borax is rapidly absorbed through damaged skin. Boron is rapidly eliminated from the body without change by humans and other species, regardless of the route of intake (Dost 1996 p.57). Borax is not expected to cause skin irritation if handled properly. The EPA has not required inhalation studies for borax (Pesticide Fact Sheet).

Chronic (long-term) Hazards

Borax is not classified as an agent that causes cancer, genetic damage, or birth defects. Studies have indicated that chronic exposure to borax may cause reproductive damage and infertility. An EPA review has classified the related compound boric acid as a Group E carcinogen (evidence of non-carcinogenicity for humans).

Plants
Borax and other boron compounds at high levels may kill plants. Borax may be used as a nonselective herbicide. However, boron is an essential nutrient for plants, and boron compounds (including borax) occur widely in nature. Borax is also used in fertilizer formulations to supply boron. Boron is taken up from soil by plants in proportion to the amount of boron in the soil. (Pesticide Fact Sheet). It bio-accumulates in plants (Phelps, Hodges, and Russel, undated, p.13)

Soil microorganisms
At high levels, borax could be toxic to many soil microorganisms (Pesticide Fact Sheet). A range of soil micro-organisms can utilize it as a source of energy and nitrogen. Borax is considered to have small or non-existent effects on various soil organisms (Phelps, Hodges, and Russel, undated, p.13).

Aquatic animals
Borax is practically nontoxic to fish, and practically nontoxic to aquatic invertebrate animals. It does not build up (bio-accumulate) in fish (Pesticide Fact Sheet).

Terrestrial animals
Borax is practically nontoxic to birds and mammals. It is relatively nontoxic to bees. Relatively high concentrations of boron compounds are toxic to insects, and borax is used for insect control in some cases. (Pesticide Fact Sheet)

Cattle
Borax is considered non-toxic to cattle (Meister, 1981 p. C48).

Soil and Water
Borax absorbs to mineral soil particles. Soil naturally contains boron at a concentration of 5 to 150 parts per million. (Pesticide Fact Sheet). Borax persists in the soil for one or more years depending on soil types and rainfall. The decahydrate may not persist beyond one growing season in areas of 35 inches or greater precipitation (Phelps, Hodges, and Russel, undated, p.13). The potential for leaching is low. Borax may leach more rapidly under high rainfall conditions. The average boron concentration in surface waters ranges from 0.001 mg/Liter to 0.1 mg/Liter (Pesticide Fact Sheet).

EXPOSURE AND RISKS

Project Area Information
For the areas to be harvested in the Sugarberry Project, an average of approximately 45 stumps per acre with surfaces 14 inches and greater would receive borax treatment. With an average of 14 to 16 inches diameter (1.0690 square feet to 1.3963 square feet for cut surfaces), this would be approximately 0.027 pounds on approximately 14700 stumps on 325 acres, or approximately 1 pound per acre.

Units to be treated are situated on ¼ mile ridgetops along the LaPorte-Quincy Highway. The Sugarberry Project area receives 75 to 85 inches of precipitation. There are occasional intermittent channels within the treatment area of this project. These streams would not be harvested and therefore would not receive Sporax application. There is no direct channel flow from within the treatment units to perennial streams.

Exposure of and Risk to Soil and Water

Exposure routes to water are essentially none. Overland flow or leaching due to massive storms would be the only potential movement to the water which is one and one half miles away. Migration of Boron away from the site into water sources and aquatic flora and fauna at some distance from the site is unlikely (Dost 1996, pages 4 and 11).

Exposure of and Risk to Humans

Those that may be exposed as a result of this project are workers and the public. Workers include applicators, supervisors, and other personnel directly involved in the application of borax. The public includes forest workers who are not directly involved in the borax application and forest visitors. This analysis utilizes Dost (1996) as a direct comparison to this project since stump treatments with borax are the same. Dost discussed information from studies that generally deal with laboratory or work environments that had substantially greater exposure levels than the levels that occur in forest stump treatments. He reviewed these studies and compared them to the potential exposure routes during stump treatment applications.

Exposure of forest workers has few potential routes of exposure. The most likely exposure of humans should be during handling because either borax can be spilled or other wise brought into contact with eyes, skin or digestive tract. Contact can be made through sitting on treated stumps, but is unlikely.

The public exposure could be by sitting on treated stumps but this is unlikely. They could possibly eat big game that has consumed vegetation that has had uptake of boron.

For an exposure level and risk calibration point, Dost relates the following: in an industrial setting with visible borax dust, workers have been exposed over full time work schedules over extended period with no evidence of effect other than transient upper respiratory irritation (Dost pages 54,55).

For forest workers, the exposure is very limited and substantially less than the industrial setting mentioned above. Dost (1996 pages 55, 56) presents a scenario for exposure and risk to forest workers. The most likely exposure route is through abraded skin. Assume that 100 12 inch trees are treated in a work day, treatment at the label rate would consume 750 g borax or about 86 g boron over a work day. Assume that one percent or 0.86 g boron actually reaches the skin. As a hypothetical, assume a worker has enough abraded or otherwise vulnerable skin to permit absorption of 0.5 percent of the amount that reached the skin. The assumed dose becomes 4.3mg boron, for a person weighing 70 kg. Dose per unit body weight becomes 0.53 mg borax/kg/day or 0.061 mg boron/kg/day.

The assumed ratio of absorbed boron dose to applied material in this example is on the order of 1/20,000 (Dost 1996, p.56).

Dost used a rate of 10 mg boron/kg/day as the no effect level for purposes of risk assessment for humans (Dost 1996, p.58). This provides a margin of safety, or ratio of the no effect level to dose, of 162. The hypothetical exposure to forest workers is substantially less (in order of magnitudes) than the margin of safety. He concludes that workers who apply borax to cut stumps are not at risk of adverse effects due to boron exposure (Dost 1996 page 61).

In a relative comparison to the industrial setting and forest worker scenario described above, the limited exposure with any absorbed dose to forest users (walking through a treated area or sitting on a stump) is inconsequential (Dost 1996 p.59). Foraging herbivores can consume vegetation that may have taken up excess boron that migrated from the stump. Given high background boron content of forage plants and the absence of any detectable increases in those levels, this possibility may be dismissed, as may exposures of predators or hunters through consumption of herbivores (Dost 1996 page 55).

Exposure of and Risk to Plants

Exposure routes would be through borax washing off the treated surface to the surrounding vicinity of the stump or though a spill. Measurements of herbs and foliage at distances up to 5 meters from the stump and at various times after application do not show differences from measurements prior to application. (Dost 1996 page 60). Under normal application there is essentially no risk to plants. The risk to plants would be from a spill. Borax is toxic to plants in high concentrations. Applicators generally carry about 1 pound of chemical. Assuming a worker completely spilled the container and the 1 pound covered 10 square feet or less, plants could die. The spill would act as a herbicide for a few years. Then plants would reoccupy the location. However, spill instructions are for personnel to scoop up the spill and place it back in the application container. Spilled material is to be used as per normal label application instructions. When proper spill procedures are maintained, it is unlikely that plants would be harmed.

Exposure of and Risk to Fish

There are no exposure routes for fish in this project. A hypothetical exposure route of a spill is discussed below. The treatment of stumps with the borax fungicide has no impact on water quality. Borax is practically nontoxic to fish and aquatic invertebrates and does not bio-accumulate in fish. Acute toxic levels are greater than 1,000 parts per million (USDA Pesticide Fact Sheet). Even in a worse-case scenario, where someone crossing a stream spills a large quantity of Borax (assume 5 pounds) directly into a stream, dilution is such that only 650 gallons of water would be needed to dilute the borax below 1,000 parts per million, and thus below a toxic level. Chances of this scenario happening in Sugarberry Project are practically non-existent as there are no streams to cross. The application rate of about one pound of borax per acre, and the unlikelihood of any borax reaching a stream, makes the possibility any harmful levels of borax in streams extremely unlikely.

Exposure of and Risk to Livestock and Wildlife
Big game and cattle use the project area. Exposure routes for cattle or wildlife may be ingesting borax directly from a stump surface after application, or they may consume vegetation into which boron has moved as it is washed away from the stump over time. Deer displayed no attraction or aversion to application of borax to cut surfaces and there was no observed toxicity to them (Campbell undated). Grazing permittees have not observed unusual behavior of cattle in treated areas (Dost 1996 page 59).

Surface litter is largely fallen vegetation and serves as a food source for some small mammals and invertebrates. Dost (pages 10-12 1996) sampled and analyzed treated stumps and surrounding soil, litter and foliage. From these findings he made the following generalizations: There does not appear to be measurable penetration of boron into stumps (it concentrates in the first 3 centimeters); no treatment related increases in boron content of adjacent foliage, litter or soil; variation of background boron levels among areas is substantial; following spring sampling resulted in high variability (greater breakdown had already occurred) among trees and accompanying soil, litter and vegetation; absence of detectable uptake by plants also indicates that migration of boron away from the site into water sources and aquatic flora and fauna at some distance away from the site is unlikely. Measurements of herbs and foliage at distances up to 5 meters from the stump and at various times after application do not show differences from measurements prior to application. (Dost 1996 page 60).

Poultry chicks where boric acid was applied at rates of 127 g/m^2 did not accumulate any boron in any tissues assayed. For comparison, distribution over a forest site after use of one pound of borax per 50 square feet of stump area would be 0.012 g/m^2 (Dost 1996 page 60).

Dost concludes that data indicates that adverse effects of forest uses of borax on wildlife or livestock are improbable and should be expected to have no effect on surrounding plants, invertebrates or microorganisms (Dost 1996 page 61).

Exposure of and Risk to Invertebrates, Soil Micro-organisms
Exposure routes would be through borax washing off the treated surface to the surrounding vicinity of the stump or though a spill. As discussed above under exposure and risk to plants, effects from a spill would be negated by spill procedures. Due to the low dose rates in stump applications and comparison to available literature, Dost concludes that use of borax for stump treatment should be expected to have no effect on surrounding plants, invertebrates or microorganisms (Dost 1996 page 61).
(Dost 1996, page 61).

Exposure and Risk to Fungi
Exposure routes would be through borax washing off the treated surface to the surrounding vicinity of the stump or though a spill. As discussed above under exposure and risk to plants, effects from a spill would be negated by spill procedures. The

application rate of stump treatments would be substantially lower than rates that found some fungi to actually benefit from borax concentrations (Dost 1996, page 36).

Literature Cited

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