

Seadust Wildlife Controllant® and Other Techniques to Protect Forest Plantations

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Abstract: We briefly review some of the materials and methods used for reducing wildlife damage to forest crops. Many of these have also been used to protect Christmas trees, ornamentals, and other agricultural crops. Few chemicals have been effective as repellents, and few are exempted from registration by the Environmental Protection Agency (EPA) under Section 25(b) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Wildlife Services Company, Inc (WSC) recently patented Seadust Wildlife Controllant®. Seadust is a natural organic non-phytotoxic product formulated from food materials, including freshly processed seafoods which are rapidly dried to low moisture content. Seadust has been exempted as a pesticide by EPA because of the non-hazardous materials used in the formulation. It has multiple uses, including protecting plants during growing and dormant seasons. It has been tested and found effective on a wide variety of forest, ornamental, agricultural, and garden crops, acting primarily as a taste and odor repellent, but without objectionable odor or handling properties. Seadust contains available nutrients for enhancing plant growth, including nitrogen, calcium, phosphorus, and potassium, but is not harmful to aquatic environments. When Seadust is used for forest seedlings, bundled trees can be treated prior to planting, or treated after planting. Seadust has been applied in nursery beds to enhance the value of bud caps on Douglas-fir (*Pseudotsuga menziesii*). New conifer growth is protected when the active ingredient is transported upward as seedlings elongate. New untreated foliage on broadleaf plants may require re-treatment. Seadust Tape™ can be applied as a visual signal to reduce browsing and rubbing damage. Vexar® type plastic mesh tubes are treated with Seadust to prevent elk from pulling tubes and bamboo supports. Seadust contains a dry adhesive formulation which requires foliage to be wetted with water. When applied during the dormant season, or when applied to waxy foliage, such as western red-cedar (*Thuja plicata*), a non-phytotoxic spreader-sticker should be applied to foliage just prior to application of Seadust. Some of our research on protecting plants from deer and elk during the growing season is reported here.

Keyword: repellent, natural, barriers, prevention, forest wildlife damage, black-tailed deer, Roosevelt elk

Introduction

Animal damage to reforestation is economically significant in Oregon and Washington (Brodie and others 1979). Some short term studies have shown that wildlife damage in many areas of western Oregon caused significant losses in survival and growth (Campbell and others 1988). Further economic losses caused by wildlife include the costs to replant, control of competing plants, longer rotations, low stocking densities, and direct loss of merchantable timber.

Research to reduce herbivore and omnivore damage to forest seedlings and trees has been conducted for more than 50 years. Much of the research was conducted by the USDA National Wildlife Research Center (WRC) Field Station at Olympia, Washington. Research was conducted by the USDI Fish and Wildlife Service (USFWS), and later by the USDA Animal and

Plant Health Inspection Service (APHIS) in cooperation with universities, state, federal, and private land managers, chemical companies, and manufacturers.

Research emphasis in the 1950s was on seed protection, as well as seedling protection on sites where seeding was not successful. These trials and treatments were designed to reduce populations of rodents and lagomorphs by baiting and using toxic chemicals, including systemic chemicals. These chemicals were not selective and were often hazardous to other animals. Re-invasion of baited sites within 1 year was typical, even when targeted animals were successfully baited.

Research has been divided into several categories, with emphasis changing as new objectives are needed for establishing forest crops. Research categories have included trapping, hunting, baits, systemics, repellents, fencing, barriers, and habitat modification, with evaluation of possible environmental hazards in each category. Recent research has focused on modifying wildlife behavior and habitat management. Recent research by Wildlife Services Company, Inc. (WSC) has focused on natural environmentally safe materials.

Animal Exclusion and Habitat Management

Fences and Barriers

A variety of methods to exclude wildlife have been used, including fences and individual tree protectors. Fences are usually made of heavy wire, plastic fabrics, or even waste slash piles.

Wire mesh fencing is expensive and difficult to install properly on uneven ground, because animals may go under fences as readily as over them. In addition, fences must be buried several feet deep to exclude rodents. Small meshes of 1 in (2.5 cm) or less are needed for rabbits or hares. Poultry wire fences can be effective, even against elk, if they enclose small forested areas of about 0.25 ac (0.1 ha) that animals can pass around.

Smooth wire electric fences have value when animals can be conditioned to safe electric shock and are maintained to prevent shorting. Deer and elk have hollow hair which acts as insulation, and they usually react to electric shock through the mouth or nose. WSC has safely tested electrified tree seedlings for conditioning deer.

Fences made of plastic mesh can have short term value if maintained. However, nylon mesh fencing is a hazard due to entanglement risk.

Fences made of piled slash should be used sparingly; they provide safe habitats for burrowing rodents such as mountain beavers and pocket gophers.

Fences are sometimes not desirable because of aesthetics. In addition, fences may enclose vegetation that competes with tree seedlings, including plants that would normally be eaten by wildlife. Therefore, individual barriers for seedlings are used. These barriers have been made from a variety of materials. In the late 1960s, Campbell developed plastic-coated paper mesh cylinders to protect tree seedlings (Radwan and Campbell 1968), and later cooperatively developed Vexar® semi-rigid extruded plastic mesh seedling protectors (Campbell and Evans 1975a) through cooperation with EI

DuPont Company personnel. When properly manufactured, these semi-rigid tubes provide several years of protection, and then decompose from sunlight or breakage caused by stem expansion. Vexar-type plastic mesh tubes are effective when correctly constructed and installed in plantations (Campbell and Evans 1975a; Campbell 1987), and are still used to protect tree seedlings in many plantations.

Habitat Management

Habitat conditions after timber harvest may contribute to increased damage to reforestation, or may be managed to improve habitat for wildlife and minimize damage to reforestation (Campbell 1998). Initial vegetation following logging of old growth stands may contain enough high quality browse to sustain wildlife without significant damage to planted conifers. When second growth stands are cut, there is often an abundance of plants with low palatability, such as groundsel (*Senecio sylvaticus*), resulting in increased foraging on conifers. Newly disturbed sites, including clearcuts, can be seeded with selected forbs to reduce damage to conifers (Campbell 1974; Campbell and Evans 1975b). These forbs are generally evergreen, fire resistant, non-competitive with conifers, and highly palatable to a wide variety of wildlife. Flowers of cat's ear (*Hypochoeris radicata*) are preferred wildlife food, apparently due to a high content of fructose and glucose (Radwan and Campbell 1968).

Animal Repellents and Repellent Studies

A few repellents, such as the fungicide thiram (tetramethylthiuram disulfide, TMTD), were first applied in forest nurseries in the 1950s. These repellants were effective against hares and rabbits as topical (foliar) repellents and were usually applied at about 10% solids in an adhesive formulation applied to nursery bed seedlings. TMTD was used extensively in nurseries and adhered well to foliage during processing of nursery seedlings. It was also found effective at a 21% concentration for use in aversion conditioning to protect Douglas-fir (*Pseudotsuga menziesii*) seedlings from mountain beavers (Campbell and Evans 1989). After about 30 years of use in nurseries and forest plantations, further use of TMTD was challenged by some tree planters as being hazardous. TMTD can cause a severe reaction with blood alcohol, a physiological reaction similar to medical use of Antabuse (tetraethylthiuram disulfide, TETD) to treat alcoholism. This reaction, coupled with high potential re-registration expenses, caused thiram to be discontinued for repellent use in nurseries. There have been limited attempts to replace thiram because most nursery seedlings are now larger and resistant to hares, and because new plantations are usually planted prior to habitat formation for snowshoe hares or introduced cottontail rabbits. Major problems still remain in new plantations with deer, elk, mountain beavers, and pocket gophers, and in older plantations from rubbing by deer and elk, cutting by stream beavers, and girdling by porcupines and black bears.

Although hundreds of candidate repellent materials were tested at USFWS and other labs, few were suitable for field testing. A few candidate repellents were effective,

but phytotoxic. A few other candidate repellents were safe and effective, but the multi-million dollar costs required for registration of new materials, or re-registration of some other materials, were not cost effective to market for what was considered minor use in forestry practices.

Some of the more effective deer repellent materials were based upon fermented or putrified materials (Campbell and Bullard 1972; Bullard and others 1978), including fish carcasses and powdered chicken eggs. The raw putrified materials were not practical for either manufacturing or handling. A powdered egg material effective for short periods was usually labeled BGR-P, formulated at about 37% solids. This egg material was used to condition mountain beavers against damaging Douglas-fir seedlings (Campbell 1987). It was also used with plastic flagging to significantly reduce deer browsing on Douglas-fir (Campbell and others 1987). Seadust Tape™ was developed by WSC for similar usage.

Sprayable egg formulations at low concentrations were not effective. Other protein materials, such as powdered fresh carcasses of starlings taken in damage control operations, were found very effective as repellents by Campbell and Farley (1990) and Heppner (1990), but are not exempted materials under FIFRA 25(b). Other blood products and urines have been tried for many years, and may be effective for short times when applied in a non-phytotoxic formulation. Bitter chemicals, including some claimed to be systemic repellents, soaps, hair, or other products tested have not significantly reduced browsing damage. Research by USFWS on pepper materials was discontinued after possible ingestion hazards were associated with applications.

Herbicides and carriers, including water or diesel oil, used in forest practices did not show repellency to captive deer when applied to salal (*Gaultheria shallon*) or Douglas-fir in controlled tests (Campbell and others 1981). Captive deer showed no apparent health problems after eating salal treated with herbicides.

Unnatural frightening devices usually have short term value after the animals find they are not harmful to them. Loud noises are seldom effective unless associated with hunting activities. WSC is currently testing natural frightening methods that copy subtle noises disliked by deer and elk, possibly causing the animals to avoid sites where the devices are installed.

Certain non-toxic plants with natural repellency may be future candidates for protecting other plants. The properties making some plants repellent to deer or most wildlife have not been determined. Wild ginger (*Asarum caudatum*) is a non-toxic native plant, used in making candy, which has natural repellency to a variety of herbivores (Campbell unpublished data). However, this species is not on the exemption list currently established under FIFRA. Foxglove (*Digitalis purpurea*), first imported to the Pacific Northwest for harvesting as a cardiac medicine, is very toxic when ingested, but has excellent repellent properties apparently not caused by the toxic properties found in the plant (Campbell, unpublished data).

Evaluation of test materials can be a difficult process, partially because of short-term animal responses to different materials and devices, and because behavior patterns of animals under field conditions need to be anticipated for good placement of test plots. Some individual animals appear immune to repellents.

Seadust Wildlife Controllant® Studies

Seadust Wildlife Controllant® was originally formulated utilizing residual material from commercially processed crustaceans. This product was effective, but was deleted from the EPA exempted listing because of their listing as products that may cause allergies. Currently, the Seadust formulation includes a combination of corn oils with commercially processed shellfish residue, processed fish oils, and extenders in patented formulations. These are rapidly dried to very low moisture content, allowing them to remain stable for extended storage periods. The formulation becomes activated when it is applied to foliage wetted with water or with a water-based non-phytotoxic sticker.

Seadust Wildlife Controllant® has been field tested in growing and dormant seasons (Campbell 2004). Field testing was based on ASTM standards for repellent testing (Campbell and Evans 1977) and statistically evaluated for significance of damage by deer and elk. Testing has been conducted on very palatable plants, such as roses (*Rosa* spp.), strawberries (*Fragaria* spp.), apples (*Malus* spp.), dogwoods (*Cornus* spp.), and conifers such as western redcedar (*Thuja plicata*). Phytotoxicity testing has included species sensitive to chemical damage, such as green beans, and carefully monitored on Christmas tree plantations (Schmitz 2002). Palatable foods, such as freshly cut apples, are also used for evaluating formulations of Seadust.

The primary measurement of importance, after seedling survival, is seedling height growth. Seedlings in field tests were mainly treated after new buds opened to provide transport of Seadust during spring and early summer growth. Some sites were treated prior to budbreak to determine any value in protecting new growth. Most browsing of Douglas-fir stopped when new buds formed in mid-summer when other forage was more abundant.

Field tests reported here were conducted in western Washington during spring and summer. Most plantations had been planted with tree seedlings grown in commercial or public nurseries.

Natural Seedlings

Douglas-fir seedlings established from natural seeding have sometimes been considered less subject to damage than nursery grown seedlings. A test of natural seedlings was made on a Sanderson Harbor plantation from bud burst on May 5 until new buds were set on July 23. No seedlings treated with Seadust were browsed, while 83% of non-treated control seedlings were browsed (table 1).

Nursery Seedlings

Field tests for effectiveness against deer browsing were established on McGimpsey Plantation at budburst and Taylor Plantation when only about half of the Douglas-fir seedlings had broken buds. Seadust worked well when applied at budburst (table 2). However, on the Taylor Plantation, Seadust adhered on little of the new growth on seedlings and many treated trees were browsed (table 3), showing that it is necessary to treat new foliage. Despite heavy browsing

Table 1—Comparison of spring and early summer height growth and deer damage to naturally seeded Douglas-fir seedlings on the Sanderson Harbor plantation (western Washington).

Treatment	N	Mean height growth	Terminals browsed
		<i>inches</i>	<i>percentage</i>
Seadust	23	12 ^a	0
Control	23	4	83

^a Significantly different from controls. Duncan's test for significance $P \leq 0.05$ (1 in = 2.5 cm).

Table 2—Comparison of height growth and deer damage to randomized rows of nursery-grown Douglas-fir seedlings treated at budburst with Seadust Wildlife Controllant® and non-treated controls on the McGimpsey plantation (western Washington). N = 25.

Treatment	Mean height growth	Terminals browsed
	<i>inches</i>	<i>percentage</i>
Seadust	7.6 ^a	0
Seadust	6.6	0
Seadust	8.4 ^a	0
Seadust	7.7 ^a	0
Control	3.6	53
Control	4.5	33
Control	3.5	33
Control	3.5	67

^a Significantly different from controls. Duncan's test for significance $P \leq 0.05$ (1 in = 2.5 cm).

Table 3—Comparison of spring and summer height growth and deer damage to nursery-grown Douglas-fir seedlings on the Taylor plantation (western Washington) that were treated prior to budburst on seedlings.

Treatment	N	Mean height growth	Terminals browsed
		<i>inches</i>	<i>percentage</i>
Seadust	23	1.9	74
Seadust	21	3.0 ^a	65
Control	21	0.9	91
Control	20	0.7	100

^a Significantly different from controls. Duncan's test for significance $P \leq 0.05$ (1 in = 2.5 cm).

and poor growth, one replication treated with Seadust had significant growth when compared with controls.

Tests to control elk damage to Douglas-fir seedlings in both summer and winter have been very successful. Protection of several plantations at Italian Creek have allowed establishment of plantations that are now above the reach of resident elk. A recent test of nursery-grown seedlings during the growing season on a 2-year-old plantation is shown in table 4.

Seadust Wildlife Controllant® has proven to be one of the most successful repellent formulations WSC has tested. Corn oil, combined with powdered extenders such as clays and ground grains, and with freshly dried and powdered or granulated shellfish and crustaceans, has been tested by our company from 1995 to 2006. We determined that deer,

Table 4—Comparison of spring and summer height growth and elk damage to nursery-grown seedlings in a 2-year-old Douglas-fir plantation at Italian Creek using Seadust Wildlife Controllant® and non-treated control seedlings.

Treatment	N	Mean height growth	Terminals browsed
		<i>inches</i>	<i>percentage</i>
Seadust	25	19.0 ^a	0
Seadust	25	16.6 ^a	4
Seadust	25	15.6 ^a	8
Seadust	25	15.9 ^a	4
Control	25	4.8	92
Control	25	2.4	100
Control	25	5.2	68
Control	28	6.3	57

^a Significantly different from controls. Duncan's test for significance $P \leq 0.05$ (1 in = 2.5 cm).

elk, rabbits, and hares rejected several of these patented formulations. The permeable structure of waste shell residues from processed shellfish, blended with other ingredients in Seadust, provides slow release of repellent properties without hazardous properties or odorous handling problems found in some materials. The shelf life of Seadust is quite stable when kept in dry packaging.

We extended the slow-release repellent properties with natural extenders, including ground food grains exempted by EPA. A variety of materials included under FIFRA exemptions were formulated and field tested for repellency. Tests to prevent browsing damage to Douglas-fir have been successful using either a latex sticker on dry foliage or a cellulose adhesive formulation on foliage wetted with water and allowed to dry. The dry cellulose formulation can be applied during light rain. Seadust can be used as a short-term repellent if applied to wet foliage without a sticker.

Tests of Seadust for protecting species with very waxy leaf surfaces have shown that Seadust will adhere best immediately after applying a latex or similar non-phytotoxic sticker. Seadust provides good crop protection under a wide variety of conditions. The nutrient values of N, Ca, P, and K add to the value of the product. Testing of other Seadust applications, including forest nursery applications, is beginning. Field testing against mountain beavers, stream beavers, and other species of wildlife is either starting or continuing.

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