CONSERVATION STRATEGY FOR *ALLOTROPA VIRGATA* (CANDYSTICK), U.S. FOREST SERVICE, NORTHERN AND INTERMOUNTAIN REGIONS

by

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October, 1995

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Cooperative Challenge Cost-share Project
Nez Perce National Forest
Idaho Department of Fish and Game

Purchase Order No.:95-17-20-001

ACKNOWLEDGMENTS

I am grateful to the following Forest Service sensitive plant coordinators and botanists who went out of their way to provide valuable consultation, maps, and data: Leonard Lake, Linda Pietarinen, Jim Anderson, Quinn Carver, Alexia Cochrane, and John Joy. These same people are largely responsible for our current level of knowledge about *Allotropa virgata*. Special thanks to Janet Johnson and Marilyn Olson who found the time to show me *Allotropa* sites on the Bitterroot and Payette National Forests, respectively. Steve Shelly, Montana Natural Heritage Program/US Forest Service, initiated this project and provided thoughtful review. I hope that this document provides both the practical guidance and theoretical basis needed for a coordinated effort by management agencies toward conservation of *Allotropa virgata*.

ABSTRACT

This conservation strategy provides recommendations for management of National Forest lands supporting and adjoining populations of *Allotropa virgata* (candystick), a plant species designated as sensitive in Regions 1 and 4 of the US Forest Service. *Allotropa virgata* presents a special conservation challenge because it is part of a three-way symbiosis involving conifers and their ectomycorrhizal fungi. First, the current state of our knowledge of the species is summarized, including distribution, habitat, ecology, population biology, monitoring results, past impacts, and perceived threats. Basic habitat and population data from element occurrence records are tabulated. The ecology of lodgepole pine (*Pinus contorta*) is discussed as it relates to habitat of *A. virgata*. Secondly, a conservation strategy is outlined, based on landscape-scale units encompassing both occupied and adjoining, unoccupied habitat of *A virgata*. A set of criteria, including quality and extent of habitat, population size, and geographic location are presented for prioritizing these "conservation units". Management recommendations are then proposed for each priority class. It is recommended that priority 1 conservation units be monitored on a landscape scale using a database with timber stands as the basic units. Monitoring should examine changes in amount and pattern of habitat and its relationship to viable populations of *A. virgata.* Recommendations are also given for monitoring at the stand level. The association of *A. virgata* with a fire-maintained community type, evidence of underburning, and a lack of climax regeneration all point to an adaptation to fire regime. The specific factors that determine habitat suitability are not known, and may relate wholly or in part to requirements of the mycorrhizal fungi involved. Potential impacts to the habitat of *A. virgata* include timber harvest and altered fire regime. The extent of past and projected use of lodgepole pine forest types for timber harvest will be central to the species' conservation status.

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BACKGROUND INFORMATION

Forest Service Policy and Regulations

The National Forest Management Act of 1976 and U.S. Forest Service policy require that National Forest lands be managed to maintain populations of all existing native animal and plant species at or above the minimum viable population level. A minimum viable population consists of the number of individuals, adequately distributed throughout their range, necessary to perpetuate the existence of the species in natural, genetically stable, self-sustaining populations (USDA Forest Service 1984).

The U.S. Forest Service, along with other Federal agencies, has recognized the need for special planning considerations in order to protect the flora and fauna on lands under public ownership. The U.S. Forest Service recognizes species in need of such consideration by placing them on Regional sensitive species lists (USDA Forest Service 1991, 1994). This list includes Federally-ranked species as well as species that have regional or state conservation concerns.

Species Status

Currently, the official status of *Allotropa virgata* according to concerned Federal, State, and private agencies and organizations is:

U.S. Fish and Wildlife Service: no status

U.S. Forest Service: Sensitive in Regions 1 and 4 (the Regional Forester has identified it as a species for which viability is a concern as evidenced by: a) significant current or predicted downward trends in population numbers or density, and/or b) significant current or predicted downward trends in habitat capability that would reduce its existing distribution (USDA Forest Service 1984).

The Nature Conservancy: Global rank G4 (not rare and apparently secure, but with cause for long-term concern).

Idaho: State rank S3 (rare or uncommon but not imperiled; Conservation Data Center 1994a).

Montana: State rank S3 (21-100 occurrences; MNHP 1994a).

Objectives

Objective of this Conservation Strategy: to provide recommendations for management of National Forest lands supporting and adjoining metapopulations of *Allotropa virgata*.

Management objective: to provide for the long-term viability of *Allotropa virgata* throughout its inland range while minimizing conflicts with other resource values.

BIOLOGICAL AND GEOGRAPHICAL INFORMATION

Nomenclature and Taxonomy

Scientific name:	*Allotropa virgata* T. & G. *ex* Gray
Common names:	candystick, sugarstick
Family:	Ericaceae (Heath family).
Subfamily:	Monotropoideae, containing achlorophyllous members of the Ericaceae.
Genus:	*Allotropa* is a monotypic genus (contains only a single species).
Species:	*Allotropa virgata* was first collected by the Wilkes expedition in the Cascade Mountains of Washington in the late 1800s (Hitchcock et al. 1959). The first collection in Montana was from the Bitterroot Mountains, St. Mary Peak, Ravalli County in 1965 (Stickney 100b, MRC). The first records for Idaho were in the Selway River valley, Idaho County (Habeck 2503, MRC) in 1972. Prior to these records, *Allotropa virgata* was known only from low elevations in the Sierra Nevada, Cascade, and Coast ranges (Steele and Stickney 1974).
Citation:	Torrey and Gray *ex* Gray, Proc. Am. Acad. 7:368. 1867.
Synonyms:	none

Description

Nontechnical description: Fleshy, non-green plants with single or more often clustered, unbranched stems bearing the flowers and small, pointed leaves (Appendix A). The thick stems stand up to 40 cm tall. Stems are striped vertically with red and white, this feature being most obvious toward the base of the stem (small stems may be solid red). Flowers are similar in color to the stem and round in outline. An important feature of the flowers is that they open outward, directly away from the stem, as opposed to turning down as in closely related species (see below). Standing dead stems from previous years are almost always present. Old stems are dark reddish-brown with no white, and hollow.

Technical description: Achlorophyllous, simple-stemmed herbs with single to numerous, clustered stems, originating from a diffuse, deep-seated root system bearing branch roots and adventitious buds at intervals along its length (Wallace 1975); stems 1-4 dm tall, white and pink (red) striped, 5-10 mm thick, enlarged below ground (Appendix A); leaves reduced, scale-like, pinkish to yellow-brown, linear lanceolate; inflorescence a terminal, elongate, spikelike raceme, 5-20 cm long; flowers axillary and exceeded by the subtending bract, often with 1-2 bracteoles below the calyx; sepals 5, distinct, white or pinkish to brownish, about 5 mm long; corolla lacking; stamens 10, purplish, opening by basal (falsely terminal) pores, from about equal to, to twice as long as, the sepals; pistil 5-carpellary, styles very short, stigma shallowly 5-lobed; ovary superior, 5-celled, with axile placentation; fruit a capsule (Hitchcock et al. 1959).

Similar species: *Allotropa* may be confused with other non-green members of the heath family which often share the same habitat. Pinedrops (*Pterospora andromedea*) has sticky, brown flowering stems that also dry and persist a long time after dying. Unlike *Allotropa*, its flowers face downward, born at the ends of delicate, reflexed pedicels. It is generally much taller than *Allotropa* (3 dm to over 1 meter). Pinesap (*Hypopitys monotropa*), is similar in height to *Allotropa*, but is uniformly pinkish to straw-colored, drying to black. In flower the main stem bends over (nods) distinctly, but straightens again as fruits develop.

Some non-green orchids, especially coralroots (*Corallorhiza* spp.), are sometimes mistaken for *Allotropa*. Coralroots have slender stems, rather variable in color from purplish to reddish-brown to albino. However, the flowers are not subtended by pointed bracts such as those present on *Allotropa*.

Distribution

Global distribution. *Allotropa* occurs as a disjunct in the Rocky Mountains. Its main range extends from southeastern British Columbia, south into the northern Coast and southern Sierra Nevada ranges, where it inhabits mixed and coniferous forests (Wallace 1975; Appendix B, Map 1). *Allotropa* was unknown in the Rocky Mountains until 1965 when it was collected in the Bitterroot Mountains of western Montana by Peter Stickney, a botanist with the USFS Forest and Range Experiment Station (Steele and Stickney 1974). Based on similar distribution patterns of other species, and our limited knowledge of the pre-Pleistocene flora, Lorain (1988) postulated that, following the glacial retreat, *Allotropa* either 1) migrated inland via a system of mountain ranges stretching from southwestern Oregon to the Wallowa Mountains of northeastern Oregon, or 2) migrated westward from refugia in Montana. Currently, *Allotropa* does not occur in Oregon anywhere east of the Cascades, which would lend support to an eastward migration route.

Regional distribution. In its inland range, *Allotropa* occupies high-elevation lodgepole pine (*Pinus contorta)* forests in central Idaho and western Montana, roughly centered on the Bitterroot divide (Appendix B, Map 2). The known distribution stretches from the Gospel Hump Wilderness Area in Idaho, east over the Bitterroot divide, and sporadically east in Montana into the Sapphire, Anaconda-Pintler, Pioneer, and Flint mountains.

In Idaho, *Allotropa* is associated with the rolling uplands that form the upper drainage basins of the South Fork Clearwater and Selway rivers. Populations on the southern periphery of the range occur just south of the Salmon River. There are no known occurrences of *Allotropa* in the area between the upper Selway River and the Bitterroot crest. This represents a formidable gap separating Idaho and Montana populations. Because this is a remote wilderness area, this gap in the known distribution of the species may be due to lack of field survey.

Land ownership

In its inland range, *Allotropa* is known to occur only on National Forest lands. To date, all records are on U.S. Forest Service lands in Idaho County, Idaho, and in Ravalli, Beaverhead, Deer Lodge, and Granite counties, Montana (Appendix B, Map 6). In Idaho it occurs on the Nez Perce National Forest, the Selway-Bitterroot wilderness area, the Frank Church-River of No Return wilderness area, and the northern portion of the Payette National Forest. In Montana it occurs extensively on the Bitterroot and Beaverhead National Forests, and on the Phillipsburg Ranger District of the Deerlodge National Forest (Appendix B, Map 3). It is known from one location on the Lolo National Forest. The bulk of the inland range is in Forest Service Region 1. In Forest Service Region 4 it is common in a 50 square-mile area of the Payette National forest, with only a few small occurrences outside that area.

Species occurrences

Within the past five years the number of known occurrences of *Allotropa* in the northern Rocky Mountains has greatly increased. Between 1989 and 1992 the number in Idaho increased from 5 to 66. Only 27 occurrences had been recorded in Montana through 1991, compared to 58 in 1994 (MNHP 1994b). The known inland range now includes parts of six National Forests and six different mountain ranges (Appendix B, Map 3). The increased number of records is attributable to status surveys, an increase in the number of U.S. Forest Service botanists, rare plant training of field personnel, and an expanding market for lodgepole pine. Possibly due to a lack of intensive field surveys, only scattered, small occurrences are known from designated Wilderness Areas separating Montana and Idaho populations.

As observations have multiplied, a much clearer picture of the species' range has emerged (Appendix B, Map 6). Small occurrences often turn out to be part of a group of populations that may extend over many square miles, and are in close enough proximity to share genetic material. An example of such "metapopulation structure" in *Allotropa* is shown in Appendix B, Map 4.

Historic. *Allotropa virgata* was unknown in the northern Rocky Mountains until 1965 when it was collected in the Bitterroot Mountains of western Montana by Peter Stickney, a botanist with the USDA-FS Forest and Range Experiment Station (Steele and Stickney 1974). The first record in Idaho was from a 1972 collection near the mouth of Moose Creek in the upper Selway River valley. This original population has never been relocated and the habitat at that site is atypical. Records for the species began to accumulate rapidly starting in 1989 as an expanding market for lodgepole pine resulted in biological evaluations for many proposed timber sales in *Allotropa* habitat.

Current. *Allotropa* is currently known from 58 element occurrence records (EORs) in Montana (MNHP 1994b) and 81 in Idaho (Conservation Data Center 1994b). Sixty-one records note fewer than 10 individuals (Appendix C). Many records do not represent a thorough survey, and further surveys may link occurrences into larger populations or metapopulations. Consequently, the number of EORs is only a rough indication of the number of metapopulations present. Appendix C lists all of the current EORs, including basic site and population data. Vertical lines along the left margin of the table are used to group EORs that can be considered part of the same metapopulation.

Ecology

Although often referred to as a saprophyte, *Allotropa*, like other non-green members of the Ericaceae, is actually *mycotrophic*–it obtains carbohydrates from a mycorrhizal fungus associated with its roots. The fungal mycelium is shared with a photosynthesizing plant that indirectly supplies carbohydrates to the mycotroph via the fungus. The mycotroph appears to be parasitic on the fungus, but there could exist a much more complex interaction in which all three partners benefit .

Achlorophyllous members of the Ericaceae are sometimes placed in a subfamily called the Monotropoideae, or a separate family, the Monotropaceae. Monotropes are thought to be more highly evolved than other members of the Ericaceae, partly because of their specialized relationship with a dual host. *Allotropa* appears to represent an evolutionary intermediate combining the extensive, fibrous root system of a green plant with much-reduced achlorophyllous leaves (Copeland 1938). The roots of related Monotropes–*Hypopitys*, *Monotropa* and *Pterospora*–are reduced to tight root balls (Furman and Trappe 1971).

Mycorrhizal fungi are associated with the roots of all members of the Pinaceae and Ericaceae as well other plant families. Some are specific to certain genera of plants and others colonize a range of hosts. They increase the ability of the host to take up water, nitrogen, and phosphorus, and are required by conifers under natural conditions. For this reason there is some interest by silviculturists in the potential for using mycotrophs as indicators of forest health (Harvey et al. 1994).

Studies have confirmed that the normal symbionts of mycotrophic plants belong to the type of mycorrhizal fungi known as ectomycorrhizae, the type that forms associations with members of Pinaceae, Fagaceae, and Betulaceae, among others (Leake 1994). Although inland populations of *Allotropa* are strongly tied to lodgepole pine stands, it has been demonstrated that its roots can be colonized by fungal associates of various conifers as well as several hardwood species (Castellano and Trappe 1985). Species of fungi that have been identified from the roots of *Allotropa* include *Rhizopogon vinicolor*, *Cenococcum geophilum* (Castellano and Trappe 1985), and *Tricholoma magnivelare* (Castellano, pers. comm.). The mushroom producing fungus *T. magnivelare* commonly occurs with *Allotropa* in its coastal range. *Tricholoma magnivelare* has been observed at several *Allotropa* sites on the Beaverhead National Forest and (Carver 1993) and has been identified from *Allotropa* roots collected on the Nez Perce National Forest.

Dependence of mycotrophic plants on a conifer host suggests that anything that destroys the tree component or severs the mycorrhizal relationship will result in death of the mycotroph (Furman and Trappe 1971). Because *Allotropa* spreads by underground, perennating buds on lateral roots, 0.5 to 2 ft (15-61 cm) deep, it can survive a ground fire that does not kill the host tree. It is not known what effect increased insolation might have on the vigor of plants adjacent to canopy openings. Initial results of *Allotropa* monitoring do not indicate adverse effects (Cochrane 1994).

Ectomycorrhizae do not survive long after the host tree is killed. As a forest regenerates the fungi gradually recolonize via spores. The composition of fungal species on a site changes with stand age (Molina et al. 1993).

Population biology

Allotropa is a clonal species that spreads by extensive lateral roots, up to 4 ft (12 dm) long, bearing adventitious buds (Luoma 1987, Wallace 1975). The lateral roots occur as deep as 2 ft (61 cm). At the point of bud initiation a mass of fibrous roots is produced. It is these fibrous roots that form the mycorrhizal relationship. Each new individual propagated in this way is genetically identical to the one before and is therefore technically a ramet (Harper 1977) as opposed to an individual propagated by seed, or genet. Successive ramets may be as far as 1 m (3.2 ft) apart (Castellano, pers. comm.). Plants appear to flower more than once from the same root crown, as evidenced by clusters consisting of both old and new inflorescences.

The only above-ground organ in *Allotropa* is the inflorescence, and since they are not photosynthetic, above-ground growth is only required for sexual reproduction. The flowering period is from mid-July to mid-August. A roughly biennial flowering pattern has been observed in coastal populations (Castellano, pers. comm.). A biennial flowering cycle would allow the plant to put its resources into seed production one year, and the next year into developing buds. A variety of flowering patterns have been observed in monitoring plots in inland populations (Cochrane 1994, Carver 1993, and see *Monitoring Results*). A small proportion of plants were observed to flower in 3 or 4 consecutive years. It is likely that soil moisture can affect flowering, as evidenced by a general lack of flowering in 1994, which was an exceptionally dry year.

Pollination of *Allotropa* flowers is accomplished by bumblebees (*Bombus* spp.) which are attracted by large nectar pools at the base of the ovary (Wallace 1977). Other pollinators observed include an halistid bee (*Augochlora* sp.) and unidentified Lepidoptera species (Carver 1993). Although there is ample opportunity for cross-pollination, it has been suggested that flowers are autogamous because seed set is always abundant, even when plants are covered by screens to exclude pollinators (Wallace 1975).

Seeds of *Allotropa* are minute and linear, about 1 mm long, with a papery testa and small amount of endosperm (Wallace 1975). Seeds are abundantly produced, numbering more than 100 per capsule. Because of their small size they can be kept aloft for short distances by air currents. Insects and/or small mammals may also be vectors for seed dispersal (Castellano 1993). Ants have been observed to feed on the seeds, and would be instrumental in placing them in microsites suitable for infection by mycorrhizal fungi (Carver 1992). Long-distance seed dispersal is probably infrequent but must occasionally occur in order to explain the observed metapopulation structure of the species.

The small seeds of *Allotropa* lack nutrient reserves and must therefore establish a mycorrhizal association immediately upon germinating. Although this sounds like a rare event, seeds are released in late summer and autumn, at which time some mycorrhizal fungi are particularly active and supplies of carbohydrates in litterfall and plant matter are at their peak (Leake 1994). Thus, seeds may not need to lie dormant for long. Seeds of *Pterospora* have been observed to retain viability for 9 weeks after maturation (Bakshi 1959, in Leake 1994). Because of their mycotrophic nature it is suspected that the period from seed germination to flowering may extend over many years (Leake 1994). All attempts at germinating *Allotropa* seeds in the lab, in the presence of a suitable fungus, have failed (Castellano, pers. comm.). Francke (1934) demonstrated that *Monotropa uniflora* required a specific fungal symbiont for germination.

Contrary to its apparent lack of dispersal adaptation, the distribution pattern of *Allotropa* seems to indicate a reasonably good dispersal ability. A plant that is dependent on a conifer host would not appear to be well-adapted to stand-replacing fires. However it was these events that created the habitat in which *Allotropa* is now predominantly found. It appears that within a time frame on the order of 100 years, *Allotropa* has expanded from unburned forest patches, or from the periphery of burned areas, to ultimately become established throughout large, fire-created habitat patches. Unless the burns were very patchy, or *Allotropa* was initially very abundant, this seems to indicate fairly good dispersal and establishment success. There is one example of a large population in a stand that was clearcut approximately 100 years ago (EOR 037, Montana).

Habitat

In its inland range, *Allotropa* typically occurs between 5000 and 7000 ft (1525-2135 m), in mature, park-like stands of lodgepole pine with understories dominated by *Xerophyllum tenax* (beargrass) and *Vaccinium scoparium* (grouse whortleberry). Elevational extremes of 2320 ft (707 m) and 8100 ft (2470 m) have been recorded. Lodgepole pine stands in which *Allotropa* is found represent a persistent seral stage of the subalpine fir and, to a lesser extent, the grand fir series. The distribution of *Allotropa* is tied to a geographic region in which lodgepole pine is the most extensive upland cover type, as a result of extensive wildfires that occurred around the turn of the century.

Because of its mycotrophic relationship, the habitat in which *Allotropa* is found may be a function of the requirements of the associated fungus, with important factors being moisture, organic matter, and the availability of host trees. Individual plants are often found growing out of downed wood in various stages of decomposition, including buried wood. Buried, partially decomposed wood may be an important aspect of *Allotropa* habitat, because it provides moisture and organic substrates required by the mycorrhizal fungi (Luoma, pers. comm.). The downed wood component of stands is highly variable. Some observers associate *Allotropa* with a high volume of downed wood and others with low volumes. Lodgepole stands produce high volumes of downed wood through self-thinning and branch pruning. The downed wood component is a function of a stand's fire, disease, and management history.

Appendix C shows basic habitat variables associated with each element occurrence record (EOR) in the Idaho Conservation Data Center (CDC) and Montana Natural Heritage Program (MNHP) databases. Appendix C was included in lieu of complete EORs which, in addition, would include detailed location information. The tabular format of Appendix C makes it easier to review habitat variables range-wide and relate them to population sizes. Habitat types are usually not given on the rare plant observation reports but, where possible, were inferred from the list of associated species. Printouts of EORs are available from the Idaho Conservation Data Center and the Montana Natural Heritage Program.

Topography. Although topography within its range is highly varied, *Allotropa* occurs primarily on rolling upland areas well above the main drainage bottoms and below the rugged peaks of the main mountain ranges. Populations tend to occur on gentle to moderate slopes with southeast to southwest aspects, but can occur on any aspect. Plants are often found on, or just below, a ridge crest or shoulder in the most well-drained topographic positions (Appendix B, Map 4).

Areas where *Allotropa* occurs were peripheral to alpine glaciers of the Bitterroot and Clearwater Mountains during the Wisconsin glaciation (15,000 years BP). On the east flank of the Bitterroot Mountains and along the Continental Divide, *Allotropa* occurs on glaciated slopes.

Geology and soils. The inland range of *Allotropa* is associated with Cretaceous granitics of the Bitterroot batholith, a northern lobe of the Idaho batholith, and with Precambrian metamorphic rocks along its margins (Mitchell and Bennett 1979). Soils on both the metamorphic and granitic parent materials are typically coarse-textured, well-drained, acidic and often shallow to bedrock. There are not sufficient data to make generalizations about the litter/duff layer. Most of the Idaho portion of the range of *Allotropa*, and the higher elevations in Montana, were blanketed by volcanic ash 6800 years ago and most forest soils retain some ash influence. Ash influence is usually greater on north aspects. Soil profile descriptions for three *Allotropa* sites on the Nez Perce National Forest are shown in Appendix D. All soil horizons are classified as very strongly or extremely acid based on pH values of 4.6 or less. As a result, fungi make up a relatively large porportion of the microbial population (Alexander 1991).

Climate. The climate of the Clearwater Mountains in Idaho is primarily influenced by Pacific maritime air masses. Most precipitation is received during winter and spring, and summers are dry. Average annual precipitation is 30 inches (76 cm) at Elk City, which lies at an elevation of 4000 ft (1220 m). Although the Bitterroot Mountains intercept much of the precipitation from Pacific air masses, western Montana has a climatic pattern similar to the mountains of Idaho. However, climatic differences on the east side of the Bitterroot divide are apparently sufficient to largely eliminate grand fir habitat types, which are extensive to the west in Idaho.

Synecology

Allotropa is most commonly found in seral, lodgepole pine/grouse whortleberry–beargrass communities, with open understories dominated by grouse whortleberry. At least 60% of the *Allotropa* populations for which data are available occupy this community type. The overstory can also include Douglas-fir, Engelmann spruce, grand fir, western larch, or whitebark pine. Ponderosa pine is rarely present. Occasionally, *Allotropa* is found in stands dominated by Douglas-fir, Ponderosa pine, or subalpine fir, but usually with a lodgepole pine component. Most stands are seral to subalpine fir, less often to grand fir. The most striking characteristic of these stands is the open understory, with only a sparse presence of climax conifers. Some appear to represent a lodgepole pine climax, or at least a persistent sere.

Lodgepole pine stands in which *Allotropa* is found are generally considered mature. Ages given usually range from 80 to 200 years. Some are very old stands with individuals as old as 285 years recorded. Evidence of underburning is usually present, sometimes indicating repeated fires.

On the Elk City Ranger District of the Nez Perce National Forest, at the western extent of its inland range, *Allotropa* occupies grand fir habitat types, and often grand fir community types as well. These sites are below 5500 ft (1680 m) and lodgepole pine is sometimes minor or absent. *Allotropa* populations at these sites thus far appear to be minor. Grand fir does not occur extensively east of the Bitterroot divide and consequently is not associated with *Allotropa* there, however, whitebark pine becomes a common community associate.

Throughout most of its range *Allotropa* is found in understories typical of the subalpine fir/beargrass habitat type, grouse whortleberry phase. Grouse whortleberry is usually the dominant ground cover between scattered clumps of beargrass. Understory diversity is low. The heath family (Ericaceae) is particularly well-represented including, in addition to grouse whortleberry, globe huckleberry (*Vaccinium globulare*), prince's pine (*Chimaphila umbellata*), and bearberry (*Arctostaphylos uva-ursi*). Frequently the mycotrophic species pinedrops (*Pterospora andromedea*) and pinesap (*Hypopitys monotropa*) are present as well. Sites can be very cold and droughty, with low understory cover. Many associates are constant throughout the inland range of *Allotropa*, but there are regional differences. Toward the southeastern extreme of its range, on the Beaverhead National Forest, buffaloberry (*Shepherdia canadensis*) is a common associate, indicating very droughty sites, and beargrass is sometimes absent. Table 1 summarizes associated species in several different portions of *Allotropa*'s inland range.

Monitoring results

The growing number of project areas in which *Allotropa* has been found requires constant decision-making on the part of Forest Service biologists to determine cumulative effects. In response to these information needs, permanent monitoring plots have been installed on the Beaverhead National Forest, Wisdom Ranger District, Bitterroot National Forest, Stevensville Ranger District, and Nez Perce National Forest, Red River Ranger District. In all cases, plots were located in dense concentrations of flowering stems and to represent areas differentially affected by timber harvest. Methods for Red River plots are documented in Lichthardt and Mancuso (1991). Only two years of data exist for plots on the Bitterroot National Forest.

The Red River plots have been monitored yearly since 1990 (Cochrane 1994) and the Wisdom plots since 1991 (Carver 1993). Results indicate that the amount and pattern of flowering is very sporadic from year to year. Of 102 plants mapped in Red River plots in year one, 58 never flowered again over the following 4 years (or they migrated far enough before flowering that they were considered new plants). In one plot, 11 plants flowered in 1990 and no flowering has been observed since. Of the plants that did flower again, 11 flowered in consecutive years, 22 flowered in alternate years, and 11 after 2 years. Some plants flowered in 3 or 4 consecutive years.

Previously unrecorded ("new") plants were observed in every year, for both studies. It is not known whether these plants represent a first flowering of plants produced by seed, or of plants that have been non-reproductive for a number of years. Because *Allotropa* spreads along its lateral roots, it is difficult to know what constitutes an individual plant. Dried inflorescences, that may remain standing for 3 years, indicate plant locations. The migration of a genet is sometimes evidenced by a trail of previous years' stems. For the purpose of monitoring it has been assumed that lateral roots do not spread more than 1-2 ft (3-6 dm) without putting up an inflorescence. In the Red River study, only inflorescences within 1 ft of one another were considered part of the same genet. However, stems were mapped on a grid system so that the data can be reinterpreted if we gain further insight as to what constitutes an individual.

Table 1. Species associated with *Allotropa virgata* in different portions of its inland range. Constancy expressed as out of 10 plots. Average cover: <1% (1), 1-5% (3); values > 5 express cover to the nearest 10% (0.1-acre plots). Species arranged in order of decreasing constancy.

Common name	Latin name	Con-stancy	Ave. Cover	Con-stancy	Ave. cover	Con-stancy	Ave. cover
		Nez Perce NF n=9		Bitterroot NF n=10		Beaverhead NF n=6	
Trees:							
Lodgepole pine	*Pinus contorta*	10	70	10	30	10	40
Douglas-fir	*Pseudotsuga menziesii*	10	10	4	20	3	3
Subalpine fir	*Abies lasiocarpa*	1	3	10	1	10	3
Whitebark pine	*Pinus albicaulis*	-	-	5	1	8	1
Grand fir	*Abies grandis*	10	3	-	-	-	-
Ponderosa pine	*Pinus ponderosa*	4	10	-	-	-	-
Engelmann spruce	*Picea engelmannii*	-	-	1	1	7	1
Western larch	*Larix occidentalis*	1	3	-	-	-	-
Shrubs:							
Grouse whortleberry	*Vaccinium scoparium*	10	30	8	40	10	30
Beargrass	*Xerophyllum tenax*	10	60	10	20	8	3
Birch-leaved spiraea	*Spiraea betulifolia*	10	3	5	1	10	3
Huckleberry	*Vaccinium globulare*	9	3	8	20	-	-
Prince's pine	*Chimaphila umbellata*	8	3	6	1	2	1
Bearberry	*Arctostaphylos uva-ursi*	9	10	-	-	1	1
Wintergreen	*Pyrola asarifolia*	9	1	-	-	2	1
Rose	*Rosa spp.*	9	1	-	-	-	-
Serviceberry	*Amelanchier alnifolia*	7	1	-	-	-	-
Oregon grape	*Berberis repens*	4	3	-	-	2	1
Fool's huckleberry	*Menziesia ferruginea*	3	3	2	1	-	-
Matted wintergreen	*Gaultheria ovatifolia*	4	3	-	-	-	-
Boxwood	*Pachistima myrsinites*	3	3	-	-	-	-
Scouler's willow	*Salix scouleriana*	1	1	1	1	1	1
Honeysuckle	*Lonicera sp.*	-	-	1	1	2	1
Wintergreen	*Pyrola sp.*	1	1	-	-	1	1
Forbs:							
Hawkweed	*Hieracium albiflorum/spp.*	9	1	6	1	8	1
Bracken fern	*Pteridium aquilinum*	10	3	-	-	-	-
Piper's anemone	*Anemone piperi*	10	1	-	-	-	-
Golden banner	*Thermopsis montana*	6	3	-	-	-	-
Dogbane	*Apocynum androsaemifolium*	4	1	1	1	-	-
Elephant head	*Pedicularis racemosa*	4	1	3	1	-	-
Rein-orchids	*Goodyera spp.*	1	1	1	1	5	1
Harebells	*Campanula rotundifolia*	3	1	-	-	-	-
Rein orchid	*Habenaria unalascensis*	3	1	-	-	-	-
Pussytoes	*Antennaria racemosa*	1	1	-	-	2	1
Western hedysarum	*Hedysarum occidentale*	-	-	3	1	-	-
Violet	*Viola spp.*	2	1	-	-	-	-
Strawberry	*Fragaria virginiana*	1	1	-	-	1	1
Big-leaf sandwort	*Arenaria macrophylla*	-	-	2	1	-	-

Graminoids:							
Pinegrass	*Calamagrostis rubescens*	6	3	4	1	10	10
Elk sedge	*Carex geyeri*	-	-	4	1	8	1
Ross' sedge	*Carex rossii*	10	3	-	-	-	-
Forest sedge	*Carex concinnoides*	-	-	3	1	6	1
Woodrush	*Luzula sp.*	3	1	-	-	-	-

Three of the Red River plots are in cutting units that were clearcut in 1992. Units were scarified, but there was an attempt to avoid the plots. No flowering has been observed in these plots since logging occurred. Plants on the edge of clearcuts, or in leave tree islands, continue to flower and to increase in number.

Flowering of *Allotropa* appears to be affected by precipitation. In Red River plots, flowering was 28% of normal in 1994, a year characterized by a below-average spring and summer precipitation, and only 1 inflorescence was observed among nine of the Wisdom plots! Evidence from general field surveys supports this same conclusion.

MANAGEMENT CONSIDERATIONS

Based on our current level of knowledge, the conservation of *Allotropa* appears to be inseparable from the ecological characteristics of its lodgepole pine habitat. The distribution of *Allotropa* on either side of the Bitterroot divide is tied to areas of extensive lodgepole pine forest that resulted from wildfires of the early 1900s. Although *Allotropa* is strongly associated with subalpine fir habitat types, subalpine fir is rarely recorded as the stand dominant, and in only one instance does a large population of *Allotropa* occur in a subalpine fir cover type. Lodgepole pine has dominated this ecosystem for centuries based on a survey of the region by Leiberg in 1889 (Appendix B, Map 5). The association of *Allotropa* with a fire-created forest sere, evidence of underburning, and a lack of climax regeneration all point to a relationship with historical fire regimes. However, some of the lodgepole stands in which *Allotropa* occurs could represent edaphic climaxes on sites unsuitable for climax conifers. While the specific habitat factors determining the occurrence of *Allotropa* are not known, stand composition and structure appear to be good habitat indicators.

Lodgepole Pine Ecology

Lodgepole pine is typically a seral tree species that does not tolerate shade and regenerates vigorously following stand-killing fires, with the help of serotinous cones. Lodgepole pine generally has a longevity of 100-250 years depending on site conditions (Brown 1973). As trees approach maturity, they become more susceptible to attack by the mountain pine bark beetle, which plays a key role in stand structure and dynamics (Amman 1977). *Allotropa* populations on the Bitterroot National Forest tend to occupy stands that are breaking up due to insects and disease. Under presettlement conditions, over-mature lodgepole pine stands were likely to burn, resulting in a return to dense, even-aged stands. Nonlethal underburns were also common. The effects of underburning were to remove ground fuels produced by self-thinning, windthrow, and disease, and to remove the less fire-resistant climax conifers. Repeated and extensive fires nearly eliminated seed sources of climax conifers such as Engelmann spruce and subalpine fir from many areas. As a result of modern fire suppression, stands in which lodgepole pine persisted due to recurring fire may gradually become dominated by climax conifers.

Persistent and climax lodgepole pine stands. *Allotropa* typically occurs in persistent lodgepole pine stands. Characteristics of such stands include a tree layer dominated by lodgepole pine, an open understory, low diversity of vascular plants, presence of lodgepole pine reproduction, and low productivity. The only important shrubs are dwarf huckleberry, blue huckleberry, grouse whortleberry, and beargrass (Smith and Fischer 1993). Cooper et al. (1987) list factors responsible for the existence of persistent and climax lodgepole pine stands, according to their importance in northern Idaho:

1. frequent, widespread, stand-replacing fires have eliminated seed sources of competitors;
2. competitors have been removed through frequent, light ground fires;
3. dense lodgepole pine reproduction has excluded other species; or
4. conditions have been intrinsically unsuitable for establishment of other conifers (due to erosion or absence of an ash cap).

Smith and Fischer (1993) attribute a lodgepole pine edaphic climax to shallow, coarse-textured soils of low productivity. Persistent lodgepole pine is recognized as a fire or edaphic climax in both Montana and Idaho habitat classification treatments (Cooper et al. 1987; Pfister et al. 1977).

Management of Lodgepole Pine

Lodgepole pine is generally harvested by clearcutting followed by broadcast burning or slash piling and dozer scarification. On most sites stands regenerate densely from resident seed. Silvicultural prescriptions depend on the extent of cone serotiny in the stand as well as the species desired. Post-and-pole sales take a minority of the trees from young or suppressed stands. Accessible stands are usually thinned to release trees in dense, young stands or to prevent mountain pine beetle effects. Non-utilized thinning debris greatly increases the amount of downed woody fuels present. Direct effects of thinning on *Allotropa* are not known.

CONSERVATION STRATEGY

Based on the current state of our knowlege, long-term conservation planning for *Allotropa virgata* must consider the following points:

- Population viability is dependent not only on reproductive biology of the angiosperm (pollinators, seed viability, germination, etc.) but on that of the gymnosperm hosts and fungal associates.

- Factors responsible for perpetuation of its habitat operate at large temporal and spacial scales (e.g., fire, disease, and timber harvest).

- Because key habitat for *Allotropa* is typically a seral forest type, it is difficult to apply the concept of "protection", in the usual sense, to this species. Natural processes must be allowed to operate even though these may result in a loss of habitat in the short term. Extensive, stand-replacing fires appear to have played an important role in the past and current distribution of *Allotropa*.

This strategy should be viewed as a starting point. It will be important to monitor the cumulative effects of management actions and to alter this strategy accordingly. Effects of management actions may be difficult to detect because of the long time periods involved.

Assumptions. Many questions about the biology of *Allotropa* remain unanswered. The conservation strategy outlined here is based on assumptions drawn from field observations of the species' habitat, our knowledge of the ecology of lodgepole pine, our understanding of mycorrhizal relationships, and the results of permanent monitoring plots. Based on this background the following assumptions were made with regard to inland populations of *Allotropa*:

- Timber harvest and altered fire regimes represent potential threats to the viability of *Allotropa* in parts of its inland range;

- succession to climax species represents a move away from optimum habitat;

- in seral lodgepole pine types, fire, or harvest practices that emulate natural fires as much as possible, will be required to maintain a suitable network of habitat patches over the long term;

- within the known range, suitable habitat can be identified based on a combination of plant community, stand structure, and landtype;

- suitable habitat patches can be colonized through seed dispersal;

- management treatments that disturb the soil will have direct, negative impacts on resident plants via their microbial symbionts;

- large woody debris is an important habitat component; and

- the amount of genetic variation in a metapopulation is a function of the number and density of subpopulations.

Threats

The conservation strategy that follows assumes that a combination of resource extraction and altered fire regime could threaten the long-term viability of *Allotropa* in parts of its inland range.

Timber management. The primary threat to *Allotropa* is perceived to be the loss of habitat through timber harvest. The market for lodgepole pine has increased as supplies of other species dwindle. In fact, our increased knowledge of the species' distribution is a direct result of the number of new projects proposed in lodgepole pine forest types. Patterns and methods of timber harvest, and post harvest treatment, will directly affect both occupied and unoccupied *Allotropa* habitat. Because *Allotropa* cannot survive without a conifer host, local populations (i.e., stand-level or lower) will be lost after clearcutting or stand-replacing fires, owing to the loss of symbiotic fungi. A deforested area will not be suitable for recolonization until the necessary soil fungi are reestablished. Stands of persistent/climax lodgepole pine with low site indices may be difficult to regenerate (Smith and Fischer 1993). Effects of thinning and selective cuts on *Allotropa* are more difficult to predict. Carver (1992) observed *Allotropa* in selective cuts 24 years old, in which ground disturbance was minimal.

Fire suppression. Although logging and stand-replacing fires will have a direct and immediate effect on *Allotropa* populations, changes in natural fire regimes may, over time, affect viability of the species in ways that are difficult to detect. Since *Allotropa* requires a conifer host to survive it would not appear very well adapted to stand-replacing fires. However, it is associated with an ecosystem in which fire is an integral process, periodically producing large, unforested landscape patches. Therefore it must be assumed that *Allotropa* is adapted to a shifting mosaic of suitable habitat patches. Although the historical fire frequency has been altered due to modern fire suppression, extensive, stand-replacing fires like those that produced the even-aged lodgepole stands of today will become more and more difficult to prevent, and may be more severe than under pre-settlement conditions (Arno 1976). Fire suppression may ultimately represent the predominant human impact to *Allotropa*.

Existing Protection

To this point, most stands or portions of stands in which flowering of *Allotropa* has been observed have been exempted from timber harvest in order to avoid direct impacts to plants. Forest Service biologists are understandably concerned about management of these stands and the effects that forest succession, stand decadence, adjoining timber harvest, and the altered landscape mosaic will have on population viability. Pressure to use lodgepole pine forests for timber production will continue, and will increase as extensive areas of mature lodgepole pine stimulate concerns regarding forest health and wildfire.

The system of designated wilderness areas within, and peripheral to, *Allotropa*'s inland range is a very important protection factor (Appendix B, Map 3). Because prescribed fire management is practiced in these areas, they offer much greater potential for natural fire regimes than do managed forests. Also, the size of these areas allows for the development of a natural landscape mosaic that could be critical to long-term viability of *Allotropa*. In spite of a lack of survey, records of *Allotropa* in the Selway-Bitterroot, Gospel-Hump, and Frank Church-River of No Return wilderness areas indicate a potential for significant populations.

Conservation Units

Given the scale of this conservation strategy, and the strong association between *Allotropa* and lodgepole pine community types, it seems appropriate to group occurrences of the species into meaningful management units, and then to focus on habitat quality and management within these units. Cumulative effects can then be assessed at the landscape level through the use of a stand database, possibly built around the National Forest timber stand database. Since individual subpopulations likely represent limited genetic variation, conservation efforts should focus on the number and density of subpopulations in a metapopulation.

Element occurrence records for *Allotropa* have gradually coalesced into several major population centers on each National Forest (Appendix B, Map 6). It is likely that these landscape-level groups of populations experience some level of gene flow and can be considered metapopulations. Each of these metapopulations, along with a network of associated, apparently suitable habitat, will be considered a "conservation unit." A conservation unit will be defined as an area in which most of the habitat is considered suitable for *Allotropa,* and that is separated from other conservation units by large tracts of suboptimal habitat. Adjoining, suitable but unoccupied habitat should be included in a conservation unit (as practical), since these areas may not have been surveyed or may be colonized in the future. Proposed groupings of EORs into conservation units are shown in Table 2. These units should be further refined and mapped through the use of aerial photos and the timber stand database. Isolated, small occurrences were not included in the table but are included in Appendix C. These number 23 on the Nez Perce National Forest, one on the Payette National Forest, one on the Deerlodge National Forest, seven on the Bitterroot National Forest, six on the Beaverhead National Forest and one on the Lolo National Forest. Populations in designated wilderness were also not prioritized (a total of 14 occurrences).

Priority designations. Each conservation unit will be assessed by an agency biologist based on a range of criteria, including quality of habitat, health of stands (as an indicator of stability), extent of potential habitat, degree of fragmentation, and previous management impacts. Then the unit will be classified into one of the priority classes defined below, for which brief management recommendations are given. Note that *range* refers to the disjunct, inland range of *Allotropa* and *viable* is used to refer to populations with numerous, well-distributed subpopulations. Population sizes are based on numbers of genets, as best as they can be determined. A *critical geographic location* is one isolated from other conservation units, or on the periphery of the species' inland range. *Habitat* refers to optimum habitat, defined as follows:

> Mature stands of lodgepole pine between approximately 5000 and 7000 ft elevation in subalpine fir/beargrass, subalpine fir/grouse whortleberry, grand fir/beargrass, or lodgepole pine/grouse whortleberry habitat types. Moderate slopes dominate. Soils are coarse and well-drained. The understory is of low shrubs, primarily *Vaccinium* spp., and beargrass. There is no significant middle or tall shrub layer except for patches of seedling and sapling conifers; climax conifer regeneration is patchy and sparse. The upper canopy is not opening up due to insects or disease, or, if so, the dominant reproduction is lodgepole pine.

This definition can be altered somewhat to reflect differences across the range of the species, e.g., on the Elk City Ranger District of the Nez Perce National Forest where grand fir cover types are prevalent.

Where possible, I have assigned tentative priority designations to the proposed conservation units shown in Table 2. Priority designations are also indicated in Appendix B, Map 7, and in Appendix C.

Table 2. **Proposed conservation units and priority rankings for *Allotropa virgata* in Regions 1 and 4. EORs not included are small, isolated occurrences that will require further survey or assessment in order to assign an appropriate priority. Populations in designated wilderness were not prioritized.**[1]

Land Manager	Conservation Unit	EOR nos. included	Peri-pheral?[2]	Approx. Number of genets[3]	Sub-popns	Priority	Notes on Habitat/Management
IDAHO							
Nez Perce NF Red River RD	Dixie	see Appendix C, 002-048		800-1000	28	3	Numerous proposed and completed harvests.
	Jack Creek	042,043,044,052		400	29	3	Proposed projects
	Poet Creek	015		100-200	3	1	
	Red River	006, 007, 008		100-130	10	2	Interspersed with clearcuts
Elk City RD	Pilot Creek	069, 070	x	10	?	?	Priority subject to further survey
	Rainy Day–Proux Mountain	see Appendix C, 022-080	x	100-200	17	1	Critical location
	W. Fork Crooked River	030	x	20-60	5	4	
	Elk City	019	x	30	1	4	Limited habitat, critical location
	Fall Creek	060	x	20-40	2	2	
	Silver–Deadwood	072, 073		85	2	2	
	Porter's Mountain	058, 061		20-30	-	?	Priority subject to further survey
Payette NF Krassel RD	Warren	024, 025, 026, 027	x	600-1000	15	2	Thinning and clearcutting
MONTANA							
Bitterroot NF Stevensville RD	Bitterroot Front North	005, 024, 035, 057	x	100-200	5	1	
	Smith–Gash	010, 011, 025, 027		60-100	9	2	Excellent Possibly climax PICO?
Darby RD	Sleeping Child	013 014, 015,016		200-400	7	3	Patchy habitat with some stands going to ABLA

Darby RD cont.	Yellowstone Camp	008		200-400	2	3	Excellent, extensive/ Includes large clearcuts regenerating to PICO
Sula RD	Tolan	018, 026		100	2	3	Old growth PICO, critical location
West Fork RD	Lower Mine–Hughes	033		50-100	1	1	Critical location
	Rombo Creek	019		200	?	3	
Beaverhead NF	Pioneer Mountains West	039, 044	x	30-40	5	1	Critical location
	Ruby Creek	029, 038	x	40-50	2	1	
	Slaughterhouse Creek	037	x	500-600	?	1	Critical location
	Trail Creek	020, 021, 022, 023		500-800	11	3	
	West Fork Fish Trap Creek	048		60	2	2	
	May Creek	028, 031		100-200	2	2	
	Tie Creek	040, 041		70	3	2/4	Mixed conifer-habitat may not be optimal
	Johnson Creek	043		50-100	?	2	Extends into 3 quarter-sections
Deerlodge NF	Helm Creek	001		83	–	2	
	Copper Creek (Meyers Ck.)	002		93	–	2	
	Sandstone Ridge	017	x	200-300	4	2	
	Skalkaho Pass	052, 053, 054		300	5	3	

1 These units are subjective and should be refined through the use of the timber stand database and aerial photos. Small populations were included if they are peripheral with respect to the species' inland range. Data are from CDC and MNHP element occurrence records.

2 At the margin of the species currently known inland range.

3 Numbers of genets were in many cases estimated from numbers of ramets (inflorescences) reported.

Conservation units will be prioritized as follows:

Priority 1–Those containing viable metapopulations in optimum habitat and in critical geographic locations but not extensive in area (e.g., Bitterroot Front North, Rainy Day–Proux Mountain; Table 2).

Management recommendations: Manage for lodgepole pine over the long term. Management activities should follow the proposed management strategies that follow. If management activities (other than clearcutting) are conducted in a stand occupied by *Allotropa*, the effects should be monitored. (Monitoring plots currently in place should be sufficient to show effects of clearcutting on flowering of *Allotropa*; effects on below-ground growth and mycorrhizal symbionts will require more rigorous monitoring and research than that addressed here). Also monitor the entire conservation unit on a landscape scale through use of a stand database that includes cover types, management activities, and sensitive plant occurrences (eventually mappable with GIS).

Priority 2–Conservation units containing 20 to 200 genets, not in critical geographic locations, but in optimum habitat (most conservation units fall into this category).

Management recommendations: Avoid direct impacts to subpopulations. Manage for lodgepole pine over the long term using the proposed management strategies that follow. More field surveys may be warranted.

Priority 3–Extensive units, regardless of geographic location. Abundant subpopulations are distributed over a wide area containing extensive optimum habitat. Some include hundreds of individuals (e.g., Dixie, Jack Creek, Yellowstone Camp, Trail Creek, and Skalkaho Pass; Table 2).

Management recommendations: These conservation units should be the most resilient to management impacts. Maintenance of well-distributed subpopulations will provide seed to colonize harvested or burned patches as succession proceeds. Manage for lodgepole pine production using the proposed management strategies that follow. Avoid direct impacts to subpopulations of 100 or more genets (200+ ramets). These conservation units could be used to test active management (e.g., commercial thinning, underburning, canopy opening) on a limited scale.

Priority 4–Conservation units containing small populations in limited habitat. Also, larger occurrences in suboptimal habitat and not in critical geographic locations; or where suitable habitat appears to be limiting.

Management recommendations: Additional field survey work may be needed. Generally, these will be given no special management consideration. Monitoring should not be needed unless further survey warrants. All occurrences should be documented. Small, isolated occurrences are not considered viable because of their vulnerability to random extinction.

Proposed management strategies:

The following strategies should be evaluated on a site specific basis and applied, where appropriate, to management planning and activities within *Allotropa* conservation units (priorities 1, 2, and 3):

- Silvicultural and fire prescriptions will contain *Allotropa* management objectives.
- A biological field survey will be conducted before cutting units are marked so that the data can be used to avoid high concentrations of plants.
- Field surveys will include stand descriptions that can be used to evaluate habitat quality for *Allotropa*. Habitat quality will be evaluated based on extent of disease and mortality, and the stand structure (size class distribution, species composition, canopy cover, etc.).
- When possible, field surveys will extend beyond proposed project units. GIS and landtype data will also be used to identify potential habitat.
- Harvest units will be clustered in the landscape in order to retain large continuous patches of suitable habitat and reduce edge effects.
- Timber management (harvest and prescribed fire) will maintain a staggered stand age structure. No more than 20-30% of the acreage within a conservation unit will be in an early successional stage (sapling or younger) at any given time (must be monitored through the use of the timber stand database).
- A forested buffer width of at least 50 ft will be required to avoid impacts to *Allotropa* populations adjoining harvest units.
- Following timber harvest, at least 20 tons per acre of large woody debris, both down and standing, will be left well-distributed throughout the unit.
- Broadcast burning will be used as a post-harvest treatment.
- Scarification will not be used in site preparation.
- The amount of soil disturbance will be minimized, utilizing over-the-snow harvests where practical.

Monitoring and Research Needs

Monitoring already in place on the Nez Perce National Forest should be sufficient to demonstrate the effects of canopy removal on *Allotropa* growing within and near harvest units. This monitoring should be continued for at least two more years, resulting in four years of post-harvest data in all plots. Monitoring plots in cutting units on the Beaverhead National Forest have not yet been harvested. Still, they provide baseline data from a variety of population sizes and habitats. Because flowering is highly variable, monitoring should continue there for a minimum of two more years. Mapping of individual plants is important because of the difficulty in defining genets. After two years data should be summarized and evaluated. Copies of all reports should be filed with the Montana Natural Heritage Program (Helena, Montana) or Idaho Conservation Data Center (Boise, Idaho).

Large-scale monitoring. Demographic monitoring, such as that already in place, tracks individuals over time. This results in detailed observations of a sample of the population, but it is usually not known how representative that sample is. In the future, to assess the effects of management actions such as prescribed fire, timber harvest and thinning on *Allotropa* populations, it is recommended that larger-scale monitoring be implemented. For example, the species could be monitored on a conservation unit-level using stands (delineated polygons) as sampling units. Selected stands could be sampled by walking transects across the contour and counting plants or subpopulations. Although some plants will be missed, the technique would be repeatable and could detect large changes in plant abundance due to management.

Active management can be initiated on small portions of priority 3 conservation units to assess the effects of thinning, underburning, and canopy opening on *Allotropa*. A monitoring plan should be part of the management prescription.

Survey. As a part of field clearance surveys, adjoining, suitable habitat should also be examined as time permits. Observation reports for *Allotropa* should include notes on habitat quality (extent of disease and mortality, stand structure, and species composition of the overstory and understory). When submitting an observation report to the CDC or MNHP, indicate which conservation unit or other EORs it should be grouped with for management purposes or whether it should be separate. Very young, managed stands that are part of conservation units should be sampled for *Allotropa,* to test our assumptions about optimum habitat and the effects of timber management..

Research. Important research needs include how soon *Allotropa* can colonize regenerating lodgepole stands, what types of post-harvest treatment encourage colonization by the necessary fungal associates, how soil properties relate to the presence of suitable mycorrhizae, and what role underburning plays in the ecology of the species. Monitoring plots where baseline data have already been collected could be instrumental in looking at the effects of post-harvest treatments and prescribed burning.

Mycological investigations of this ecosystem could have implications for forest health and site productivity assessment, and could possibly illuminate the role of mycorrhizal symbioses in harsh environments. Unfortunately, management-induced changes to the ecosystem will be very long-term. The only way to predict the results of our actions is to interpret the present landscape in terms of past processes. One of the assumptions of this conservation strategy is that the presence of mycorrhizae suitable for the establishment of *Allotropa* can be predicted on the basis of overt characteristics of a stand. To test this, the mosaic of stand ages, histories, and structure present within a conservation unit could be used to examine successional changes in quantity and composition of soil mycorrhizae. Also of interest, is whether the fungal symbionts differ when different conifer species are involved.

Genetic studies could show how much divergence there has been between coastal and inland populations and how genetic diversity is partitioned along the hierarchy of population organization from local colonies to large metapopulations. The amount of resources expended on conservation could then be balanced against the amount of diversity potentially at risk.

Recommended Implementation Schedule

Five-year action plan:

1995 1) Continue demographic monitoring on Nez Perce and Beaverhead National Forests.

2) Delineate conservation units in terms of stands, and make initial assessments as to habitat suitability, extent, continuity; and past management impacts.

3) Begin developing a stand-based database for Priority 1 conservation units including cover types, management activities, and sensitive plant occurrences.

4) Develop stand-based monitoring methods for *Allotropa* populations.

5) Large-scale, stand-based monitoring is recommended where management activities (fire/timber) are proposed within priority 1 conservation units. This should begin with systematic searching during the clearance survey phase, that could be repeated following management activities.

6) Advise District botanists of important habitat characteristics and population parameters needed to prioritize *Allotropa* occurrences (e.g., numbers of stem clusters and stand composition and structure).

1996 1) Continue demographic monitoring on Nez Perce and Beaverhead National Forests; tabulate data, and summarize results and observations. Submit reports to the Regional Botanists and the Montana Natural Heritage Program or Idaho Conservation Data Center.

2) Complete stand database for priority 1 conservation units and begin on priority 2.

3) Reevaluate sensitive status in Region 1 based on further survey and cumulative impacts to habitat. Make recommendations to Regional Forester.

4) Begin conducting stand-based monitoring of project areas in Priority 1 conservation units.

1997-1999: Update databases for conservation units. Continue stand-based monitoring of project areas in Priority 1 conservation units.

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