The Biodiversity Enhancement Demonstration Forest

Campus Stewardship Option

Sustainable Forestry Program

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*** Participants from fall 2000 quarter only**

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I Introduction

Old-growth forests in Washington, Oregon, and California have declined by more than fifty percent since 1930 (Waddell 1993). Despite their ecological significance and importance, little is known about remaining old-growth forests. This basis provides an excellent educational opportunity for the Evergreen community to create a demonstration of how sustainable forest management can be used as a tool to speed up the development of old-growth characteristics and transform today's second growth forests into tomorrows old-growth habitat structures. We believe it is important that the Evergreen State College manage its forestlands responsibly for the benefit of both wildlife and education.

The Biodiversity Enhancement Demonstration Forest proposed location is on the "Sherman Tract" which is a plot of land located in the Organic Farm Cluster on The Evergreen State College campus. The proposed thinning would benefit the campus and students by providing an outdoor on-campus laboratory and providing an excellent opportunity for the college to extend educational information to our surrounding communities. It could help fulfill the college's requirement to "defending the value of its un-built property" (Campus Master Plan 1998). This thinning will also lead to the creation of greater biodiversity in tree species and understory plant species, which could develop vertical and horizontal layering that is characteristic of late-successional habitat. These characteristics will provide the many of the unique habitat niches that late-successional associated species need. This proposed plan would also provide a working model of the benefits and practices of sustainable forest management, which can be observed and used by students and the community on their own land, thus improving habitat at a landscape scale.

The Evergreen State College Sustainable Forestry Program proposes that the college take a leadership role in educating future land managers with the skills and insights to help improve current stand conditions resulting from poor past management practices.

II Ecological Goals and Objectives

Our ecological goal is to use thinning to move the stand from the "competitive exclusion stage" to the "understory reinitiating stage" (Carey 1996). The and canopy gaps that will provide for the establishment of multiple canopy and shrub layers, and diversity within species composition.

This method of forest management, ideally, will create high quality wildlife habitat with important late-successional habitat characteristics in a much shorter period of time than it would take to develop in nature (Hayes et al 1997). The removal of select trees will increase the quantity of light reaching the forest floor, which in turn increases the growth of understory trees and vegetation that provide important horizontal and vertical structural variations for wildlife. The other characteristics we hope to develop include large snags, large diameter trees, and large coarse woody debris. The use of silvicultural practices could reduce the total time needed to produce late successional habitat characteristics as much as 150 years (Dowling 2000).

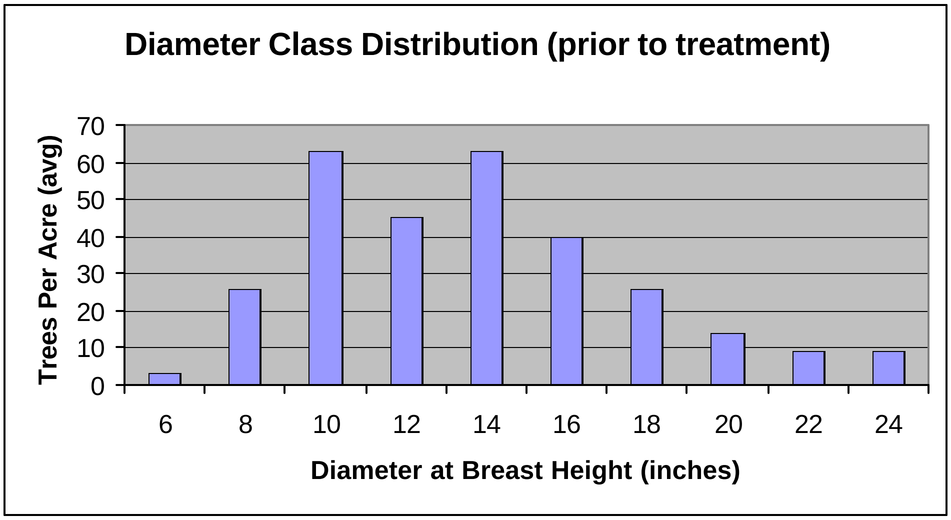
Therefore species requiring this increasingly rare habitat will have better odds of recovery and/or prevention of listing.

III Stand Description and Forest Inventory

The forested land on campus and much of the surrounding landscape consists of diverse second growth stands. These stands contain varying populations of western redcedar (*Thuja plicata)*, bigleaf maple (*Acer macrophylum)*, red Alder (*Alnus rubra)*, Douglas-fir (*Pseudotsuga menziesii)*, black cottonwood *(Populus trichocarpa)*, western hemlock *(Tsuga heterophylla)*, grand fir *(Abies grandis)* and an assortment of understory tree species.

The fragmented nature of the surrounding landscape and the lack of mature and old-growth habitat in the area makes it crucial that our land on campus should be managed to maximize its habitat opportunities.

The proposed demonstration forest is 4 hectares in size. This forest was clearcut and burned in the 1930's. The second growth regeneration is composed of over 90% Douglas-fir composition and is now approximately 70 years of age (Winn 1975). This stand is currently in the competitive exclusion stage. This is where "trees compete for water, light, and nutrients and the understory trees, shrubs, and herbaceous plants decline" (Carey 1996). The stand relative density is 76 (Dowling 2000). There are currently 298 trees per acre with an average diameter of 13 inches (Dowling 2000). There is visible evidence of disturbance to the soil from the harvest in the 1930's. The land was tractor logged and burned. The ruts in the soil from the equipment used can still be seen and burnt logs and stumps are also visible.



The main understory component is salal (*Gaultheria shallon*). It covers approximately 50% of the understory. Some of the other understory components include; dwarf Oregon grape (*Berberis nervosa*), evergreen huckleberry (*Vaccinium ovatum*), red huckleberry (*Vaccinium parvifolium*), and western sword fern (*Polystichum munitum*)(Dowling 2000). Additional detailed understory vegetation data will be collected at a later date.

There are two legacy trees in the stand, and there are some large legacy snags and downed wood. The current downed wood and snags per acre over 15 inches in diameter will be available this spring.

IV Preferred Silvicultural Prescription

Our preferred management prescription is designed to establish 4 demonstration blocks, each one-hectare in size. This would utilize nearly all of the forested land inside the Sherman Tract. Each block will be thinned to a different prescribed relative density. This would provide an increased variation in habitat and would lead to different rates in stand development. These rates can be studied and monitored. The first block will be a light thinning from below to a relative density of 40, which would leave approximately 174 trees per acre. The second block will be a medium thinning from below to a relative density of 30, which would leave approximately 130 trees per acre. The third block will be a heavy thinning from below to a relative density of 20, which will leave approximately 87 trees per acre.

Pre-Treatment

	Trees/Acre	Relative Density(RD)	Basal Area/Acre
Block 1	298	76	274
Block 2	298	76	274
Block 3	298	76	274
Control	298	76	274

Post-Treatment

	Trees/Acre	Relative Density(RD)	Basal Area/Acre
Block 1	174	40	160
Block 2	130	30	120
Block 3	87	20	80
Control	298	76	274

The fourth block will not be thinned at all. It would act as a control with a relative density of 76 and approximately 298 trees per acre. Additional establishment of controls outside the Sherman tract might offer additional comparison benefits and are being considered.

Seedlings will be underplanted in the thinned areas to increase the development of canopy layering. A variety of species will be planted including pacific yew, western hemlock, Douglas-fir, big-leaf maple, western red cedar, and grand fir. These species were determined by their ability to grow and survive in the shade provided by the leave trees. The amount of each species will be determined by its frequency on campus. Planting audits and regeneration surveys will be used to ensure proper planting and to determine if replanting is needed.

Our management schedule was partially based on Dr. Andrew Carey's "biodiversity thinnings" (Carey 1996). The demonstration blocks will be re-entered for the next thinning in 20 years or a relative density of 20 to 30 for the first block, 30 to 40 for the second block and 40 to 50 for the third block. An additional thinning will take place after another 20 years to maintain the previously stated relative densities. The stand should attain the "fully functional stage" in 50 to 70 years (Carey 1996). At each of these thinnings, coarse woody debris will be left and cavity trees will be created at a variable density. Computer generated growth models will be used to help determine the needed re-entry schedule for our particular forest.

V Expected Yields, Costs, and Sources of Revenue

The expected yields are determined by the size and number of trees that will be selected for removal in order to reach the prescribed relative density for each thinned block. Data from the updated cruise and computer volume programs will be used to predict this.

Horse logging is the preferred method of log extraction. The cost of the horse logger is approximately 30% of the timber market value depending on current market prices (Harpol 2000). The logs removed from the thinning operation can be milled on campus using a portable sawmill and used on campus by facilities, wood shop, boatbuilders or other campus wood consumers. In order for the wood to be used on campus these wood consumers may have other requirments for the wood to meet their standards. For example the wood may need to be kiln dried, stamped, and graded before they can be legally used for construction. There is also the option of selling the wood to an industrial sawmill (possibly Smart Wood certified). The money generated by either of these options can go toward the project and operational expenses. Some of these expenses include; forest certification, seedlings for underplanting, snag creation, wood bundling for large coarse woody debris, conversion of roads into educational trails, road construction, permits and application fees, timber falling, milling costs (if done on campus), monitoring expenses, brush piling for small mammal habitat, hauling costs, horse logger, and any fuel reduction expenses.

The main objective in funding the Biodiversity Enhancement Demonstration Forest is to not feel pressure to sacrifice the ecological principles. Decisions to be made that often pit economics against ecological principles include: which trees to harvest, harvesting methods used, the relative density to thin, CWD and LWD left on the forest floor, fuels disposal, and replanting. We will not let economics be a concern no matter whether our funding is from grants or from the wood removed. The decision will be based on what is best for the forest.

There are trade offs between using grants vs. using wood profits. Grants may be found now to fund the study but others in the future may not. The selling of wood to the campus for campus use is much more stable and provides a source for on campus wood consumers that want wood that is obtained in the most ecological way. The campus has a strong demand for wood in their wood shop, boat building, facilities, etc. and this can be predicted well into the future. We recognize there are cost factors we cannot predict and we must prepare for them in the most stable and predictable way.

As an option, we are attempting to obtain funding through grants. We have identified various grant options and will pursue them winter quarter. It would take little modification to format the Biodiversity Enhancement Demonstration Forest plan into the grant application forms we have available. We feel confident that we can apply for grants professionally and we have grant-writing resources we can utilize. The proposed grant allocation would cover the costs not recovered from the wood harvested. It has been suggested that long-term monitoring could be covered through a grant-funded internship with the Evergreen Long term Ecological Database project. This would ensure a constant applicant pool and a high caliber of data being collected.

VI Alternative Silvicultural Prescriptions

Overview. Although the greatest attention is being paid to the drafting of a complete management plan for the chosen silvicultural system mentioned above, we feel it is also important to briefly expose the following alternatives.

***Alternative one**:* **Thinning Two One Hectare Blocks With a One Hectare Unthinned Control**. In this proposal, two blocks would be treated instead of the preferred options three blocks. These blocks would be located in the same portion of the Organic Farm Cluster and would consist of a light thinning of 40 RD and a medium thinning of 30 RD. The method of harvest would be the same as well as road placement. This alternative would simply be the same as the preferred option except there would be no heavy thinned block.

This method would not create as much late successional habitat as the preferred option and would not provide an educational demonstration to the same extent.

***Alternative two*: Thinning One Block, One Hectare in Size With One Unthinned Control**. In this proposal, one block would be treated instead of the preferred options three blocks. These blocks would be located in the same portion of the Organic Farm Cluster and consist of a light thinning of 40 RD. This alternative would require, the extraction of the logs, to be performed by using a human powered logging arch instead of a horse logger. Otherwise the lower number of logs extracted would not be able to pay for itself. This alternative would also require 100 meters less road than the preferred option.

This method would not create as much late successional habitat as the preferred option and would not provide an educational demonstration to the same extent or be considered a scientific experiment.

Alternative 3: **Thinning Six Blocks Each One-Hectare in Size With Two Unthinned Controls.** In this proposal, six blocks would be treated instead of the preferred options three blocks. Three blocks of these would be located in the same portion of the Organic Farm Cluster and the other three would be located in the north side of the South Campus Reserve just south of the Organic Farm Trail. The thinning blocks would consist of two light thinning blocks of 40 RD, two medium thinning blocks of 30 RD and two heavy thinning blocks of 20 RD. The method of harvest would be the same. An additional 100 meters of road would be needed. This alternative would be two replications of the preferred option.

This method would create the largest area with late successional habitat characteristics and would provide an educational demonstration as well as a scientific experiment with replication.

Alternative 3: **No Action.** In this alternative the forest would continue developing at the same rate of development in the competitive exclusion stage. The benefits of late successional habitat to the flora and fauna would be delayed for as much as 150 years (Dowling 2000). Biodiversity would remain low as well as the development of habitat niches. The students, faculty, and the community would not have the educational benefits that action alternatives would provide (Dowling 2000). Knowledge of how second growth stands develop into late successional forests would be limited. The demonstration of how to promote late successional habitat characteristics for the benefit of late successional associated species would not be realized.

Alternatives Considered But Dismissed. The following alternatives, or sub-options, were developed as other ways of achieving the goals and objectives but were dismissed due to their drawbacks. These options are important in demonstrating the wide variety of ideas considered and helped in forming our preferred option.

Dismissed Alternative A: **One-Hectare Management**. In this proposal, land managers would thin a one hectare forested block within a densely stocked stand on campus. The placement of this block would be inside the boundaries of the forested portion of the organic farm cluster.

The main objective for this small parcel of land would be to create a working example of a low-tech, student thinned forest that focused attention on hands-on sustainable harvest of local wood products. Participation would be encouraged on all levels, from stand inventories and pre-harvest planning to on site milling and the utilization of finished wood products in the campus wood shop. Management would promote enhanced growth of remaining trees and biodiversity through increased canopy openings. Also, thinning densities would follow prescribed "best management practices" for the enhancement of wildlife habitat.

Benefits from this sub-option include an on campus educational model for the use and harvest of local wood resources, active participation from students and skilled community members, small plot size that allows for flexibility in determining which stands are most appropriate, and a small-scale "flagship" model for the promotion of good forest management in an otherwise unmanaged campus landscape.

There are several limiting factors to this proposal. First this thinning would not be large enough to provide room for the duplication of treatments to be a scientific experiment. Second, the use of students to use "human power" means of log extraction would have liability risks. Third, such a small scale of tree removal would not be of adequate size to demonstrate biodiversity enhancement.

***Dismissed Alternative B*: thinning from snag creation by girdling live trees**. This alternative silvicultural prescription arose from concerns of removing merchantable timber from campus land and selling the logs to a mill. The main objectives here are to thin a stand for increased diversity and to speed up the development of late seral forest characteristics without any tree falling taking place and without the use of any mechanized equipment.

In this proposal, plots chosen from within a dense stand would be thinned by simply girdling trees in place and letting the slow death of the standing trees create canopy openings. All girdled trees would remain standing and down logs would only accumulate on the forest floor by means of natural events. Changes within the forest structure would happen gradually as girdled trees slowly died and increased light reached the forest floor. There would be no dramatic edge created from this type of management, as densities of girdled trees would be low. After trees have completely died some under-planting could be done but would be limited to shade tolerant species.

This proposal does not involve the actual falling of any trees, thus keeping costs of the operation very low. All activities would be done with simple hand tools with no special skills required.

There are many limiting factors to this management proposal though. First, as the number of standing dead trees increases so does the populations of insects associated with those tree species. This increases the probability of a large scale insect attack that could result in unwanted damage to the remaining stand. The second limiting factor results from the raising of fuel loads from the standing dead trees, thus creating a forest much more susceptible to uncontrollable fire. Also this would not be a realistic demonstration because it is much less sustainable for communities and landowners, who would want to use a model of sustainability, to afford it because there is no economic return or product. The creation of so many snags would also pose a high liability hazard as well.

VII Desired Future Conditions Under Preferred Option

Forest ecosystems are complex functional systems that need be studied and understood. The creation of the Bio-diversity Enhancement Demonstration Forest would help do this. Also when managing for future stand conditions past forest conditions and disturbance that shaped them should be understood and integrated into the management.

The fully functional stage we want to attain through habitat management is described by Carey (1996) as an "additional ecosystem development that provides habitat elements of necessary large size and time for development of functions to provide for life requirements of diverse vertebrates, fungi, and plants". Tapeline (1997) describes it as follows, "The typical structure consists of large trees in the overstory, smaller trees of varying sizes and species in the lower and middle story, large standing and fallen dead trees, and patchy shrub and herb communities." In this stage there would be adequate numbers of large snags for primary and secondary cavity nesting birds. There would be large quantities of large course woody debris for small mammals, amphibians, and microbial habitat. Rich organic soil would be developed from large amounts of litter fall decomposing for nutrient availability for trees, shrubs, and herbs. The dominant leave trees would attain large diameters and height. The forest canopy would contain complex structure (horizontal and vertical variation) to provide multiple habitats for bird species feeding niches, cover needs, and nesting requirements. The future condition:

A well developed multi-layered canopy is in place. Coarse woody debris is in abundance; prime habitat for late seral plants, microbes, and animals creates tremendous species diversity. The forest functions are operating at their highest efficiency. A complex biotic community prevails

VIII Description and Rational for Preferred Harvest System

There are two proposed methods of harvesting for the Sherman tract. The first is directionally felling marked trees using chainsaws, falling wedges and axe to limit damage to leave trees during the actual felling, and facilitate log removal by horse. This would limit damage to leave trees during skidding by felling trees at angles to the skid trails so as to limit the logs need to pivot. A faller/horse logger should be consulted prior to marking so the trees will be marked with an understanding of these considerations.

Lacking that, a "loggers option" method of tree marking where all potential harvest trees are marked and counted, and a designated portion then removed by the logger could be used to keep leave tree damage to a minimum.

Non-mechanized falling options were considered but rejected due to time constraints, felling accuracy, and safety. The chainsaw offers advantages over the crosscut saw in terms of speed. Additional information about this discision is found in the logging plan portion of the appendix.

Other methods of extraction were considered, such as the use of the feller-buncher, skidder and bulldozers, but all were rejected on the grounds of possibility of causing too much damage to the soil and vegetation. The horse logging option won out over other methods due to its common use for tree removal in ecologically sensitive areas. (Harpol 2000)(See Appendix) No tree length yarding is to take place, trees will be limbed and topped where they fall, and suitable log lengths cut from them with consideration given to the potential for increased leave tree damage as the skidded log length increases. Timber extraction will be done in mid-summer to early fall to further reduce soil compaction and movement.

X Road Construction and Monitoring Plan

Road construction is essential to protecting soil and water quality affected by erosion. "A well designed, located, constructed, and maintained system of forest roads is essential to forest management and protection of public resources" (WSDNR, Ch.222-24

WAC). Planning for the road on campus requires information from stream location and classification maps, soil survey maps, and topographic maps.

The Biodiversity Enhancement Demonstration Forest will need to construct approximately 487 meters of road for the extraction of logs (Dowling 2000). Approximately 100 to 150 meters of the road would require the removal of some trees for construction of a standard 8 foot roadbed. The proposed road placement would run parallel and just inside the fence of the organic farm garden and extend into the Biodiversity Enhancement Demonstration Forest where it turns north. The portion of the road along the edge of the Organic Farm will not require any tree removal. This previously cleared area is unusable to the farm because of the shade created by the trees in the South Campus Reserve (Dowling 2000). The proposed location of the road is on very flat ground (0 to 5 percent) and is a long distance from any stream.

The road constructed for the extraction of wood will only consist of a temporary dirt spur. This is all that is needed due to the low amount of road use and the time of year it will be in operation. The proposed road would follow the rules of Washington Forest Practices set by the Department of Natural Resources with emphasis on temporary road guidelines. The time of road use must be approved in the forest practices application. A temporary dirt spur will be constructed with the plans of exercising closure and decommissioning when intended forest practices are complete (WSDNR, 222-24-026). The DNR will then determine whether proper decommission procedures have been exercised, notifying the landowner of the status of such road. Upon specific planning of the harvest, a road decommissioning date will be set. The roads will be decommissioned to educational trails after the log extraction is completed. The decommissioning consists of loosening the soil and revegetating with native flora.

The only vehicles on the proposed road will be a pickup towing the horse trailer, a pickup towing a portable saw mill, and a flat bed pickup to haul out the finished lumber. If milling does not occur on campus, then adjustments will have to be made to the road plan to enable access to heavy self-loading log trucks. This may include widening road corners and capping the road with rock material.

The construction of landings will not be necessary. The use of horse logging will not need landings because the team of horses will use road edge as the landing (Harpool 2000).

The soils in the Organic Farm Cluster, which the constructed road will be located, are a glacial till. The surface layer is composed of 6 inches of a very dark brown gravelly sandy loam followed by a subsoil layer 9 inches deep containing dark brown gravelly sandy loam and the lower 15 inches below the subsoil is dark brown, very gravelly sandy loam (U.S.D.A. 1980). The hard pan is weakly cemented together at 20 to 40 inches below the surface (U.S.D.A. 1980). These soil characteristics make this soil type stable and well drained, which is suitable for road construction.

Due to the site's low gradient, no stream crossings, and minimal length of road, there is a low risk of serious damage due to erosion. The road surface should be crowned along with proper drainage ditches in slumps. Water bars and rolling dips are positioned strategically on dirt spurs to divert runoff and minimize erosion. Runoff should drain into a catch basin, if necessary, to control water velocity.

The use of cross drain culverts will not be necessary because the road will not cross any streams but a culvert will be needed where the planned road meets Lewis road (Forest Practices 1997). “In western Washington, culverts in non-fish bearing waters need to be a minimum of 18” in diameter” (Forest Practices Illustrated, 1997). The idea of removing the culvert after the applied forest practice will be considered.

The proper construction will help to prevent poor hydrology of campus lands. The opening of the canopy and the soil compaction due to the road will alter the hydrology for a short time.

This soil is classified as suitable for year round logging, but logging would only take place in the summer or early fall to minimize the impacts (U.S.D.A. 1980). Monitoring and maintenance of the road will be in practice until the road is decommissioned.

XI Forest Protection

The Campus Master Plan has clear fire management guidelines but it does not differentiate between natural and man caused fires. Without such a distinction, it is necessary to treat all fires the same, i.e. put them out. It may be beneficial to have guidelines that allow for a “let burn” policy within a strict set of environmental parameters, the policy would allow for some fires to burn with close monitoring if conditions are favorable for a under-burn. This would be in line with the current guidelines in the master plan that state that prescribed fire may be necessary in the future to reduce fuel loads (Campus Master Plan 1998). The Campus Master Plan also addresses the possible need in the future for prescribed burning as per Forest Service guidelines.

The plan does not, however, address what level of fire preparedness needs to be maintained during a logging operation on campus. We will work with the local Department of Natural Resources Fire Warden to determine the proper preparedness level for our stand and environmental conditions at the time of harvest.

Post harvest fuel loads will be examined and a determination will be made as to what, if anything, needs to be done. Should the fuel load be deemed excessive, there are several opportunities to modify the fuels arrangement to reduce the hazard (See Logging Plan in Appendix).

The Campus Master Plan does not address the issue of forest pests and what, if anything, should be done should become a significant problem. Should forest-wide tree mortality occur, it is unclear if the dead trees be harvested, or left in place despite the fire hazard? While it is unlikely that such event would occur under current forest and climate conditions a few years of drought, coupled with an insect infestation could result in sufficient tree mortality enough to cause concern. We should address this possibility and implement monitoring procedures to track tree mortality on campus and provide suggestions to the CLUC for managing possible future conditions.

Similarly to insect infestations, windstorms have the potential to kill large numbers of trees. Large-scale blow-down can in turn provide feeding opportunities for insects such as wood boring beetles. The newly increased beetle populations then often spread to healthy trees in the surrounding area. Large-scale blow-down, by itself, or followed by an insect infestation can cause high intensity fires due to vastly increased fuel loads. Additionally, we should be monitoring our forest for the evidence of other organisms that can adversely affect forest health. For example, there are several species of root rot that have the potential to cause concern for forest managers when their prevalence increases beyond normal levels. Periodic monitoring can help determine action should be taken to manage outbreaks or to leave the condition to follow its natural course.

XII Noxious Weeds/Invasive Species

The Campus Master Plan identifies the need for the control of exotic invasive species when they dominate within the ecological reserves and provides “encouragement” for restoration efforts within those areas.

The Master Plan does recognize the importance of some removal of invasive species from its core and clusters:

> Invasive, exotic species such as Scot's broom, English holly and English ivy are inappropriate for landscaping. While these species may be attractive in a formal setting, they quickly spread to invade native habitat, and can displace native vegetation (see Ecological Restoration, page 98). Efforts should be made to remove these species from the campus Core and Clusters whenever possible. (Campus Master Plan 1998)

The Master Plan addresses these issues with an even stronger statement in it “ecological restoration” portion:

> Removal of invasive, exotic plant species should be a major, ongoing restoration activity in the Reserves as well as other areas of campus. The invasion of exotics is beginning to have an obvious impact to the

> vegetation communities in several areas on campus and this threatens a valuable academic resource. While it is probably impossible to entirely eradicate invasive species, efforts should be made to keep them under control. Also, since invasive species tend to flourish in disturbed areas, protecting native habitat from negative impacts such as overuse will aid in slowing their spread. Application of ecological restoration theory on campus lands is an exciting possibility that should be considered as a part of both academic and land use planning. These activities directly benefit the health of the ecological laboratory and provide invaluable educational experiences for the students involved in any part of the process. (CMP)

Every effort should be made to prevent, eliminate or reduce the spread of invasive exotic species into new areas. The introduction of invasive exotic species by accident takes place when plants are brought in as contaminants on vehicles and other conveyance devices (Gordon and Thomas 1997). Tire treads can carry weed seeds and can spread them from one area to another (Federal Interagency Committee 1998). Simberloff (1997) mentions that a long-term project in Carolinas to eliminate Witchweed (*Striga asiatica*) has succeeded by regulating the movement of soil contaminated equipment. Therefore, incoming vehicles should be washed, including the wheels, wheel wells, and bumpers prior to entering the unit for the first time and additionally as needed.

It will be impossible to prevent establishment of invasive exotic species in a demonstration area. However, early detection of these species will keep them under control (Simberloff 1997). Early detection will also keep control cost low. Once invasive species are detected, an eradication effort should be made. Eradication is more likely to be successful if it is done early (Federal Interagency Committee 1998). Invasive species may not be eradicated completely, but can be controlled (Schardt 1997). Pulling and digging are the most effective ways of manually controlling weeds, although pulling is not a suitable method for more mature plants (Dodd et al. 1994). Systematic checks for new invasions will be effective even after eradication of the invasive species has taken place (Randall et al. 1997). Therefore, it will likely be necessary, in spite of precautions, to monitor the area for invasive species for some time after harvest. This monitoring could easily be done while other monitoring activities in the area are taking place. Students in the next Sustainable Forestry program will perform further monitoring in the 2002.

XIII Environmental Protection Measures for Sensitive Areas

Environmental protection measures for the site containing the demonstration forest will primarily be associated with increasing wildlife habitat and minimizing soil compaction. No protection measures for wetlands or riparian areas are required for the preferred option. Two guidelines for environmental protection measures were used for this study, The Forest Stewardship Council Guidelines (Draft 3.0 Nov. 1, 1999) and the Washington State Environmental Policy Act Guidelines (SEPA)(Chap 222-10 WAC).

The Forest Stewardship Council (FSC) would classify the Sherman stand as a "Type 4" forest or one where late-successional/old-growth remnants or characteristics are absent or virtually absent (FSC, Section 6.3). One of the main goals of the BEDF is to increase biodiversity within this section of campus land. As stated previously we hope to achieve this through thinning; adding course woody debris to the forest floor, increasing light levels for understory plant species development and leaving existing snags and potential snags for use by existing wildlife.. This plan also includes protection measures for endangered species found in the stand as well as species which may not be endangered but rely on a healthy forest for survival.

The FSC guidelines for environmental protection require that forest managers consider numerous ecosystem functions while constructing plans. Decisions made about green tree retention and course woody debris must allow for sustaining and protecting existing associated populations of plants, fungus and animals. Specific course woody debris goals for post harvest include 4 to 12 logs of at least 15' in length and at least 20 inches in diameter to remain (FSC section 6.3(i)).

FSC also has several guidelines pertaining to snags and stumps as important components for forest health and ecosystem function. The proposed area for the BEDF has some legacy stumps and very few large snags for use by cavity nesting birds and small mammals. The demonstration area shall have no net loss of legacy stumps or large snags, and managers will have to select trees for snag recruitment. Protective measures of flagging and communication with the logger/faller will help to retain these trees after treatment.

The Washington State Department of Natural Resources has also outlined environmental protection measures for wildlife habitat. In general, the state guidelines are not as stringent in their measure of protection when compared to the FSC guidelines. The minimum DNR requirements for Western Washington call for 2 green recruitment trees / acre at least 10' tall and 12"dbh, 3 wildlife retention trees / acre at least 30' tall and 10"dbh, and downed trees at 2 / acre at least 20' long and 12"diameter at the small end. (Chap222-10 WAC).

To achieve our goals of using ecologically sound forestry practices we propose to exceed these guidelines. The following guidelines will be followed in the implementation of this plan;

- Conduct a thorough survey of the proposed area prior to harvest to determine the exact amount of necessary coarse woody debris additions, number of green trees to retain, and legacy snags and stumps to protect.
- Due to the dominance of Douglas-fir in the proposed area, retain all hardwoods and other shade tolerant species that have started to develop to retain a greater species diversity and vertical structure within the stand.

Exceed minimum requirements for coarse woody debris with at least 7 pieces of large downed wood / acre with 20" diameter and at least 15' long.

XIV Restoration Areas

The 487 meters of a temporary road that will need for this project will be decommissioned. This will be achieved by converting the road into an educational trail. This educational trail will lead into the area of thinning blocks from the Organic Farm trail. Revegetation of native plant species such as Evergreen huckleberry, Red huckleberry, Oregon grape, Salal, and Salmon berry will be done along the tail. The revegetation should be done as soon as possible since invasive exotic species are more likely to establish in a disturbed area. The revegetation of native plant species will minimize invasion of non-indigenous species. This will also reduce the erosion impacts (Randall 1997). Interpretive signs will be place along the trail. Placing the signs is a good way of educating people who use the trail.

Planting of trees that are commonly found in a similar forest in Pacific Northwest will be carried out after harvesting. This will encourage the development of canopy layering and will also reduce the establishment of invasive exotics.

All the restoration activities such as revegetation and planting will be held after the thinning operation. If it is impossible to do these activities right away. Students in the next Sustainable Forestry program and volunteers will perform the activities. Those students will also carry out monitoring activities for the area of the trail, the revegetation, and the planting to observe presence of invasive species. Any invasive exotic species (such as scotch broom, English ivy and holly) will be removed by hand as soon as they are found in the area.

There is a potential for damage to the fence and land at the Organic Farm Cluster. Any instances of repair will be identified by the Organic Farm manager and directed to Gabriel Tucker for action.

XV Protocol for Biological Monitoring

Long term and pre-harvest monitoring surveys will be implemented to the four 1ha size plots. Different silvicultural treatments of each stand will produce a variety of vegetation structures. These will then be evaluated for their structural change and the reaction of local species in these areas. The data collected will be used for many purposes including tracking biological diversity, tracking improvement of stand structure, and as an educational resource for future forest research.

Students of the Sustainable Forestry program will conduct pre-harvest vegetation monitoring and wildlife monitoring in the spring of 2001.

Vegetation Monitoring & Surveys

Our long-term ecological research program will partly follow the protocol introduced by the H.J. Andrews Experimental Forest in Blue River, Oregon. This calls for a production of a stem map for each reference stand. Monitoring all trees, snags and, downed wood within the four plots will indicate species diversity, density, and succession of the stand structure (Hawk et al.1978). The following protocol from the H.J. Andrews experiment will be slightly modified for ours.

Data recorded for each reference stand includes tree location by X and Y coordinates, tag number, species code, and dbh in cm. Conditions of the live trees are recorded with a tree-digit code. The location and size of downed logs and stumps are also included for each stand. H.J. Andrews includes several other monitoring regimes to include the following; saplings; seedlings; cover and frequency of shrub species; and cover and frequency of herb and moss species. Data were also collected for estimates of understory biomass and leaf area. (See Research Protocol I in Appendix)

Inside each of the four stands a sectioned grid will be marked on the ground and mapped into data form. The size of each grid will take into account the buffer zone that will be of sufficient size as to negate the effect of neighboring trees. A 30-x-30 size interior plot will be established. The size of the plot may be increased with the evaluation of species' reaction to the size of plot. The corners will be tagged and mapped with GPS for ease of finding. The sections are then divided into a 10-x-10m grid and all trees greater than 5 cm dbh are mapped and tagged with aluminum number tags (See Research Protocol II in Appendix).

Two general types of re-entries are made for data-collecting updates, 1) re-measurements and 2) mortality checks. Stand re-measurement involves collecting information about tree growth and growth attributes; this will be completed every two years by the Sustainable Forestry class. Mortality checks are done more often because they are quicker to perform than re-measurements. In our case the mortality checks will be done twice every two years, once in the early fall and another in the late spring.

Finally sample trees are measured for tree height and canopy class indicating overall stand type to be used with LMS or other stand visualization programs.

Implemented correctly, these measurements can be mapped and used to indicate forest health. They may be altered due to accuracy and efficiency. The information produced will be valuable to researchers, students and faculty for those interested in other forest, vegetation, or habitat research. These could be coupled with wild life surveys to indicate any noticeable change in species biodiversity and composition.

Wildlife Monitoring & Surveys

It is our intention that a large diversity species will colonize new habitat as it develops over time. The objectives of the species monitoring programs are, 1) to determine the extent to which stand management produce the anticipated habitat and, 2) to determine the effect different silvicultural treatments have on species composition. Some species may react negatively toward the initial thinning, but with complete records and thorough monitoring we will be able to evaluate and compare stand structure with species composition. To aid in this biological monitoring, a long-term transect line will be installed.

As with vegetation monitoring, initial species monitoring will determine the species we have in and around the Sherman tract. Some specific habitats will also be analyzed to indicate potential immigration of listed species. The following are several species, taxa, and habitats that may be affected and are planned to be surveyed and monitored in the future.

Of particular concern is the impact that the proposed thinning would have on Piliated Woodpecker (*Dryocopus pileatus)*. Piliateds may be a key species for indicating the health of the entire range of cavity nesting birds on campus (Schroeder 1982). Careful maintenance of Piliated habitat requirements, such as large snags, is beneficial for a wide range of species.

Piliated Woodpeckers are a listed species of concern for Washington State (WDFW 1991). This species has been sighted both on campus and within the BEDF by students and faculty. However, it is our belief that due to the small average diameter of trees in the Sherman tract, it does not constitute critical nesting habitat (Aubry and Raley 1992). While there is some evidence of foraging use by the Piliateds, the BDEF covers only a small fraction of their 1180 acre foraging range (Mellen et al. 1992). Furthermore, by thinning the stand we would not eliminate this food source. Rather, it would be only temporarily reduced.

Studies of habitat usage and potential snag utilization are planned for this spring, prior to any thinning. However, in the long term Piliated Woodpeckers are a good example of a species that could be greatly benefited by the creation of larger diameter trees and snags.

As Piliateds are not the only bird species that use the stand's resources, a complete inventory of bird species will occur spring quarter using point-count methodology (See Bird Monitoring Section in Appendix). Permanent counting stations will be located in the center of each treatment hactare. In addition to the valuable learning experience provided by this exercise, data collected will provide critical baseline information

Detailed stem mapping of the BEDF will indicate the size and location of snags in the area. Despite the lack of large diameter snags we intend a more intensive survey for the potential of nesting sites. Indicating the least adaptable habitat for the Piliateds will influence our thinning. The least diameter of habitat and snag condition will influence what type of materials will be left at thinning. These surveys will begin in the beginning of spring 2001.

Several thinning regimes may potentially impact mushrooms. Long-term impacts are rarely seen in disturbed areas while short-term effects may be drastic due to logging. In the heavy thinned areas there may be an impact due to increased light as well as reduction of mycorrhizal mushrooms, which depends on the interactions with tree roots. An extensive mushroom survey will be established with the help of mycologist experts on campus. A pre-harvest survey will take place in the summer or fall when mushroom numbers are highest. Permanent plots will be established to monitor long-term effect of mushroom habitat from multiple thinning regimes.

Salamanders show a wide range of biological stability. Their life history indicates the following: extremely long-lived (20+ years); high survivorship; low fecundity; often guard their eggs; take 2 or more years to mature; eliminated the energetic costs of lungs and ventilating; respire directly through their skin; can go for months, if not years, without eating; and body temperatures fluctuate with the local substrate. Logging, insect defoliation, development, and canopy fires all can reduce population levels indirectly through loss of soil moisture, exposure to sun, or the compacting and disruption of soils. (USGS).

Tracking changes in salamanders provides insights into forest ecosystem health. Given their longevity and low fecundity, changes in salamander population are much more likely to represent significant environmental changes than any other group of North American Amphibians (USGS).

The permanent transect previously installed would provide a proper method for monitoring terrestrial salamanders. Walking the transect line and searching under downed woody debris and rocks will indicate many terrestrial salamanders (Corn et al.1990). Although, some salamanders would not be accounted for in these walks due to weather, time of year, or habitat requirements of specific species. There may also be an initial lack of downed wood for amphibians and would prefer to hide underground out of site. Laying cover boards down will provide cover and will be regularly checked to determine an accurate account. The USGS North American Amphibian Monitoring Program (NAAMP) suggests using cover-board plots to monitor trends in terrestrial salamanders (USGS)

Programs such as Herpetology, Ornithology, Biology, Soils, Mycology, Botany, and Forestry are intended to use information out of our data. They will have the opportunity to continue research in stands and may feel the need to add to the LTER. Incorporating monitoring in these courses would be a good introductory method to learn about the conditions and processes of a working model.

Other options that may ensure long-term monitoring are through internships, volunteers and offering of MES (Master of Environmental Studies) programs. The addition of these programs would be a valuable addition to the Evergreens Long-Term Research Database project.

XVI Conclusion

The Evergreen State College community is very fortunate to have such a beautiful forested campus. However, this seemingly pristine forest is far from being a mature and fully functional. We believe that it is our responsibility to effectively manage Evergreen's forest for the maximum benefit to wildlife and education.

The site of the Biodiversity Enhancement Demonstration Forest is *not* a naturally occurring stand. It has been impacted and influenced by man drastically since European settlement by completely removing the old growth habitat from our landscape.

The choice is either to actively enhance biodiversity through the creation of old-growth structural characteristics through thinning and other management or to take "no action" are both critical management decisions.

XVI Bibliography

Aubry, K.B. and Raley, C. 1992. Ecology of Piliated Woodpeckers in Managed Landscapes on the Olympic Peninsula. USDA. For. Serv. Olympia. PNW Research Station annual report.

Bibby, Colin J., Burgess, Neil D., and Hill, David A. 1992. Bird Census Techniques. British Trust for Ornithology. Academic Press. London. 257p.

Campus Master Plan. 1998. Goals and Policies for Land Use. Pg 31,107,63.

Carey, A.B.; Curtis, R.O. 1996. Conservation of Biodiversity: A Useful Paradigm for Forest Ecosystem Management. Wildlife Society Bulletin 1996, 24(4): 610-620.

Carey, A. B. and Manuwal, D.A. 1991. Methods for Measuring Populations of Small, Diurnal Forest Birds. USDA. For. Serv. Gen. Tech. Rep. PNW-GTR-278.

Corn, P.S. and Bury, R. Bruce. 1990. Sampling methods for terrestrial amphibians and reptiles. USDA Forest Service, Pacific Northwest Research Station, Portland, Oregon. Gen. Tech. Rep. PNW-GTR256.

Davis, F. 2000. Interview, NEPA process and assessment written format, Flat Boundry Assessment.

Dettmers, R., Buehler, D.A., Bartlett, J.G., Klaus, N.A. July 1999. Influence of Point Count Length and Repeated Visits on Habitat Model Preformance. J. Wild. Manage. 63:3.

Dodd F. S., et al. 1994. Control and Management of *Heracleum mantegazzianum* (Giant Hogweed). P.111-126 in Ecology and Management of Invasive Riverside Plants, Waal L. C., et al. (eds.). Chichester, New York.

Dowling, C.D. 2000. A Hypothetical Environmental Assessment for Forest Ecosystem Restoration Plots. Evergreen State College Student Paper 2000, Pg 1-37

Federal Interagency Committee for Management of Exotic Weeds (eds.). 1998. Together: National Strategy for Invasive Plant Management. 2nd edition. 22p. US Government Printing Office.

Forest Stewardship Council, Pacific Coast Working Group Principles and Criteria handbook, Draft 3.0, Nov. 1,1999.

Gordon D. R., and K. P. Thomas. 1997. Florida's Invasion by Nonindigenous Plants: History, Screening, and Regulation. P.21-37 in Stranger in Paradise, Simberloff D., et al. (eds.). Island Press, Washington, DC.

Hannah, I. 2000. Interview, Windfall Lumber and Milling, portable wood miser requirements and costs.

Harpol, J. 2000. Interview, Horse logging operations, requirements and costs.

Hawk, G.M.; Franklin, J.F.; Mckee, W.A.; Brown, R.B. H.J Andrews Experimental Forest Reference Stand System: Establishment and Use History. Copies of this report are available from the coniferous Forest Biome, University of Washington, AR-10, Seattle, Wa 98195. (July 1978)

Huff, M.H., Bettinger, K.A., Ferguson, H.L.,Brown, M.J., and Altman, B. Sep. 2000. A Habitat-Based Point-Count Protocol for Terrestrial Birds, Emphasizing Washington and Oregon., USDA. For. Serv. Gen. Tech. Rep. PNW-GTR-501.

Lynch, J.F. 1995. Monitoring Bird Populations by Point Counts. USDA. For. Serv. Gen. Tech. Rep. PSW-GTR-149.

Mellen, T.K., Meslow, E.C., and Mannan, R.W. 1992. Summertime Homerange and Habitat Use of Piliated Woodpeckers in Western Oregon. J. of Wild. Manage. 56:1. p. 96-103.
Randall J. M., et al. 1997. Ecological Restoration. P205-219 in Stranger in Paradise, Simberloff D., et al. (eds.). Island Press, Washington, DC.

Schardt J.D. 1997. Maintenance Control. P.233-254 in Stranger in Paradise, Simberloff D., et al. (eds.). Island Press, Washington, DC.

Shroeder, R.L. 1982. Habitat Suitability Index Models: Piliated Woodpecker. U.S. Dept. Int. Fish. Wild. Serv. FWS/OBS-82/10.39. 15pp.

Simberloff, D. 1997. Eradication. P.221-228 in Stranger in Paradise, Simberloff D., et al. (eds.). Island Press, Washington, DC.

Price, J. 2000. Evergreen State College Stream Survey. Pg. 7-8

Occupational Safety and Health Administration. United States Department of Labor. 2000 Standards 29 CFR 1910.266.
http://www.oshaslc.gov/OshStd_data/1910_0266.html (2000)

Tappeiner J.C.; Huffman, D.; Marshall, D.; Spies, T.A.; Bailey, J.D.; 1997. Density, Ages, and Growth Rates in Old Growth and Young Growth Forests in Coastal Oregon. Forest Research Laboratory, Oregon State University, Paper 3166. Pg. 638-648.

U.S.D.A.; WA State Dep. Nat. Resources; Washington State University; Agriculture Research Center; Soil Conservation Service 1982. Soil Survey of Thurston County Pgs. 13-14,39.

USGS North American Amphibian Monitoring Program. *www.im.nbs.gov/amphibs.html*

Washington State Department of Natural Resources, Forest Practices Illustrated. 1997. Pgs 2-56

Winn, JE.; Jackson, M.D.1975. Forestry Report for The Evergreen State College. Professional Forestry Services, Inc., 1975.

Appendix

A) Logging Plan

A. Preferred Silvicultural Prescription

Our preferred management prescription is designed to establish 4 demonstration blocks, each one-hectare in size. Each block will be thinned to a different prescribed relative density. This would provide an increased variation in habitat and would lead to different rates in stand development. These rates can be studied and monitored. The first block will be a light thinning from below to a relative density of 40, which would leave approximately 174 trees per acre. The second block will be a medium thinning from below to a relative density of 30, which would leave approximately 130 trees per acre. The third block will be a heavy thinning from below to a relative density of 20, which will leave approximately 87 trees per acre. The fourth block will not be thinned at all. It would act as a control with a relative density of 76 and approximately 298 trees per acre. Additional establishment of controls outside the Biodiversity Enhancement Demonstration Forest might offer additional comparison benefits and are being considered.

Our management schedule was partially based on Dr. Andrew Carey's "biodiversity thinnings" (Carey 1996). The demonstration blocks will be re-entered for the next thinning in 20 years or a relative density of 20 to 30 for the first block, 30 to 40 for the second block and 40 to 50 for the third block. An additional thinning will take place after another 20 years to maintain the previously stated relative densities. The stand should attain the "fully functional stage" in 50 to 70 years (Carey 1996). At each of these thinnings, coarse woody debris will be left and cavity trees will be created at a variable density. Computer simulated growth models will be used to plan a schedule for this process.

B. Alternative Silvicultural Prescriptions

Overview. Although the greatest attention is being paid to the drafting of a complete management plan for the chosen silvicultural system mentioned above, we feel it is also important to briefly expose the following alternatives.

***Alternative one**:* **Thinning Two One Hectare Blocks With a One Hectare Unthinned Control**. In this proposal, two blocks would be treated instead of the preferred options three blocks. These blocks would be located in the same portion of the Organic Farm Cluster and would consist of a light thinning of 40 RD and a medium thinning of 30 RD. The method of harvest would be the same as well as road placement.

This alternative would simply be the same as the preferred option except there would be no heavy thinned block.

This method would not create as much late successional habitat as the preferred option and would not provide an educational demonstration to the same extent.

***Alternative two*: Thinning One Block, One Hectare in Size With One Unthinned Control**. In this proposal, one block would be treated instead of the preferred options three blocks. These blocks would be located in the same portion of the Organic Farm Cluster and would consist of a medium thinning of 30 RD. The method of harvest would be the same but would require 100 meters less road. This alternative would simply be the same as the preferred option except there would be no light or heavy thinned blocks.

This method would not create as much late successional habitat as the preferred option and would not provide an educational demonstration to the same extent or be considered a scientific experiment.

***Alternative 3:* Thinning Six Blocks Each One Hectare in Size With Two Unthinned Controls.** In this proposal, six blocks would be treated instead of the preferred options three blocks. Three blocks of these would be located in the same portion of the Organic Farm Cluster and the other three would be located in the north side of the South Campus Reserve just south of the Organic Farm Trail. The thinning blocks would consist of two light thinning blocks of 40 RD, two medium thinning blocks of 30 RD and two heavy thinning blocks of 20 RD. The method of harvest would be the same.

An additional 100 meters of road would be needed. This alternative would be two replications of the preferred option.

This method would create the most late successional habitat and would provide an educational demonstration as well as a scientific experiment with replication.

Alternative 4: **No Action.** In this alternative no tree extraction would take place. The forest would continue developing at the same rate of development in the competitive exclusion stage. The benefits of late successional habitat to the flora and fauna would be delayed for as much as 150 years (Dowling 2000). Biodiversity would remain low as well as the development of habitat niches. The students, faculty, and the community would not have the educational benefits that action alternatives would provide (Dowling 2000). Knowledge of how second growth stands develop into late successional forests would be limited. The demonstration of how to promote late successional habitat characteristics for the benefit of late successional associated species would not be realized.

C. Milling

The milling of the wood harvested will be performed on campus and in the forest with a portable one man saw mill. This will eliminate the need for a self-loading log truck and the reinforced roads to support it. This will also allow the mill by products such as sawdust to remain in the forest.

The wood will be transported out of the woods using a flat bed truck.

The wood will be used on campus for such things as facilities, woodshop, and campus boat building. Professional off campus kiln drying and stamping may be necessary to meet the quality standards of on campus users. Some of the lumber, if not needing this for user needs could be air-dried on campus.

D. Description and Rational for Preferred Harvest System

There are two proposed methods of harvesting for the Sherman tract. The first is directionally felling marked trees using chainsaws, falling wedges and axe to limit damage to leave trees during the actual felling, and facilitate log removal by horse. This would limit damage to leave trees during skidding by felling trees at angles to the skid trails so as to limit the logs need to pivot. A faller/horse logger should be consulted prior to marking so the trees will be marked with an understanding of these considerations. Lacking that, a "loggers option" method of tree marking where all potential harvest trees are marked and counted, and a designated portion then removed by the logger could be used to keep leave tree damage to a minimum.

Non-mechanized falling options were considered but rejected due to time constraints, felling accuracy, and safety. The chainsaw offers advantages over the crosscut saw in terms of speed. Should we write the contract to specify the use of hand tools for all felling, limbing, and bucking, the costs will be much higher than for mechanized felling. Since we propose to harvest the smaller trees, non-mechanized felling costs may well exceed the value of the timber. Felling accuracy can suffer with the use of hand tools. Fellers can manipulate the hinge wood through the back-cut as the tree is about to fall which aids in accuracy. In addition, as the tree commits to the face cut, the feller can remove a little more hinge wood to allow the tree to fall with more force. A bow or crosscut saw is simply too slow to be of much use here. We are concerned about the accuracy sacrificed non-mechanized felling especially as it applies to the back cut. We are requiring directional felling as is required by Smart Wood guidelines. This stand will be difficult to fell accurately due to the number of trees per acre. The closely spaced tree crowns, as well as the fact that we propose to harvest only the smaller trees, will make it difficult to harvest without hanging trees up. Trees that are lodged in the crowns of one or more trees are difficult to and dangerous to get down. Even an expert feller will likely hang some trees in this stand, but far fewer will be hung up if he or she is allowed to use a chainsaw. Another reason to utilize chainsaws is the relative ease that a wedge may be inserted into the back-cut to keep the tree from setting down on the saw, or in directional falling enabling the cutter to wedge the tree over. The narrow kerf provided by a bow saw is difficult to get a wedge in and the depth of a cross-cut saw precludes the use of a wedge in small diameter trees such as those we propose to thin. However, should the one acre light thinning be implemented, then the use of hand tools would not be as objectionable so long as a high degree of safety awareness is employed by the workers.

Other methods of extraction were considered, such as the use of the feller-buncher, skidder and bulldozers, but all were rejected on the grounds of possibility of causing too much damage to the soil and vegetation. The horse logging option won out over other methods due to its common use for tree removal in ecologically sensitive areas. At least one study has shown it to have a lighter touch on the soil and cause less damage to leave trees than extraction by mechanical means. (Harpol 2000) In any case, no tree length yarding is to take place, trees will be limbed and topped where they fall, and suitable log lengths cut from them with consideration given to the potential for increased leave tree damage as the skidded log length increases. Timber extraction will be done in mid-summer to early fall to further reduce soil compaction and movement.

E. Snag, Down Wood, and Wildlife Tree Protection and Creation During Harvest

- 7 pieces of large diameter downed wood per acre, 20 inches in diameter or greater and at least 15 feet long
- 12 snags per acre minimum
- Green trees left around all legacy stumps and snags
- Due to the dominance of coniferous Douglas fir in the tract, retain all native hardwoods to maintain a healthy vertical structure and understory
- All current snags and wildlife trees will be protected

F. Road Construction

The Biodiversity Enhancement Demonstration Forest will need to construct approximately 442 feet of road for the extraction of logs (Dowling 2000). Approximately 100 to 150 meters of the road would require the removal of some trees for construction of a standard 8 foot roadbed. The proposed road placement would run parallel and just inside the fence of the organic farm garden and extend into the Biodiversity Enhancement Demonstration Forest where it turns north. The portion of the road along the edge of the Organic Farm will not require any tree removal. This previously cleared area is unusable to the farm because of the shade created by the trees in the South Campus Reserve.

The road constructed for the extraction of wood will only consist of a temporary dirt spur. This is all that is needed due to the low amount of road use and the time of year it will be in operation. The proposed road would follow the rules of Washington Forest Practices set by the Department of Natural Resources with emphasis on temporary road guidelines. The time of road use must be approved in the forest practices application. A temporary dirt spur will be constructed with the plans of exercising closure and decommissioning when intended forest practices are complete (WSDNR, 222-24-026). The DNR will then determine whether proper decommission procedures have been exercised, notifying the landowner of the status of such road. Upon specific planning of the harvest, a road decommissioning date will be set. The roads will be decommissioned to educational trails after the log extraction is completed. The decommissioning consists of loosening the soil and revegetating with native flora.

The only vehicles on the proposed road will be a pickup towing the horse trailer, a pickup towing a portable saw mill, and a flat bed pickup to haul out the finished lumber. If milling does not occur on campus, then adjustments will have to be made to the road plan to enable access to heavy self-loading log trucks. This may include widening road corners and capping the road with rock material.

The construction of landings will not be necessary. The use of horse logging will not need landings because the team of horses will use road edge as the landing (Harpool 2000).

The soils in the Organic Farm Cluster, which the constructed road will be located, are a glacial till. The surface layer is composed of 6 inches of a very dark brown gravelly sandy loam followed by a subsoil layer 9 inches deep containing dark brown gravelly sandy loam and the lower 15 inches below the subsoil is dark brown very gravelly sandy loam (U.S.D.A. 1980). The hard pan is weakly cemented together at 20 to 40 inches below the surface (U.S.D.A. 1980). These soil characteristics make this soil type a stable and well drained, which is suitable for road construction. The road will also be at a lower risk to the creation of sediment because of it has a low gradient, no stream crossing, and runs a short distance (Dowling 2000).

This road surface will be crowned and water bars will be built where necessary to minimize erosion. The use of cross drain culverts will not be necessary because the road will not cross any streams but a culvert will be needed where the planned road meets Lewis road (Forest Practices 1997). The proper construction will help to prevent poor hydrology of campus lands. The opening of the canopy and the soil compaction due to the road will alter the hydrology for a short time. The roads will be decommissioned to educational trails after the log extraction is completed. The decommissioning consists of loosening the soil and revegetating with native flora.

This soil is classified as suitable for year round logging, but logging would only take place in the summer or early fall to minimize the impacts (U.S.D.A. 1980)

G. Fire Protection

Post harvest fuel loads will be examined and a determination will be made as to what, if anything, ought to be done. Should the fuel load be deemed excessive, there are several opportunities to modify the fuels arrangement to reduce the hazard. If the branched tops are viewed as a problem, they may be limbed and stacked in piles along with limbs removed from extracted logs. These piles could be burned, or left in place to provide wildlife habitat. Another method of treating these fuels, provided that they are not too numerous, would be to scatter limbs and tops throughout the area to avoid jackpot fuel accumulations. Finally, the limbs and tops could be chipped; such a treatment tends to compact the fuels and greatly decreases fuel volatility. In addition, chipped/shredded fuels decompose much more quickly than untreated fuels although this may not be a benefit in long-term nutrient cycling. High carbon composting should be considered in conjunction with chipping should it be determined that the volume of chips on the forest floor would have a negative impact.

B) Bird Monitoring

Appendix: Point-count methodology

1. Sites are entered between sunrise and 10 a.m. (Huff et al. 2000). Counts would be conducted only on dry days. Previous to counting, a three minute pause is observed in silence (Bibby et al. 1992).

No auditory stimuli of any kind should be used to attract birds (e.g., recorded bird calls, whistles, etc.) (Lynch 1995). A flag placed at a distance of fifty meters from each site would aid in the visual estimation of bird distance (Carey et al. 1991).

2. At each of the four stations, record all birds heard or seen for five minutes (Dettmers et al.1999). Tally them into one of the following categories (along with species and possibly sex):

- Typical detection 0 to 50 m: birds up to top of vegetation/canopy, <50 m from the station center point.
- Typical detection >50 m: birds up to top of vegetation or canopy, >50 m from the station center point.
- Fly-over associated: birds above top of vegetation or canopy, but in your judgment are associated with the local habitat.
- Fly-over independent: birds above top of vegetation or canopy, and in your judgment are unassociated with the local habitat

If possible, juveniles would be recorded in a separate count than adults. (Huff et al., 2000).

3. Counts should be conducted on three to five mornings during the spring. On each counting day, all four sites should be visited (Carey et al. 1991).

4. Data should be recorded on standardized data forms. Following collection, it should be entered into an established Microsoft Excel or Access database and possibly a specialized database program such as Flight Attendant 4 (Huff et al. 2000).

C) Research protocol

Research protocol taken from H.J. Andrews Experimental Forest Reference Stand

System: Establishment and use History (Hawk et al. 1978).

APENDIX I OF RESEARCH PROTOCOL

Establishment of reference stands in these major vegetation communities focuses research in a limited area on species diversity, density, biomass, leaf area index, structure, and succession. The stands will also serve as reference points for other studies of ecosystem patterns and processes on similar sites.

METHODS:
Reference stand sites were chosen as near modal examples of common plant communities. They often included areas originally sampled in the reconnaissance survey of Franklin et al. (1970).

Stands were of sufficient size to include 50- x 50-m plots with as large a buffer as possible. Each reference stand was surveyed and slope-corrected to a 1/4 ha area (Figure 3). Metal stakes were installed at 10-m intervals on the perimeter of each plot and at the corners of an interior 30- x 30-m plot. The entire reference stand was then divided into a 10- x 10-m grid, and all trees greater than 5 cm dbh (breast height = 1.37 m) were mapped and tagged with aluminum number tags.

Data recorded on each reference stand included location by X and Y coordinates, sequential tree tag number, species alpha code (Garrison et al. 1976), and dbh in cm. Vigor, crown condition, and bole condition were recorded for each tree with a three-digit code: vigor by I--good, 2--moderate, 3--poor; crown by 1--broken, 2--forked, 3--dead top, 4--dying top, 5--half crowned, 6--suppressed; and bole by 1--swept butt, 2--leaning tree, 3--layering observed, 4--rot present, 5--split butt, 6--generally suppressed.

The location of downed logs and stumps was also included on maps of each stand. Stem mapping was completed by, at. least two men, and most trees were accurately mapped to + 1 m (Appendix).

Saplings (> 0.5-m tall and < 5-cm dbh) were tallied within the 30- x 30-m interior plot by a total count or by a count of representative subsections of the interior plot. Seedlings (< 0.5 m tall) were tallied in a 120-m2 area inside the 30- x 30-m plot in four 1- x 30-m strip transects (lines A, B, C, and D in Figure 3).

Cover and frequency of shrub species were tallied along 60 m of line intercept at the top and bottom of each 30- x 30-m plot (lines A and D in Figure 3). Cover and frequency of herb and moss species were tallied in 60 microplots (2 x 5 dm) placed at 1-m intervals along the inside of the two central lines.

Data were collected for index estimates of understory biomass and leaf area. Not all understory species were sampled with equal intensity. The -eight plant species sampled intensively were *Acer circinatum, Rhododendron macrophyllum, Castanopsis chrysophylla, Gaultheria shallon, Berberis nervosa, Polystichum mun.ztum, Taxus brevifolia,* and *Xerophyllum tenax.* Data were also collected for many locally important understory species when growth-form similarity to one of the eight major species permitted good estimates. The measurements for this part of the study are listed in Table 2. Each of the species was sampled by total count within one or more of the representative 10- x 10-m sections within the inner 30- x 30-m plot.

Each reference stand was monitored with a two-pen, 30-day thermograph equipped with air and soil probes. Air probes were located at 1 m above ground surface, or at 3. m or 5 m where snowpack is heavy during winter months. Soil probes were buried at a depth of 20 cm.

Analysis

Collected data have been analyzed for a baseline description of vegetation structure within each reference stand. A series of tables of vegetation cover and frequency within each reference stand was completed and reduced to a table including trees (mature and immature), shrubs, and herbs or mosses (Table 3). Table 4 includes other characteristics of each reference stand and a summary of cover values by stratum. Size-class distribution on each reference stand is given in Table 5.

<u>APENDIX II OF RESEARCH PROTOCOL</u>

Remeasurement/Mortality check procedures

Two general types of data-collecting trips are made to LTER reference stands, 1) remeasurements and 2) mortality checks. Stand remeasurement involves collecting information about both tree growth and growth attributes and occurs once every several years. Mortality checks are done annually in selected stands and involve gathering data only about tree mortality. Mortality checks are usually quicker to perform than stand remeasurements. The procedures below have information that is applicable to both procedures, but many of the tasks would be omitted during a mortality check trip. Tasks restricted to remeasurements are noted in the headings.

I) Find the stand

Use the printed directions, copy of the topographical map, and other information on the Field Work Documentation sheet to find the stand. Note any errors and inform the Andrews LTER contact person listed on the Documentation page.

2) Record obvious disturbances

On the bottom of the Documentation page, describe any obvious, profound natural or human-caused disturbance to the Reference Stand (e.g. road construction, removal of tree tags, loss or destruction of plot stakes, catastrophic windthrow). If no such disturbances are apparent, write "None." Write your name and the date.

3) Record date and personnel on data sheets

For mortality checks, fill in year, month, and day, and place your initials directly below the blank for day. For remeasurements, fill in year, month, and day, and record the last names of those participating in the "Personnel" blank.

4) Check tagged trees for mortality

Working plot by plot, consult the data sheets to establish which tag numbers were alive at the last observation. Locate each tag and examine the tree to determine if it is alive or dead. Trees with any green foliage are considered alive. For stands with tight canopies, it may be necessary to move around a bit to obtain a view of the tree's foliage. For stands with stem maps, refer to the maps to help locate trees.

If the tree is alive, write a "1" in the status blank for the tag number and year. If the tree is dead, write a "6" in the
status blank for the tag number and year (historical note: this status code refers to trees that are "deep-sixed"). It
will also be necessary to record the appropriate information on a tree mortality data sheet (see below). If, after
repeated searching, you cannot find the tree, write a "9" in the status blank for the tag number and year. Record any
pertinent comments on the data sheet, prefaced with the current year. Note: If you *are performing a remeasurement,*
the mortality check will be done as part of the remeasurement.

Use temporary write-on tags to replace tags that are being swallowed or that have been lost (if you are certain of the appropriate tag number). Write the original tag number on the tag, and note in the comments that a temporary tag has been hung. Replace any temporary tags from the last visit with permanent ones and make a note in the comments field that the tag has been replaced.

5) Measure live tagged trees (remeasurement only)

In most cases, we will record tree measurements on a data logger, (current model is Husky Hunter 16/80). We will carry field sheets to provide information to aid in locating trees, as a back-up for the data loggers. See the attached "Operating Instructions for Husky Hunter 16/80" for details on use of the data loggers. Write the last three digits of the data logger serial number on the first data sheet for each plot. Note: *Be sure to copy information recorded on the data loggers to a personal computer every day!*
In addition to status (step 4), we record diameter at breast height (DBH), canopy class (CC), overall vigor (OV), and crown ratio (CR), for all live tagged trees, as follows:

DBH Defined as the diameter of the tree bole at 1.37 meters above the ground, on the uphill side. For consistency, we measure diameter just above the tag nail. Be sure the diameter tape is straight and level. On larger trees, especially on sloping ground, straightening the tape is at least a two-person job, often using long forked sticks to push the tape up the bole.

CC Record one of the following:
D dominant Crown emerges from the general canopy layer and receives light from the top and the sides
C co-dominant Crown extends to the top of the general canopy layer and receives light from the top but not much from the sides
I intermediate Crown extends into the lower portion of the general canopy layer and receives mostly filtered light from the top and the sides
S suppressed Crown completely beneath the general canopy layer

Note: "general canopy layer" refers to the trees most responsible for shading the tree being measured. Thus, a small tree in the middle of a large gap could be a C or D.

OV Record one of the following:
1 good vigor No apparent signs of distress (e.g. discolored foliage/paucity of leaves)
2 fair vigor Some signs of distress apparent
3 poor vigor Extreme distress apparent (i.e. death imminent)

CR Defined as the proportion of a tree's total length for which at least 1 /3 of the bole's circumference is covered by live crown. Do not include widely scattered branches. Estimate to the nearest 5 percent and record. If epicormic branches are present, (short branches arising directly from the bole), note these in a comment.

Status Summary of status codes:
I Live
2 Ingrowth
6 Dead
9 Missing tree

6) Tag and measure ingrowth trees (remeasurement only)

Many of the smaller trees in the stand will eventually grow large enough to require tagging and measurement. The minimum DBH varies between reference stands, and in some cases between plots within a reference stand. Check the Field Work Documentation sheet to determine the minimum DBH for each plot in the stand. Do not tag trees smaller than the appropriate minimum DBH. All untagged trees growing into the 5 cm diameter class should be tagged, measured and brought into the data set.

Attach tags to ingrowth trees at 1.37 meters above the ground (breast height), measured on the uphill side. Attach the tag on the same side of the tree as the tags on nearby trees. Pound the nail in far enough to hold the tag firmly, but leaving some of the shaft exposed to allow for growth of the tree. In unusual cases, it may be impossible to attach the tag at breast height (e.g. due to burls, or multiple stems). Attach the tag above or below the problem area, 2
and record the tag height in a comment. If multiple stems are tagged separately, indicate in a comment that the two tagged stems belong to the same tree.
Measurements recorded for ingrowth trees are the same as those for live, previously-tagged trees: i.e., status, DBH, CC, OV, and CR. Note that the status code for ingrowth trees is "2". Be sure to indicate in the comment field the tag number of a nearby, large tree, and/or other information to help locate the tree in the future.
Important: *For stands with stem maps, record the location and tag number on the field copy of the map, and the distance and azimuth of the ingrowth from a nearby mapped tree so that the new tree can be added to the map for the next visit to the stand.* This will save the next crew much frustration in trying to relocate the tree.
7) Record mortality data

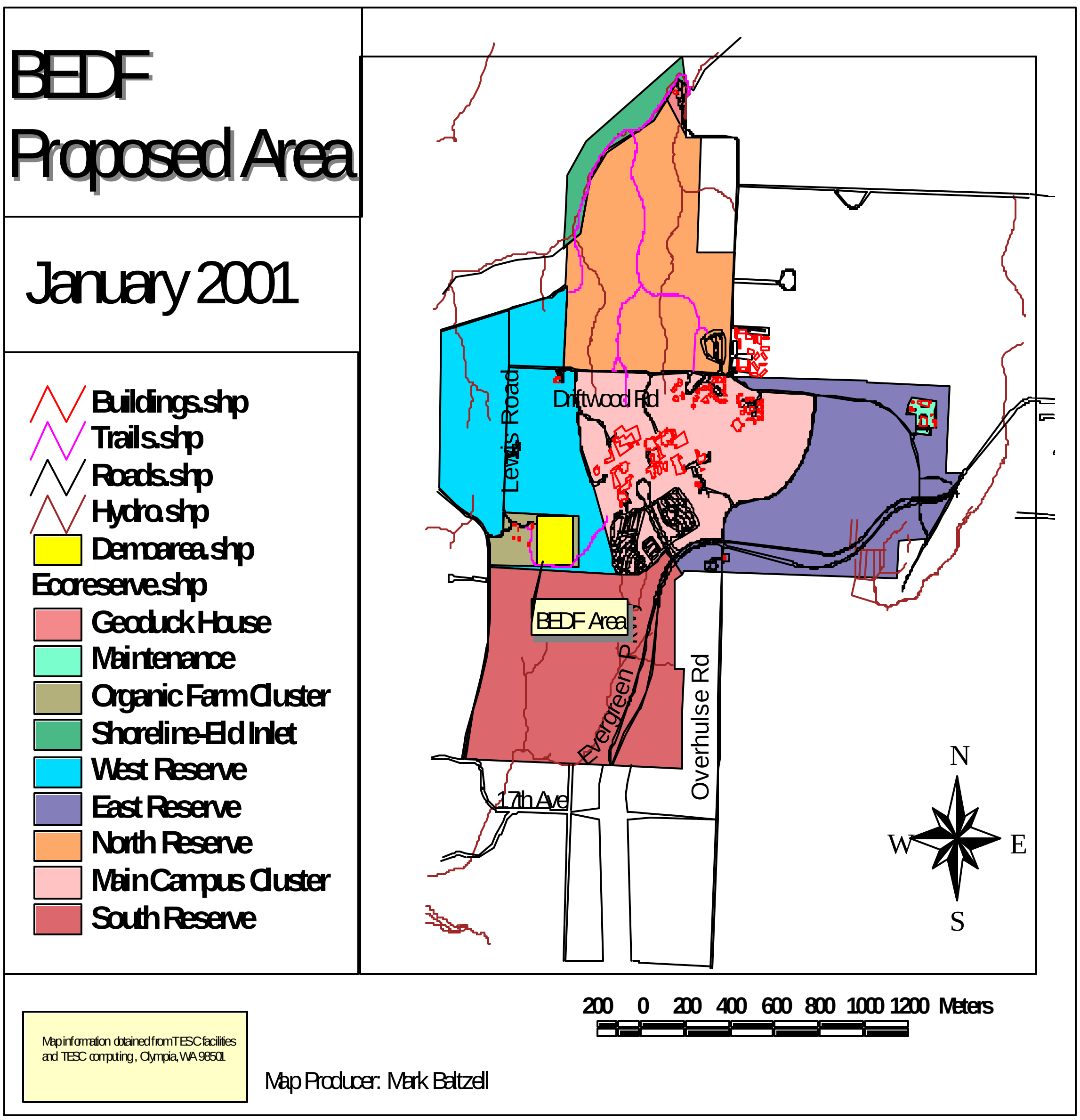
Record information for each newly dead tree on a tree mortality data sheet or the data logger. The back and the front of the mortality data sheet contains instructions--carry one with you for reference if you are using a data logger. Mortality information is also included at the end of this document.

8) Measure tree heights (remeasurement only)

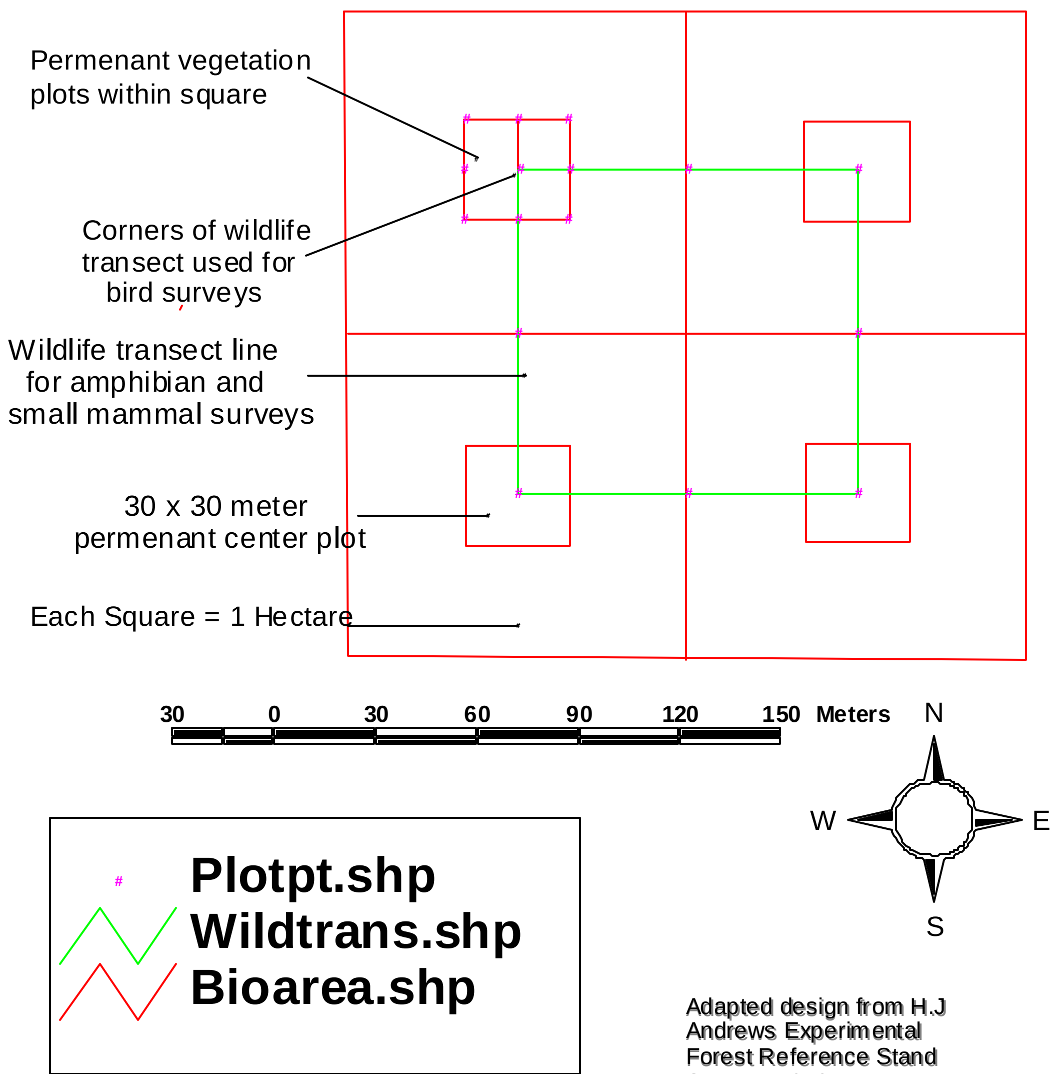
Occasionally, heights of a sample of trees in the stand will be measured during remeasurements. The sample should include representatives of all the species and canopy classes in the stand. In addition, live trees with previous height measurements should be remeasured if possible. A list of trees with previous height measurements will be provided when heights are to be measured.

To calculate tree heights, locate a position roughly one tree height away from the tree's base from which you can see both the base and the top of the tree. It is better to find a position close to the same contour as the tree, rather than going up or down hill. Try to find a location where the absolute values of the angles to both the bottom and the top of the tree are less than 100%. Clinometer readings over 100% are very imprecise. After recording plot number, tag number, and species, (you can leave DBH blank, assuming that this is during a remeasurement), record the distance from this position to the base of the tree, the percent reading to the base of the tree, the top of the tree and to the base of the live crown. As of the date of this revision the tvl .pig program for the Husky Hunter 16/80 has no field for the crown base angle so you will have to write it in the comments field. Feel free to abbreviate, but make sure the meaning of the value is preserved, for instance, "CB=45%". If possible, record all angles in percent.

D) Maps

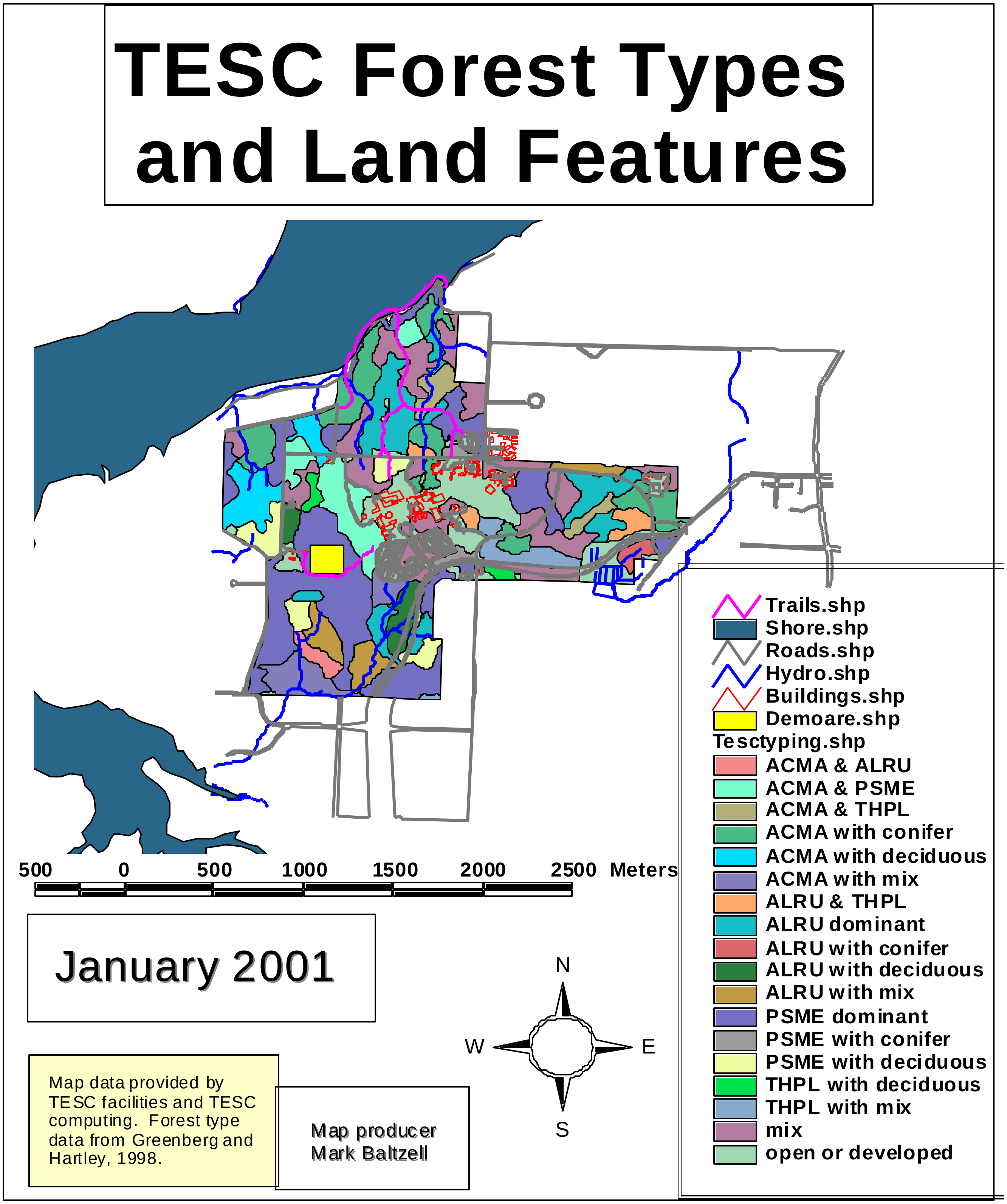


Biological Monitoring Outline

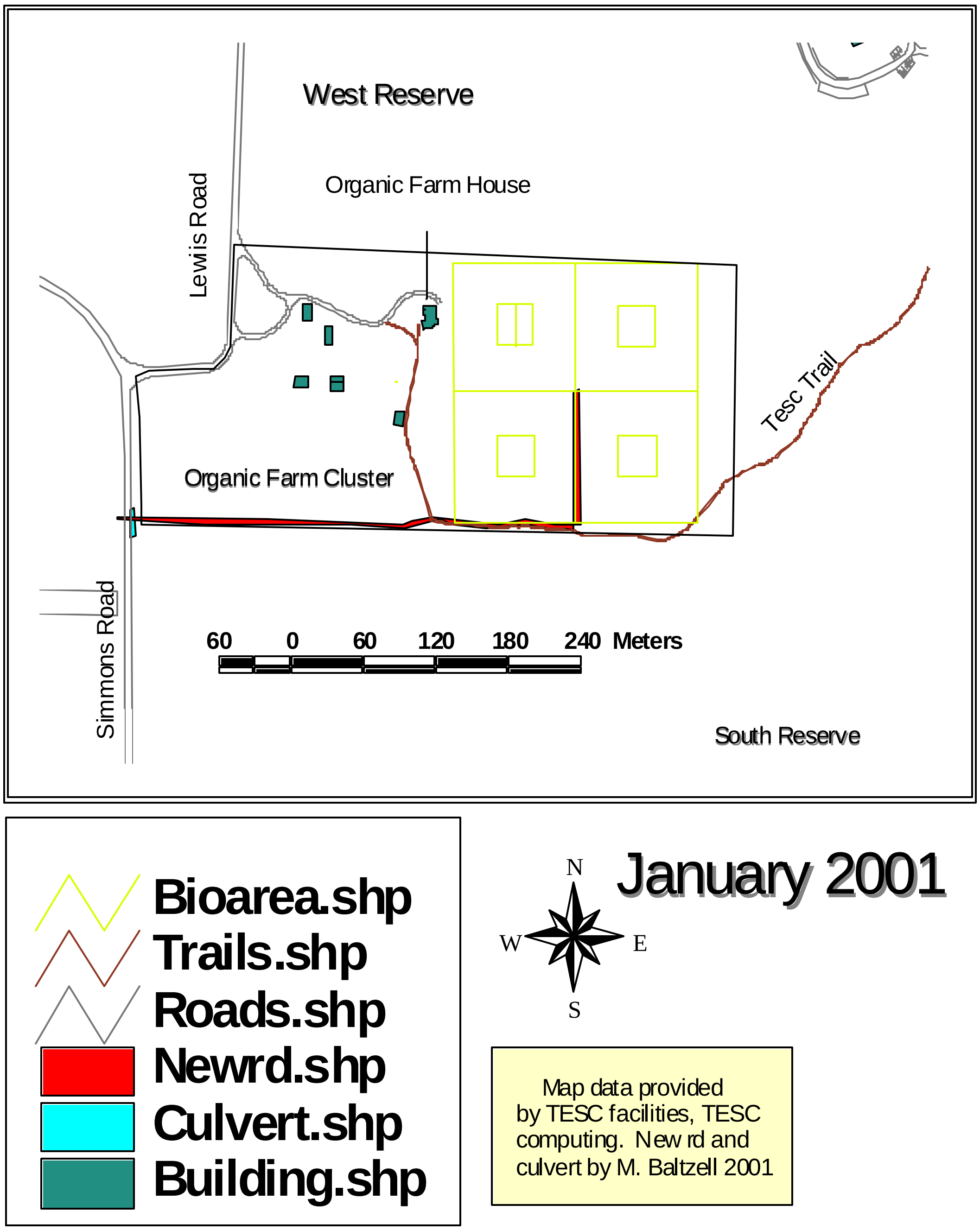


Adapted design from H.J Andrews Experimental Forest Reference Stand System, 1978.

Produced by Mark Baltzell


TESC Forest Types and Land Features
Trails.shp
Shore.shp
Roads.shp
Hydro.shp
Buildings.shp
Demoare.shp
Tesctyping.shp
ACMA & ALRU
ACMA & PSME
ACMA & THPL
ACMA with conifer
ACMA with deciduous
ACMA with mix
ALRU & THPL
ALRU dominant
ALRU with conifer
ALRU with deciduous
ALRU with mix
PSME dominant
PSME with conifer
PSME with deciduous
THPL with deciduous
THPL with mix
mix
open or developed
500 0 500 1000 1500 2000 2500 Meters
January 2001
N
W
E
S
Map data provided by TESC facilities and TESC computing. Forest type data from Greenberg and Hartley, 1998.
Map producer Mark Baltzell

Organic Farm Cluster and proposed temporary road



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B) Bird Monitoring……………………. Miranda Benvenuti

C) Research protocol……………………………Josh Pearce

D) Maps……………………...Mark Baltzell, Jen Bernstien*

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* Participants from fall 2000 quarter only