Two-Hearted River Forest Reserve
CFA Forest Management Plan

Prepared for
State of Michigan Commercial Forest Reserve Program
by
Cold Springs Forestry
(Compass Land Consultants as of 2011)
and
The Nature Conservancy

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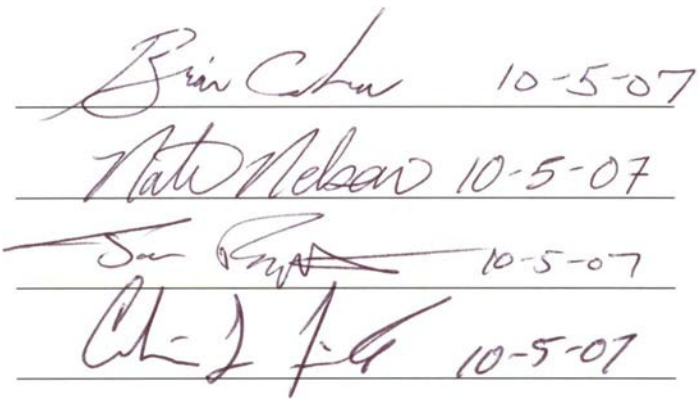

Signatures of plan writers *Date*

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Statement of Purpose

This forest management plan has been developed to guide the management activities of the Two-Hearted River Forest Reserve (THRFR) property in accordance with the State of Michigan Commercial Forest Reserve Act requirements and the objectives of the landowner, The Nature Conservancy. This plan has been written to guide activities on the property for at least the next 10 years and should be reviewed and revised if needed at least every 10 years. This plan is one component of the comprehensive property management for this property which will include a Forest Stewardship Council-approved management plan, a wildfire management plan, a collaborative research plan, and written policies regarding various aspects of the property management.

The Nature Conservancy (the Conservancy) is an international, private, nonprofit organization whose mission is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive. To achieve this mission, the Conservancy uses a science-based, non-confrontational and market-based approach.

With the acquisition of the Two Hearted River Forest Reserve, the Conservancy in Michigan is making the commitment to 'working forest lands' as a critical conservation strategy in land management philosophy. The Conservancy manages similar forest lands across the country, including Minnesota, Pennsylvania, Maryland, Virginia, Vermont, and Maine. The Conservancy has over 287,000 acres in a group FSC certificate.

The goal in the Conservancy's efforts regarding this property is to reach a balance of sustaining jobs, timber management, and timber revenue along with enhancing the quality of water resources, and improving diversity of forest communities and wildlife resources.

Forest Management Goals

The following are overarching goals that will drive the management activities on the property:

1. Maintain, restore, and enhance the biological diversity, water quality, and ecological integrity of the Two-Hearted River watershed and the broader landscape context through long-term, sustainable, forest management practices.

2. Meet the requirements of Michigan's Commercial Forest Act and Forest Stewardship Council Certification, as well as The Nature Conservancy's organizational objectives in all aspects of land management.

3. Reinvest revenue generated from sustainable production of forest products into the Reserve, as well as fund additional conservation work in the Two-Hearted River Watershed and Michigan.

4. Foster the sharing of lessons learned and future forest management innovation by establishing the property as an education and research center for ecologically-based land management.

5. Create and maintain positive, viable collaborations with other landowners to achieve individual and common objectives across the landscape.

6. Contribute to the local economy through forest jobs, forest products, and compatible outdoor recreation opportunities.

Forest Management Principles

An important component of achieving the management goals on this property involves adhering to the following set of management principles when conducting any management activities. The principles are grouped by categories. Specific objectives for the various forest types on the property are presented in the "Forest Cover Type Description and Objectives" section of this plan.

Protecting soil & water resources

- Ensure that all activities meet or exceed Best Management Practices, state (MDEQ), county (Soil/Sedimentation) and Natural River regulations and permitting requirements.

- Assess potential impacts of all management activities on soil & water resources before conducting those activities.

- Ensure that roads do not degrade water quality of wetlands and/or streams or modify sheet flows of water.

- Use the existing road network rather than constructing new roads and close or improve roads that are found to have negative impacts on water resources.

- Improve existing road stream crossings to meet or exceed BMPs, state (MDEQ), and county (Soil/Sedimentation) regulations.

Forest characteristics

- Promote levels of standing and down coarse woody debris that are necessary for regeneration for a variety of tree species.

- Promote age and structural diversity across the forested landscape that are appropriate for a variety of tree species.

- Promote species composition of forests that are appropriate for the site characteristics.

- Where economically possible, silviculture should attempt to mimic the natural disturbance patterns of the landscape (such as windthrow, disease, and fire).

Protection of wildlife and natural communities

- Consult with Michigan Natural Features Inventory ecologists before conducting any activity in areas identified as Element occurrences (rare species or exemplary natural communities).

- Assess proposed harvest sites for rare species and other wildlife considerations (vernal pools, bear dens, raptor nests, etc.) before conducting harvests.

- Minimize negative impacts of harvests on wildlife, understory vegetation, and soils by limiting all harvest activities to frozen ground conditions or dry summer months when possible.

Research

- Partner with academic institutions and other public and private forest land managers to incorporate practical, forest management-related research questions into harvests on the property.

Property management

- Identify all property boundaries before beginning any management activity, consulting with the adjacent landowner to ensure accuracy of the boundary line.

- Develop or adopt a system of documentation to track all management activities on the property.

- Support local economy directly by hiring local loggers, selling wood products to local merchants; and indirectly by allowing access for canoeing, fishing, and hunting.

- Encourage use of the property for forest ecology research.

- Be a responsible landowner in the community by developing good working relationships with adjacent landowners, recreational enthusiasts, and community organizations.

Public Use of the Property

The property is open to non-motorized public access for hunting, fishing, hiking, birdwatching, and nature study. As stipulated by the Commercial Forest Reserve Act, public access on foot for hunting and fishing is allowed. In addition, the Conservancy desires that the general public be able to access and enjoy this property for any low-impact activity, so hiking and general nature study on the property are welcome. Camping is not allowed on the property, except in the case of Conservancy-approved research or inventory work on the property. Use of snowmobiles on the property is allowed on designated trails (see maps in Exhibit C). The use of ORVs off of existing, improved roads is prohibited except in the case of Conservancy-approved research or property management activities. The Conservancy is in the process of developing more detailed policies regarding hunting blinds, baiting, and motorized vehicle use.

Compliance with Commercial Forest Reserve Act Reporting Requirements

As stipulated by the Commercial Forest Reserve Act, The Nature Conservancy will be responsible for adhering to the following procedures pertaining to the management of this property.

1. Cutting notification. Prior to any timber harvest, the form “Notification prior to cutting, harvesting, or removal of forest products from CF land” will be submitted to the DNR. The completed form should be accompanied by a detailed map that the DNR forester can use to visit and evaluate the site. This form should be submitted well in advance of the proposed harvest.

2. Sand/Gravel extraction. If sand or gravel is to be extracted from the property, the form “Application to remove sand and/or gravel from CF land” will be submitted to the DNR. No sand or gravel pit may exceed 5 acres in size.

3. Management plan updates/revisions. The current plan covers a 10 year period. At the end of this period an updated management plan will be submitted to the DNR. If any changes are proposed for the management of the property before the end of this 10 year period, an amendment to the current plan will be submitted to the DNR.

4. Sale/transfer of land. If any portion of this property is sold or transferred to a new owner, the form “Notification of ownership change” will be submitted to the DNR within 30 days of the transfer of title.

Timber Resources

Inventory Data

Upon purchase of the property from the Heartwood Forestland Fund IV in the spring of 2005, The Conservancy received a GIS dataset of the stand data for the property. However, the stocking data included in this data layer had not been updated for roughly 10 years, and the stand boundaries were not accurate. This information was not adequate for management purposes, so it has been necessary to generate a new forest cover assessment of the property, with updated stocking data, and revised stand boundaries.

In 2006 the Conservancy contracted with Cold Spring Forestry (CSF) to conduct a timber cruise of the property. CSF began by generating an initial cover type map for the entire property based on aerial photo interpretation. This cover type map uses six broad cover type classes. The total acreage in each cover class for the whole property, and by compartment, is shown in Table 2.

During the summer of 2006, CSF conducted a timber inventory across roughly 15% of the property (3,648 acres), giving priority to the upland sites. Standard timber inventory data was collected, along with Kotar habitat types (Burger & Kotar 2003). In March 2007, CSF collected field data focusing on the lowland conifer forest type that comprises the majority of the property. Since 2007, an additional 6,450 acres has been inventoried including 3,787 acres of comprehensive Key Ecological Attribute (KEA) inventory. As of the writing of this report, 41.74% of the total productive forestland on the property has been re-inventoried. Over the next several years, annual timber inventory of approximately 10% of the remaining forestland per year will be conducted to complete the forest cover assessment.

Forest Cover Type Summary

Based on the recent inventory work, the property has been delineated into hundreds of stands that are grouped into several cover types. Table 2 presents a summary of the cover types across the entire property. It is clear that the dominant cover type is the swamp conifer type that is found on the abundant poorly drained soils throughout the property. Northern hardwoods and Hemlock-northern hardwoods make up another 40% of the property, with a very minor acreage of white and red pine found on a few of the drier sites.

Table 2. Cover Type Summary (based on initial assessment by CSF)

	Compartment #					
General cover type*	**1**	**2**	**3**	**4**	**Total acres**	**% of total**
SC (swamp conifer)	1,793	3,585	3,275	2,561	11,214	48%
HH (hemlock-hardwood)	1,116	1,605	1,184	736	4,642	20%
NH (northern hardwoods)	741	1,318	1,154	1,277	4,490	19%
M (non forested wetland)	601	450	503	706	2,260	10%
W (open water)	48	262	51	119	479	2%
P (red & white pine)	186	0		4	226	1%
Grand Total	**4,485**	**7,221**	**6,167**	**5,439**	**23,312 ****	**100%**

*Note: Stand classifications in Table 3 split some of these cover types into multiple categories. SC is split into SC & SX & CW; HH is split into HH & NM; and P is split into PW & PR.

**There is a minor discrepancy of 6 acres between this acreage, derived from GIS boundaries, and the official deed acreage of the property.

Based on the inventory data and forester observations, initial covertypes were further refined. Refer to

the key in Tables 3 and 4 for detailed descriptions of these covertypes. The maps in Exhibit C display the stand boundaries for the entire property along with either the general cover type code (for those stands not included in the recent on-site inventory) or the more detailed cover type/stand density code (for stands included in the recent on-site inventory).

Table 3. Detailed cover type descriptions.

CODE	NAME	DESCRIPTION
NH	Northern Hardwoods	Shade tolerant species, typically found on upland sites and dominated by sugar maple with beech, basswood, yellow birch, and red maple occurring as associated species.
NM	Mid-Tolerant Hardwoods	Moderately shade tolerant species, typically occurring on transitional, more mesic sites and are dominated by red maple with black cherry, birch species and an increase in softwoods such as balsam fir, hemlock and spruce.
HH	Hemlock-Hardwoods	These stands are dominated by hemlock with hardwood species occurring as an interspersed, secondary component.
A	Aspen	A stand comprised of over 60% aspen.
P	Mixed Pine	Forest cover dominated by red, jack and/or white pine.
FS	Fir-Spruce	Upland sites dominated by balsam fir and white spruce with red maple and birch species typically occurring as an associated component.
SC	Swamp Conifer	Mixed lowland forest cover dominated by conifers such as black spruce, cedar, tamarack and balsam fir.
SH	Swamp Hardwoods	Typically dominated by black ash with associated species such as yellow birch, red maple and swamp conifers.
CW	Northern White Cedar	Lowland stands dominated by cedar (≥60%) with a secondary component of mixed lowland hardwood and softwood species.
M	Marsh	Wetlands dominated by grass/sedge complexes.
W	Water	Open water – may be subject to seasonal fluctuation.
SX	Non-Productive Swamp Conifer	Lowland marsh and bog community which typically has swamp conifer forest cover that is not capable of growing into a merchantable size class due to high water table and poor nutrient capacity.
LB	Lowland Brush	Lowland stands which are dominated by shrub species such as alder and willow.

Table 4. Stand Density Codes

CODE	DESCRIPTION
1	Lightly stocked sapling stand (100 – 300 stems/acre)
2	Moderately stocked sapling stand (300-500 stems/acre)
3	Heavily stocked sapling stand (500+ stems/acre)
4	Lightly stocked poletimber stand (4-10 cords/acre)
5	Moderately stocked poletimber stand (10-20 cords/acre)
6	Heavily stocked poletimber stand (20+ cords/acre)
7	Lightly stocked sawtimber stand (1000 – 3000 board feet/acre)
8	Moderately stocked sawtimber stand (3000-6000 board feet/acre)
9	Heavily stocked sawtimber stand (6000+ board feet/acre)

Forest Cover Type Descriptions and Objectives
The cover type descriptions were developed from 2006-2007 timber inventory work. Because of the landowner's desire to use timber harvest to increase diversity, the management objectives for the forest types are based on nationwide LANDFIRE models that defines the natural range of variation in age classes of forest types across the country. These models were written through the compilation of regional expert opinions and scientific research regarding past conditions. More detailed information about these models can be found at www.LANDFIRE.com.

Lowland mixed conifer (includes CW and SC cover types)
This stand type represents the largest percentage of land area on the THRFR. Approximately 48% of the acreage has been identified as productive lowland mixed conifer. Northern white cedar is the largest component in this stand type. Cedar can occur in pure stands as well as a large component of mixed stands. Where cedar occurs in pure stands it is often densely stocked and of small diameter. More frequently cedar occurs in mixed stands with black spruce, tamarack, balsam fir, and black ash. These stands also can contain a significant component of white pine. Slight elevation changes yield red maple, yellow birch and hemlock in small patches. These species are generally poor formed and suppressed due to the high water table throughout the growing season. As these stands transition to the hardwood/hemlock type the spruce and fir percentage increase with larger average diameters and improved quality. These stands have very little recent harvesting activity with the only cutting taking place in these transitional areas of the stands. As a rule access to these stands is poor with very few established roads and poor soil conditions.

The importance of these stands in relation to protection of the health and quality of the Two Hearted river watershed is the primary consideration with respect to management. Young cedar stands generally support healthy populations of small mammals (especially hare) and the predators that depend on them. These stands form the headwaters of the Two Hearted River and serve as an integral part of the transition from upland to the waterway. Any management activities within these covertypes will have to consider the greater landscape and impacts on the watershed as a whole. Where possible management activities will only take place under frozen conditions in an effort to minimize impact. Management objectives and activities should mimic natural disturbance patterns, but at the same time they should be carefully designed in order to prevent unwanted and excessive blowdown. Extensive field work will have to take place in the summer months to verify that any proposed activity will not have a detrimental impact on seasonal waterways, unique features, and adjacent wetlands.

Based on models of natural disturbances and estimates of the natural range of various age classes of this forest type, the broad objective across the landscape is to maintain roughly 40% of the 11,372 acres of productive swamp conifer stands in the 55 to 115 year age class and another 50% of the acreage older than 115 years. The inventory data gathered to date suggest that the current conditions on the property are not dramatically different from this scenario.

Northern Hardwoods (includes NH cover type)
Nearly 20% of the THRFR falls into this stand classification. For the purposes of this management plan we have further divided this stand type into two classifications. Two distinct stand types were identified in the field and management objectives and descriptions are as follows:

Northern Hardwoods - "maple monoculture": Given the industrial history of this land base this stand

was the ultimate goal of land managers for many years. Past harvesting practices encouraged the growth of sugar maple and removal of red maple, beech, and hemlock when possible as market conditions existed. Diameter distribution in these stands tends to follow the Arbogast model with higher numbers of stems occurring in the smaller size classes, with fewer high quality stems in the larger size classes. These stands were typically selectively harvested every 10-12 years with the goal of producing high grade sawtimber and pulpwood.

General management objectives for this stand type are threefold. First, any harvesting activity will promote species diversity. Generally these stands are in the Acer-Tsuga-Fagus-Dryopteris (ATFD) habitat type (Burger and Kotar 2003). These stands are predominately maple with hemlock, yellow birch, and beech as secondary species. White pine would have been a component of this type as well, generally associated with the super- canopy. Small canopy gaps are also a goal of management in this type. Long term management of these stands has eliminated canopy gaps. Restoration of these gaps is an important component, creating species diversity and a multi-layered canopy, including super-canopy white pine. Finally, an increase in average diameters is desired and encouragement of saw-log production will be necessary to create a more mixed forest condition.

Northern Hardwoods – "beech-maple": This stand type is common on the THRFR. Again this stand type is a direct result of years of management and timber market conditions. During the 1970's and early 1980's these stands were "mined" for valuable yellow birch and sugar maple. During that period conditions were such that only high value veneer and sawlogs were harvested. This process termed "high-grading" was carried out by logging contractors with little management oversight. The result was that stands were left with an unusually high percentage of "less desirable" species and quality. That legacy has resulted in today's stands with a high percentage of beech and poor formed maple. These stands have prolific regeneration and are highly variable with respect to diameter distribution. Beech bark disease (BBD) is present in virtually all of this stand type and significant (greater than 75%) beech mortality has occurred.

The overall management objective of restoring more diverse forest characteristics remains the focus of planning in these stands. The age class objective will be to achieve 90% of the northern hardwood forest cover in a greater mix than present. The management recommendations will vary greatly from stand to stand however. The nature of these stands today is highly variable, therefore silvicultural considerations will reflect current conditions. Generally, species diversity, promotion of non-maple/beech species, creation of canopy gaps, and the formation of coarse woody debris will be the goal of management planning.

Mixed Hardwood / Hemlock (includes HH and NM cover type)

Twenty percent of the THRFR falls into this stand classification. Generally these stands have a higher percentage of red maple and hemlock which has resulted in less industrial pressure over time. These stands are typically situated in transition areas between upland and lowland as well as in isolated pockets in maple/beech uplands. Soils in this type tend to be silt/loams or loamy sands, and have a higher water holding capacity which has also limited logging access over time. In recent years these stands have held a higher percentage of yellow birch but most were lost during the 1970's and 1980's as markets were very good for birch veneer.

Given that this stand type is most often associated with the ATFD habitat type, management activities will preserve and promote those characteristics. Promotion of hemlock, yellow birch, and white pine regeneration will be of high priority in these stands. Creation of canopy gaps and small patches will be

employed in this type to mimic windthrow and create disturbance necessary for regeneration of these species. Creation of "pit and mound" topography associated with uprooted stems will be employed as well to create both mineral seedbeds as well as "nurse" logs. This can be accomplished by carefully selecting individual trees that will be pushed over (rather than cut and harvested) during the harvest operation – in effect mimicking a small blowdown. Employing low impact management practices in these stands is of high priority. Given the high seasonal water table often associated with these soils management activity should take place during frozen periods or dry summer months when appropriate. Summer operations will allow for the potential use of soil scarification and the creation of 'tip-ups' to encourage species and structural diversity. The objective for this forest type is to achieve roughly 80% of this forest cover in a greater diversity of age classes.

Upland Conifer (includes PW and PR cover types)

A very small percentage (1%) of the THRFR occurs in this classification. These stands are generally dominated by red pine with white pine occurring as a co-dominant species. This stand type is located on sand ridges associated with old lake beds and outwash plains. These stands are of natural seed origin and generally occur in small patches and fragments across the ownership.

This stand type is managed extensively in the region. Thinning regimes are employed to manage these types until ultimately stands are clear-cut and the cycle begins again. The LANDFIRE models predict that there would naturally be roughly 40% of this forest type in older stands. These older saw-log stands appear to be dramatically underrepresented across the regional landscape. Therefore, management of these stands on THRFR ownership will promote stands of a diversity of ages and promote larger average diameters. If necessary, small gaps may be employed to create disturbance necessary for natural regeneration of red and white pine. Prescribed fire may also be considered as a management tool to promote regeneration. Historic GLO data for the property will also be analyzed to determine if there are existing stands of another cover type that have been converted from red/white pine. Such stands will be considered for potential restoration to this upland conifer cover type.

Non-productive lowland – open water

The remainder of the THRFR is classified as non-productive lowland and open water. Generally the non-productive lands are open bog and fen. The Michigan Natural Features Inventory (MNFI) has identified these areas as unique features and they contain a wide variety of rare and unique plants (refer to Table 6). These areas will be managed to maintain their natural processes and will not be subject to timber management.

Silvicultural Treatments by Forest Type

Based on the management goals and principles listed at the start of this plan, and the more detailed objectives defined for the broad forest types found on the property, general silvicultural treatments have been developed for each stand type. What follows are "broad brush" approaches to the silvics for these stand types. Management decisions are best made on a stand by stand basis, but the silvicultural treatments that follow will serve as the general approach across the property as a whole.

Another critical component of these treatments is the use of forest management to answer important research questions that can help guide future management activities both on the property and on other properties in the region. The Nature Conservancy will partner with academic institutions and forest land managers to develop research questions and methods so that harvests on the property contribute to our understanding of these forests and their management. In the process of developing research methods, combinations of the treatments presented below, or alternative treatments not included in this plan may be considered. Prior to implementing any treatments that differ significantly from the treatments below, the Conservancy will submit an amended management plan to the DNR.

Lowland Mixed Conifer
Due to the great importance of these forests to the protection of the Two Hearted River watershed, the sensitive wetland soils, and the potential for excessive windthrow, any harvests in these stands will concentrate near transitional areas and will likely be part of an adjacent upland harvest. Any harvests will also be designed to answer important management questions that have application to other landowners in the region. One possibility is to closely examine how well these stands regenerate with various harvest strategies, especially given the impacts of deer herbivory.

To achieve the management goals for lowland conifers, and depending upon the site- specific conditions and research questions being addressed, the following treatments may be applied to individual stands.

Treatment 1
Some stands will have deferred harvest. Limited harvesting will take place during the period of this management plan, but information about natural regeneration and/or other stand data will be gathered to determine if harvesting can be done sustainably with reasonable regeneration.

Treatment 2
Conduct small, irregular patterned patch openings (1/2 to 2 acres) oriented to optimize seed dispersal and reduce the likelihood of windthrow (perpendicular to prevailing winds). This treatment attempts to harvest in a manner that mimics windthrow, the typical natural disturbance found in this forest type, without resulting in a condition that makes the adjacent stands excessively prone to windthrow. This treatment will only be considered when the important hydrological function of this forest type will not be disturbed.

Note: Traditional industrial management that might include strip clearcuts 50 to 150 feet in width in cedar dominated stands is not likely to be considered as a treatment option due to the potential impact of this type of harvesting on the important hydrological function of these forests.

Slash disposal (mechanical removal or fire) may be required during harvest operations in this covertype in order to provide ample sunlight on the seed bed for regeneration.

Northern Hardwoods

Given that these stands have highly variable species composition, they are best managed on a stand by stand (case by case) basis. The ultimate goal is to increase species and structural diversity as well as promote saw-log development. The most effective method to achieve this condition silviculturally employs a combination of techniques. To do this with a rapid response is not well documented, however, there is some recent research into this topic (Keeton 2006). Two general treatment options will be considered for use. One research goal will be to reveal any differences in these treatments as they affect development of greater species diversity in forest characteristics. Underplanting of beech bark disease (BBD) resistant beech seedlings, or other site-appropriate species may be considered in areas with major BBD mortality. Soil scarification in limited areas may also be considered to encourage establishment of tree species that require exposed mineral soil for germination, such as yellow birch and white pine.

Treatment 1

This option focuses on stand level management prescriptions utilizing single tree selection to improve stand health and promote saw log production. Much of the initial harvesting will be in the smaller diameter classes (TSI) promoting a residual stand of larger diameter hardwood stems. Species diversity will be encouraged by maintaining non-maple species. Regeneration of non-maple species will be promoted by creating canopy gaps, retaining nurse logs, and potentially incorporating some level of soil disturbance for seed establishment of these species. Potential BBD resistant stems will be retained in all cases as well as scattered infected beech for wildlife purposes and establishment of coarse wood debris. Potentially resistant stems will be reported to the State Forest Health Monitoring program. The first harvest rotations will remove approximately 30% of the stocking and will be maintained at 10 to 15 year intervals.

Hemlock/Hardwood

These stands generally have a higher water table and a silt or loam component to their soils. All silvicultural options for this cover type must account for seasonal operation restrictions to minimize overall impact. Again, management will be conducted in order to answer specific questions about which methods are most effective at achieving goals of enhancing and maintaining KEAs. Soil scarification in limited areas may be considered to encourage establishment of tree species that require exposed mineral soil for germination, such as yellow birch and white pine. For this stand type two treatment options are proposed.

Treatment 1

The focus of this will be very similar to Treatment 1 of the northern hardwoods prescription; stand level management prescriptions utilizing single tree selection will be employed. The management will focus on improving stand health. Other goals will be to promote stand diversity with hemlock, yellow birch and red maple being primary components of the stand. Canopy gaps will be established to promote hemlock, yellow birch, and white pine regeneration when needed.

Treatment 2

The management for this option will utilize single tree selection focusing on thinning the hardwood poletimber component of this hemlock-hardwood type. This option preserves the softwood component while promoting growth of hardwoods and improving overall forest health. The softwood management will be limited to the harvesting of the poorest quality stems, some of these trees will be left as a source of coarse woody debris to provide potential seed beds for hemlock and yellow birch regeneration.

Upland Conifer
These stands represent only a small portion of the THRFR (±1%). This stand will need to be managed to ensure that adequate natural regeneration is taking place. These stands will be re- evaluated in 10 years to assess regeneration rates. Thinning, small patch cuts, or prescribed fire may be used in these stands to encourage natural regeneration.

Ecological Management Considerations

Water Quality
Protection of water quality across this property is a priority for all management activities. The Two-Hearted River has been designated by the State of Michigan as a Natural River due to its high quality. All management activities on the property will be conducted in a manner to protect the water quality, scenic beauty, and ecological health of this river system. Specific guidelines for management activities near the river can be found in the Two Hearted River Natural River Plan (Michigan DNR 2002).

There is evidence that selective harvesting in northern hardwoods may impact aquatic habitats and their invertebrate populations (Huckins and Burgess 2004), so special attention will be given to this issue when designing harvest plans for specific stands. At a minimum, Michigan BMP's will be strictly adhered to throughout all management activities. In addition, existing stream crossings and roads that were constructed by previous owners will be assessed and upgraded to prevent deterioration of the water quality. Those crossings with the greatest potential for negative impacts on water quality are shown on the property maps in Exhibit C.

In 2007/2008 we developed a Riparian Management Zone Plan entitled "Two Hearted Riparian Analysis" to protect the water resources within the Two Hearted. These zones were developed using the latest scientific research on riparian corridors and based on a Watershed Management Planning project completed by the Superior Watershed Partnership in 2008. Rather than defining a set width for these zones, the 'functional' size was determined on a site-by-site basis. By taking into account the soils, slopes, vegetation, and water body affected, a zone size was calculated suitable for protection of the water resources. For example in a steep slope with highly erodible soils, harvest activities are limited within the total area of the steep slope, rather than within a pre-set distance which may or may not encompass the area with the steep slope.

Conservation of Biological Diversity
The conservation of the biological diversity of the property is central to the organizational mission of the Conservancy and a management goal of this property. All management activities on the property will be carefully evaluated to determine the potential impacts on biodiversity. Although it may not be feasible in every circumstance, our goal is to conduct an assessment of rare plants, natural communities, and wildlife habitats before any given parcel is harvested.

Rare species and natural communities
The Conservancy has reviewed the database of rare species and exemplary natural communities that is maintained by MNFI. There are several occurrences in this database that are known to occur on or immediately adjacent to the property (Table 6 below). There are likely to be additional occurrences of rare plant and animal species on the property that are not included in Table 6 because the property has not been thoroughly inventoried.

The Conservancy will work closely with MNFI ecologists to determine the level of management activities that would be acceptable to conduct in and near the exemplary natural communities. No management actions will take place without the guidance of MNFI. The Conservancy will also work with MNFI biologists, private consultants, and academic groups to obtain a more thorough inventory of the rare species and natural communities on the property.

Table 6. Element occurrences documented to occur on or immediately adjacent to the Reserve (based on Michigan Natural Features Inventory Data, January 2007).

Community	Common name	Scientific name
Plants		
	Algae-like pondweed	*Potamogeton confervoides*
	Wiegands sedge	*Carex wiegandii*
	English sundew	*Drosera anglica*
	Fir clubmoss	*Huperzia selago*
Birds		
	Yellow rail	*Coturnicops noveboracensis*
Wetlands		
	Leatherleaf bog	(*Chamaedaphne calyculata*) - *Ledum groenlandicum/ Kalmia polifolia* Bog/Dwarf- shrubland
	Northern Poor Patterned Fen	*Betula pumila - (Chamaedaphne calyculata, Andromeda glaucophylla) / Carex oligosperma* Patterned Herbaceous Vegetation
	Patterned Rich Fen	*Pentaphylloides floribunda - Betula pumila / Carex lasiocarpa*
	Black Spruce / Leatherleaf Semi Dwarf-Treed Bog	*Picea mariana / Chamaedaphne calyculata* / *Sphagnum* spp Dwarf Shrubland
	White cedar - (mixed conifer) / alder swamp	*Thuja occidentalis - (Picea mariana – Abies balsamea) / Alnus incana* Forest
Upland Forests	Beech - Maple - Northern Hardwoods Forest	*Acer saccharum - Fagus grandifolia - Betula* spp. / *Maianthemum canadense* Forest
	Great Lakes White Pine - Hemlock Forest	*Pinus strobus - Tsuga canadensis* Great Lakes Forest
	White Pine / Blueberry Dry-Mesic Forest	*Pinus strobus / Vaccinium* spp. Forest
	Hemlock Mesic Forest	*Tsuga canadensis - (Betula alleghaniensis)* Mesic Forest

Note: Community names are those of the International Vegetation Classification System used by NatureServe.

Many of the element occurrences are associated with open wetlands. These features will be protected by the design of adequate buffer areas when harvesting adjacent uplands, and by avoiding the construction of roads or skid trails of any type in or adjacent to these unique habitats.

Wildlife Habitat

In addition to the element occurrences on the property, habitat needs of more common wildlife species will be considered during specific harvest operations. Prior to harvest, existing locations of habitat features such as vernal pools, large snags, cavity trees, and raptor nests will be documented and these locations will be incorporated into the site planning. Buffer areas will be identified around vernal pools and raptor nests. At a minimum, existing management guidelines for species such as Bald Eagle, Red-shouldered Hawk and Northern Goshawk will be followed. Potential cavity trees and large mast-producing trees will be retained.

One goal of harvest activities will be to increase the abundance of many habitat features, including snags, coarse woody debris, and cavity trees. The target goals for these features will be established based on best available scientific knowledge (ie. Keddy and Drummond, 1996). The specific silvicultural techniques used to achieve these goals will be a key subject of research questions linked to harvest activities. Existing research on this topic has tested some methods in northern hardwood forests in New England (Keeton, 2006; Bryan, 2003) which should be tested in Michigan's forests.

Habitat for wide-ranging species that are known to occur within the Two Hearted River watershed, such as red crossbills, pine marten, wolves, moose, and black bear, will be provided by maintaining continuous forest cover across the property through the use of small patch or selective tree harvesting, and by avoiding even-aged management. The larger landscape context of individual stands will also be considered when planning harvests to ensure that adequate canopy cover is maintained.

The property supports a wide variety of migratory birds, many of which breed and raise young in spring and early summer. Limiting harvests to dry late summer months (late July – September) or frozen-ground winter months will prevent direct negative impacts on the reproductive success of these birds.

Fire Management

Wildfire is a natural form of disturbance in the landscape of the Upper Peninsula. Although not common in hardwood dominated forests of the Upper Peninsula, wildfires do occur in pine-dominated forests as well as in peatlands and lowland conifers during periods of drought. As a natural part of the ecological processes that shape the landscape, fire is not considered to be a threat to the conservation values of this property. However, given the property interests of neighboring landowners and individuals, as well as the legal mandate of the DNR to suppress wildfires, the Conservancy recognizes the reality that wildfires may need to be confined or controlled by the DNR.

The Conservancy has begun to work with the Michigan Department of Natural Resources to develop a wildfire management plan. This plan will clarify the Conservancy's view that it is not imperative to absolutely minimize timber losses from wildfire on Conservancy property, and it will encourage the use of light-on-the-land firefighting techniques such as hand crews, water drops, and backfiring. Natural firebreaks such as rivers and non-natural breaks such as roads are preferable to the creation of new firebreaks with heavy equipment.

As more inventory work is conducted on the property, the use of prescribed fire may be considered if areas are identified that require fire to maintain the health of the ecosystem. For example, site preparation may include prescribed fire to clear the seedbed, reduce potential pathogens and reduce competition during germination and seedling establishment.

To help inform our understanding of the fire dynamics, the ecological systems and other natural disturbances on the property, the Conservancy is working with other organizations.

A current project underway by Seney National Wildlife Refuge and Ohio State University is investigating historical fire patterns in the region, and they will be sampling on the subject property. Also, a crew of Student Conservation Association (SCA) employees gathered detailed vegetation plot data throughout the property and the Two Hearted River watershed in 2006. These data provide detailed information about the composition and structure of the canopy and herbaceous vegetation, coarse woody debris and snags at 15 plots across the property.

The SCA data will be used in the LANDFIRE project, a nationwide assessment of the current status of disturbance regimes of ecological systems. Through its spatial datasets, ecological models, 'condition-class' concepts and descriptions of reference conditions for ecological systems, this project will provide information that will help us better understand the current conditions of this forested landscape in terms of natural disturbance regimes. This understanding will help us to better imitate natural disturbances through our timber management practices, set desired future conditions, set goals for coarse woody debris, identify areas with fuel build up and validate timber cruise data. The SCA data will also guide future inventory of the property for rare plants and for wildlife.

As the LANDFIRE project progresses, it may contribute information that affects the specific management objectives for certain forest types on the property. Any significant changes to the objectives presented in this management plan will be submitted as an addendum.

Invasive Species & Forest Pests & Pathogens

The property currently has few known problems with invasive plant species. However, harvesting activities and ATV use present the risk of spreading invasive plant species into the forest. Dense populations of species such as garlic mustard or glossy buckthorn can prevent natural regeneration of native forest tree, shrub, and herbaceous species. If any re- seeding is required to stabilize slopes or roadways, only weed-free, native seed mixes will be used. If gravel is required for road improvements or road-stream crossing projects, the gravel must be obtained from a source that is known to be free of invasive plant seeds. A monitoring program will be established to detect the presence of terrestrial and aquatic invasive plants in high risk areas, including areas near homes or camps, recent harvest sites, sites with recent road work, and public rights-of-way, such as powerline corridors.

Beech bark disease is a significant management issue on the property. This disease is already causing significant mortality among mature beech in stands across the property. A significant loss of basal area has been documented across the property and stands are actively "self-thinning" as a result. This will likely delay our first entry in many stands we initially intended to harvest as part of our initial plan. Salvaging beech is no longer an option, our primary goal now will be to identify trees that are resistant to the disease and report these trees to the Michigan DNR Forest Health Monitoring group. In stands that we do harvest, some diseased beech may also be retained as snag trees, providing wildlife habitat. In stands which sustain a large percentage of canopy loss due to BBD, underplanting with BBD-resistant beech seedlings may be considered once such seedlings become available. Planting of white pine seedlings may also be considered in such stands.

Other exotic insects that could cause significant mortality on the property include the emerald ash borer and hemlock woolly adelgid. Although neither insect has been found on the property, if they are ever introduced to the property they could result in significant tree mortality.

Excessive deer browse is a well-documented forest management issue. Excessive browse of preferred species such as northern white cedar and eastern hemlock can prevent adequate regeneration of these species. Due to the high snowfall amounts in this region, deer typically do not concentrate in this area during winter months; therefore the effects of deer browse are expected to be less severe than in other part of the state. However, due to the potential negative impacts on regeneration, deer browse as well as moose browse must be considered when designing any harvest on this property. Techniques for regenerating deer-preferred tree species may also be a topic of research on the property.

Herbicide use

Widespread application of herbicides, such as for post-harvest treatment or pest control, is not desired by the landowner. The local use of herbicides to control non-native plant species will be determined on a case by case basis by the landowner. Use of herbicides will only be considered if can be applied with minimal negative impacts on native flora and fauna and aquatic habitats.

Harvest Plan

Overview

This first period of management under ownership of the Conservancy will be focused primarily on increase in species diversity in upland hardwood stands that have been intensively managed for many decades. This period of management may take decades to achieve its goals. Over time, as the forests are gradually shifted to higher age and species diversity, the focus of management is expected to shift from restoration to the sustainable management of a saw-log and veneer forest product in a manner that derives economic benefit while protecting the ecological integrity and unique features of these forests.

Research

Conducting research in various aspects of forest management and how to best maintain and restore the forested and aquatic ecosystems is a priority of the Conservancy. The prmary research question being address is one of strategy effectiveness – does our method(s) of timber harvest increase species diversity; and which type of harvests produce the most reseeding by the most types of trees. This research question will *only* be conducted on the first four harvests – 414, Spotted-hardwood, Stuart Lake, and Bye-way; all harvests after the first three will proceed using the results and techniques learned. Within the first four harvested stands, vegetation and bird inventory has been taken comparing various harvest techniques to a deferred cut stand. The deferred cut stand is only established for the life of the research and then will be put into appropriate rotation. Treatments studied included gap openings and economic/biologic analysis of several types of harvest intensities.

10-Year Harvest Summary

The summary acres of potential harvest areas shown for the ten year period in Table 7 were derived from forest inventories conducted in the summer of 2006 and the winter of 2007. Based on inventory data, professional foresters made recommendations for each stand for the next year of entry. In addition to stocking levels, the selection of harvest sites was also based the presence of heavy beech bark disease infestation, access features, and the potential for use as demonstration sites. The first harvests are not proposed until 2009 in order to provide time to establish the research component described above.

As Table 7 shows, the proposed harvest areas for the NH type average about 4.7% per year of this forest type (based on 10 year total of 2116 acres out of 4490 total NH acres). With estimated removal of 30% of volume from those acres, approximately 1.6% of the hardwood volume would be removed in a given year. With average hardwood growth estimated to be 2.5% per year in the region, this harvest plan still stays well below the expected growth. Actual harvest volumes will be closely tracked to ensure sustainable harvests are not being exceeded.

The detailed stand maps which display the specific harvest areas summarized in Table 7 are not included in this plan, but they are available upon request.

Table 7. Tentative 10-year harvest plan by Compartment, subject to modification based on beech mortality and research design. Total stand acres shown.

	Comp 1	**Comp 2**	**Comp 3**	**Comp 4**	**Totals**
2009	0	0	38	230	268
2010	145	108	0	0	253
2011	0	186	59	0	245
2012	0	0	154	14	168
2013	0	0	199	0	199
2014	0	0	180	196	376
2015	275	0	0	192	467
2016	0	149	0	0	149
2017	0	102	83	64	249
2018	168	177	544	0	889
Totals	**588**	**722**	**1303**	**682**	**3295**

Literature Cited

Albert, Dennis A. (1995.) *Regional landscape ecosystems of Michigan, Minnesota, and Wisconsin: a working map and classification*. (Gen. Tech. Rep. NC-178.) St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. Jamestown, ND: Northern Prairie Wildlife Research Center Online. http://www.npwrc.usgs.gov/resource/habitat/rlandscp/index.htm (Version 03JUN1998).

Bryan, R.R. (2003.*) Long-Term Impacts of Timber Harvesting on Stand Structure in Northern Hardwood and Spruce-Fir Forests: Implications for Biodiversity and Timber Production.* Report to Maine Audubon.

Burger T.L., and J. Kotar. (2003.) *A Guide to Forest Communities and Habitat Types of Michigan.* Madison, Wisconsin: University of Wisconsin-Madison Press.

Comer, P.J., D.A. Albert, H.A. Wells, B.L. Hart, J.B. Raab, D.L. Price, D.M. Kashian, R.A. Corner, and D.W. Schuen. (1995.) [Map] *Michigan's Presettlement Vegetation, as Interpreted from the General Land Office Surveys 1816 – 1856.* Retrieved from Michigan Natural Features Inventory, Lansing, MI.

Huckins, C.H. and A. Burgess. (2004.) *The Influence of Forest Management on Stream Communities in the Upper Peninsula of Michigan.* Lansing, MI: Michigan Department of Environmental Quality, Office of the Great Lakes Report to Michigan &Great Lakes Protection Fund.

Keddy, P.A. and C.G. Drummond. (1996.) Ecological Properties for the Evaluation, Management and Restoration of Temperate Deciduous Forest Ecosystems. *Ecological Applications, 6,* 748 – 762.

Keeton, W.S. (2006.) Managing for late-successional/old-growth characteristics in northern hardwood-conifer forests. *Forest Ecology and Management, 235,* 129-142.

LANDFIRE. (2005.) Rapid Assessment Reference Condition Model completed by Dave Cleland, Jim Merznich and Linda Parker. Retrieved from http://www.landfire.gov/zip/GL/R6NHHEgl.pdf.

Mattei, L. and E. Rice. (1995.) *Two Hearted River Landscape Ecosystem Conservation Plan*. [Draft 2] Lansing, Michigan: The Nature Conservancy in Michigan.

Michigan Department of Natural Resources. (2002.) *Two Hearted River Natural River Plan.* Revised March 2002.

Price, D.L. (1994.) *An ecological study of the composition, structure, and disturbance regimes of the preEuropean settlement forests of western Chippewa County, Michigan*. (Dissertation). Michigan State University, East Lansing, MI.